

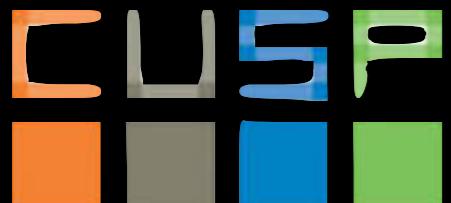
# Principles of Urban Informatics

Fall 2017

dr. federica bianco [fbianco@nyu.edu](mailto:fbianco@nyu.edu)



@fedhere



# Principles of Urban Informatics

Dr. federica bianco [fbianco@nyu.edu](mailto:fbianco@nyu.edu)

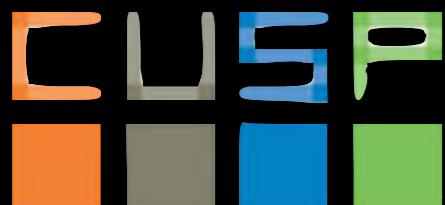
Office hours: Tue/Wed 3:00-5:00

Office: CUSP 1928, NYU Physics 726 Broadway 1054

TAs:

Vamsi Ramineedi (morning) [vmr286@nyu.edu](mailto:vmr286@nyu.edu)  
office hours: M10-12/W1-2

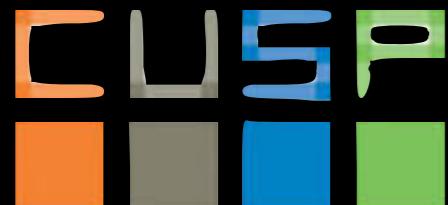
Aishwarya Das (evening) [aishwarya.das@nyu.edu](mailto:aishwarya.das@nyu.edu)  
office hours: M12-2/Th2-3

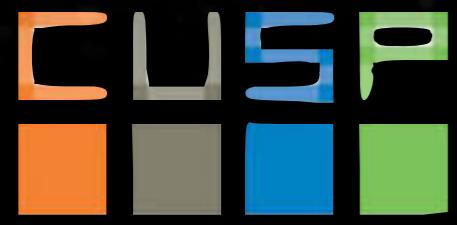


# Principles of Urban Informatics

Dr. federica bianco [fbianco@nyu.edu](mailto:fbianco@nyu.edu)  
astrophysicist

[http://blogs.teradata.com/international/  
sciences-loss-gain-data-science/](http://blogs.teradata.com/international/sciences-loss-gain-data-science/)

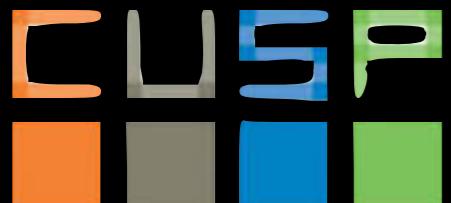




Urban Observatory

# Principles of Urban Informatics

Class website:  
[serv.cusp.nyu.edu/~fbianco/PUI2017](http://serv.cusp.nyu.edu/~fbianco/PUI2017)

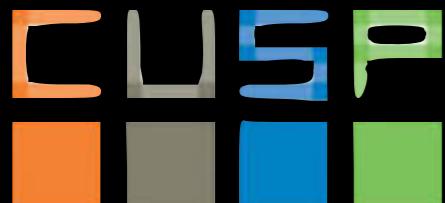


# Principles of Urban Informatics

Class: 3 hours, lecture + lab

Grade

- 5% on pre-class question
- 10 % class performance and participation
- 25 % homework
- 25 % midterm
- 35 % final



This repository Search Pull requests Issues Gist

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No description or website provided. — Edit

61 commits 1 branch 0 releases 1 contributor

Branch: master New pull request Create new file Upload files Find file Clone or download

 fedhere committed on GitHub Update README.md Latest commit a183019 2 minutes ago

 HW1\_fb55 Update README.md 21 hours ago

 Lab1\_fb55 Delete github\_create\_repo\_cmds.md 21 hours ago

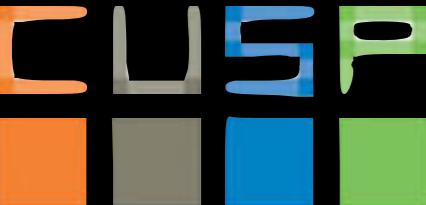
 PEP8MinimalRequirements.md Update PEP8MinimalRequirements.md an hour ago

 README.md Update README.md 2 minutes ago

 README.md

# Class: 3 Grade

- 5%
- 10
- 25
- 25
- 35



## PUI2016\_fb55

This repository contains the assignments for NYU CUSP Principles of Urban Informatics 2016. Check here for the new assignments, and for the solutions to be posted.

### GRADING GUIDELINES

- Each HW must be turned in as a directory in PUI2016\_<netID>.
- The directory HW<hw\_number>\_<netID> must have a README.md which states the student's participation. No penalty if the student declares not to have had any contribution but to have just followed and learned. However missing the README.md, missing the statement about who the student worked with and what they did, or inconsistencies between the statements of students within the group that cannot be easily reconciled by asking will cost them 10% of the grade.
- Each assignment turned in as a notebook must have rendered plots with axis labels and captions. Each missing/non rendered plot, or plot without axes labels or caption will cost 10% of the grade.
- The notebook must be executables: the TA must download the notebook and run it cell by cell without errors. If

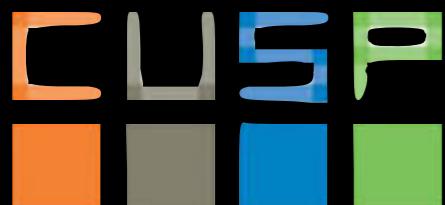
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- 25 % midterm
- 35 % final

*from beginning of class to 5 minutes past the hour (be on time!)  
questions on previous class material AND READING ASSIGNMENTS*



# Principles of Urban Informatics

Class: 3 hours, lecture + lab

Grade

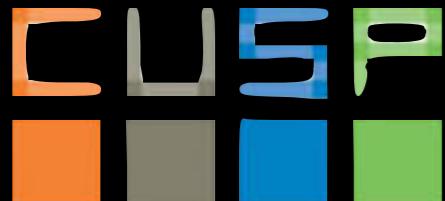
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- 35 % final

ask questions

answer questions

get up and code

extra credit assignments



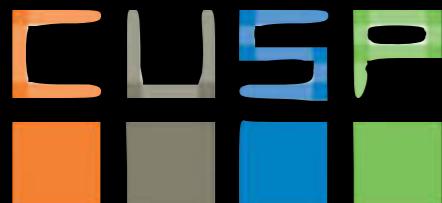
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Homework projects must be turned in as iPython notebooks by checking them into your github account in the PUI2017\_<netID> repo and the project directories HW<hw number>\_<netID> (unless otherwise stated). <nyuid> is e.g. fb55



# Principles of Urban Informatics

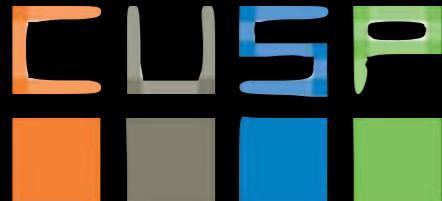
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- 35 % final

**I encourage you to work in groups!** but as a collaborative project where different group members lead different aspects of the work.

**A statement to describing your contribution to the project MUST be included in the README (a la Nature Magazine).**



# Light echoes reveal an unexpectedly cool η Carinae during its nineteenth-century Great Eruption

A. Rest, J. L. Prieto, N. R. Walborn, N. Smith, F. B. Bianco, R. Chornock, D. L. Welch, D. A. Howell, M. E. Huber, R. J. Foley, W. Fong, B. Sinnott, H. E. Bond, R. C. Smith, I. Toledo, D. Minniti & K. Mandel

Affiliations Contributions

*Nature* 482, 375–378 (16 Feb 2012); doi:10.1038/nature10783  
Received 26 August 2011 / Accepted 11 January 2012 / Published online 1 February 2012  
**Brief Communication Arising from: The light echo of the 1834 eruption of η Carinae**

**Contributions**

All authors contributed to the drafting of the paper. A.R., N.S. and R.C.S. imaged the area around η Car. A.R. and M.E.H. reduced the imaging data. H.E.B. provided images of the echoes that guided our spectroscopic pointings. J.L.P., R.C., R.J.F. and W.F. obtained the spectra and reduced them. A.R. and J.L.P. performed spectral analysis and interpretation. A.R., N.R.W. and F.B.B. performed spectral classification. F.B.B. and K.M. correlated the spectra. A.R., D.L.W. and B.S. modelled the light echo. I.T. and D.M. provided imaging of η Car. F.B.B. and D.A.H. provided the FTS images, and F.B.B. and A.R. reduced them.

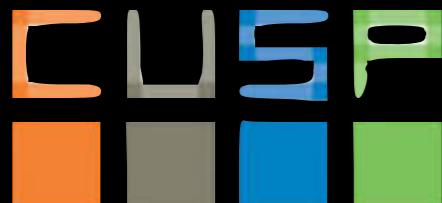
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# Example of a README.md for a PUI homework: missing the README.md costs you 10% of the grade!

The README.md is a MarkDown (md) file. The syntax of a MarkDown is rather simple: <https://github.com/adam-p/markdown-here/wiki/Markdown-Cheatsheet>. Also the MD syntax can be used in Jupyter notebook cells to include text (not code) that is automatically formatted (which you will need to do over and over...)

## CitiBike HW - v1

### Question

Are CitiBike's easing commuter journeys across the East River?

### Hypothesis

- H0: The probability of a citibike subscriber crossing the East River in a given month is independent of whether the trip is taken during rush hour
- H1: The probability of a citibike subscriber crossing the East River in a given month is not independent of whether the trip is taken during rush hour

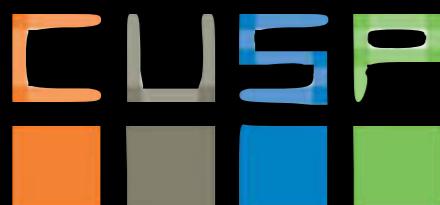
### Project work balance

#### hypothesis generation

Max, Arno, Clayton discussed and equally shared hypothesis generation. Max had the original idea of looking at bridges as he is an avid CitiBike user

#### Tasks

1. Clayton is tagging trips as cross east river or not
2. Max is defining historic hours as "on peak" or "not on peak"
3. Arno completes a chi-square test of our hypothesis



# Principles of Urban Informatics

Class: lecture + lab

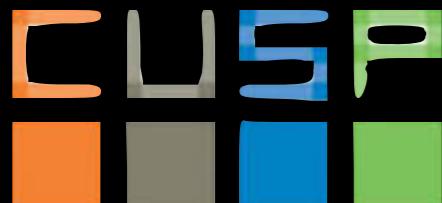
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After the midterm, projects will be code-reviewed by your peers.

We'll have 1 multi-week homework project from proposal to peer review.

<https://blog.fogcreek.com/increase-defect-detection-with-our-code-review-checklist-example/>

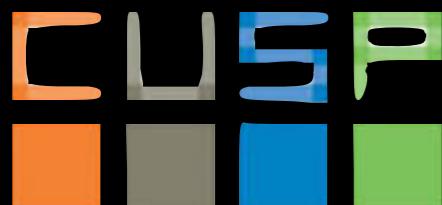


**Midterm and Final will include aspects of the work developed in the homework sessions.** Failing to actively participate in the homework will result in not being able to get the Midterm and Final done.

Class: lecture + lab

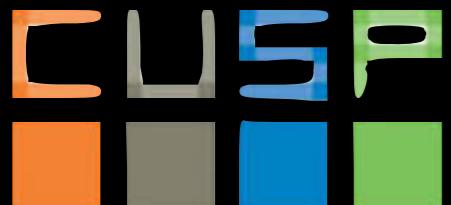
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# Principles of Urban Informatics

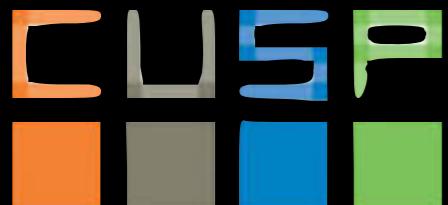
## GOALS



# Principles of Urban Informatics

GOALS

*turn all of you into data-driven scientists*



- IDEA The workflow of a data driven project
- dataset
  - define ideal data
  - figure out best data available
  - figure out if you can get new data
  - obtain data (including policy issues + technical issues)
- data handling
  - joining databases
  - formatting data
- exploratory data analysis
  - machine learning (clustering? dimensionality reduction?)
- statistics/machine learning
  - models (regression)
  - prediction
  - validation (simulations)
- interpretation
- presentation
  - visualization
  - paper or report

I: Good scientific practice  
& work flow

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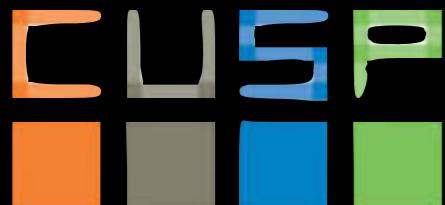
I: Good scientific practice  
& work flow

# Principles of Urban Informatics

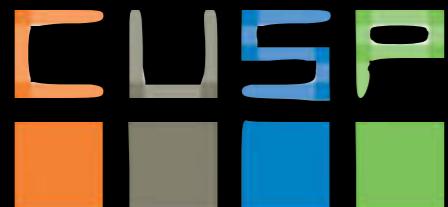
## GOALS

*turn all of you into data-driven scientists*

- understand how a project is managed
- familiarize with tools to extract information from data
- learn how to interpret statistical conclusions from data
- learn how to communicate statistical conclusions from data

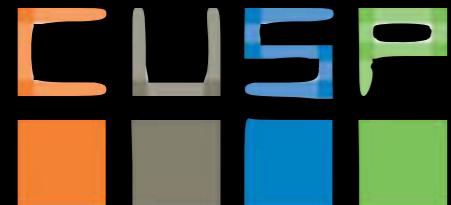


# *The philosophical side of things*



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& work flow

# what is a scientific theory?

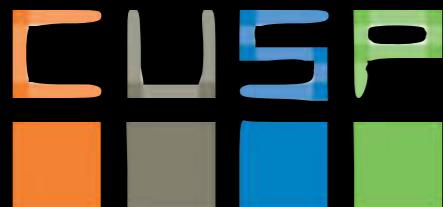


I: Good scientific practice  
& work flow

## The Demarcation Problem: a scientific theory must be *falsifiable*

My proposal is based upon an *asymmetry* between verifiability and falsifiability; an asymmetry which results from the logical form of universal statements. For these are never derivable from singular statements, but can be contradicted by singular statements.

— Karl Popper, *The Logic of Scientific Discovery*



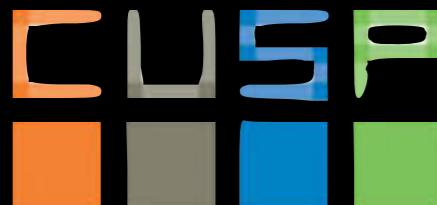
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— Karl Popper, *The Logic of Scientific Discovery*

things can get more complicated though:

most scientific theories are actually based largely on *probabilistic induction* and modern *inductive inference* (Solomonoff, frequentist vs Bayesian methods...)



**Ockham's razor: *Pluralitas non est ponenda sine necessitate***

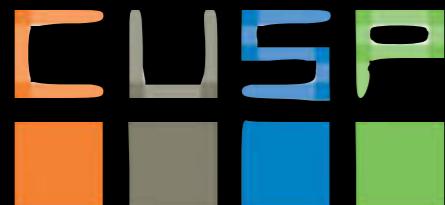
or “the law of parsimony”

William of Ockham (logician and Franciscan friar) 1300ca

but probably to be attributed to John Duns Scotus (1265–1308)

“Complexity needs not to be postulated without a need for it”

“Between 2 theories choose the simpler one”



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& work flow

the earth is round, and it orbits around the sun



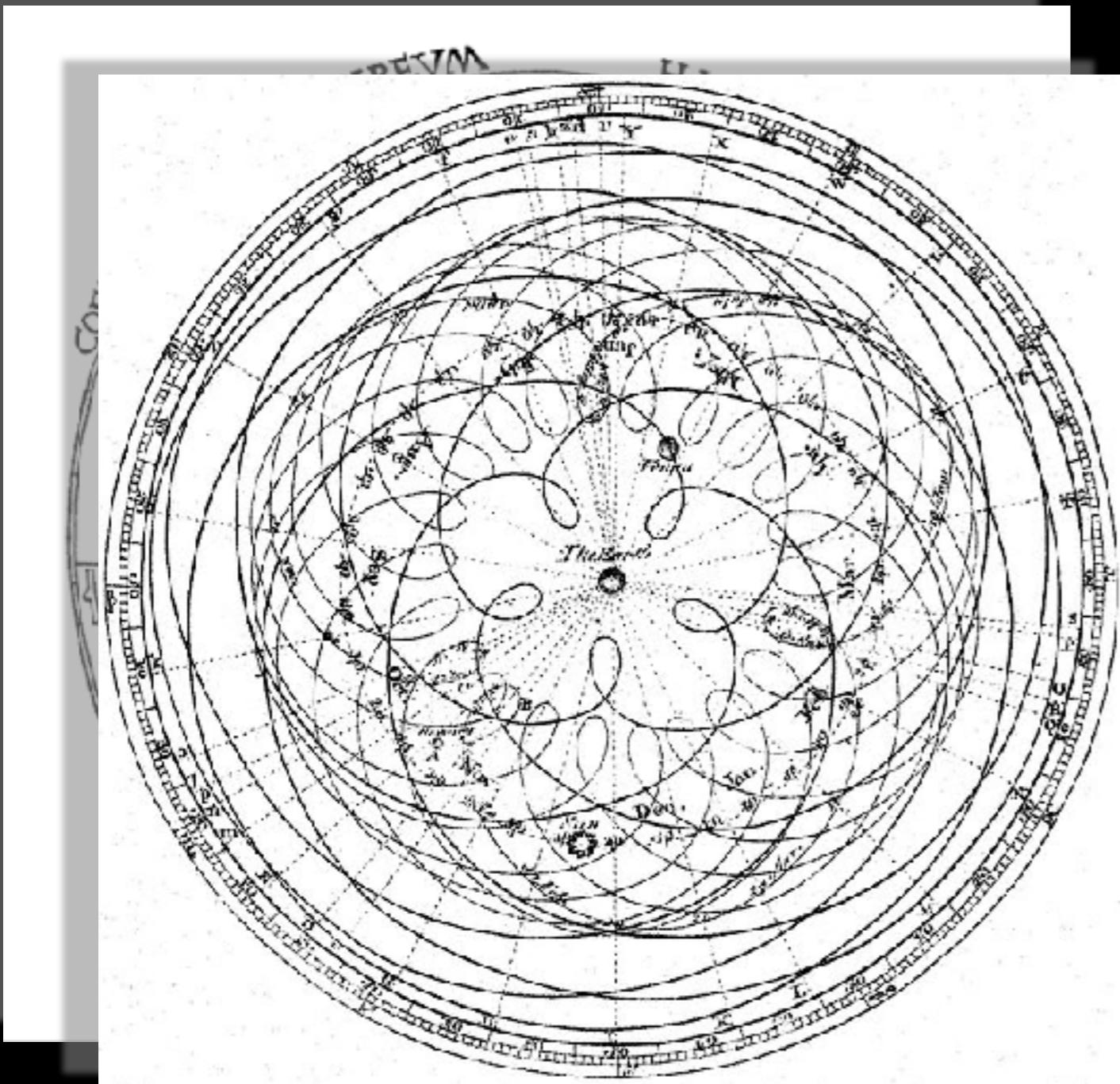
<http://en.wikipedia.org/wiki/File:Ptolemaicsystem-small.png>

Peter Apian, *Cosmographia*, Antwerp, 1524

from Edward Grant, "Celestial Orbs in the Latin Middle Ages", *Isis*, Vol. 78, No. 2. (Jun., 1987).

Geocentric models are natural:  
from our perspective  
we see the Sun moving, while we stay still

the earth is round, and it orbits around the sun



Source Encyclopaedia Britannica 1st Edition  
Author Dr Long's copy of Cassini, 1777

As observations improve  
this model cannot fit  
the data anymore!  
not *easily* anyways...

the earth is round, and it orbits around the sun

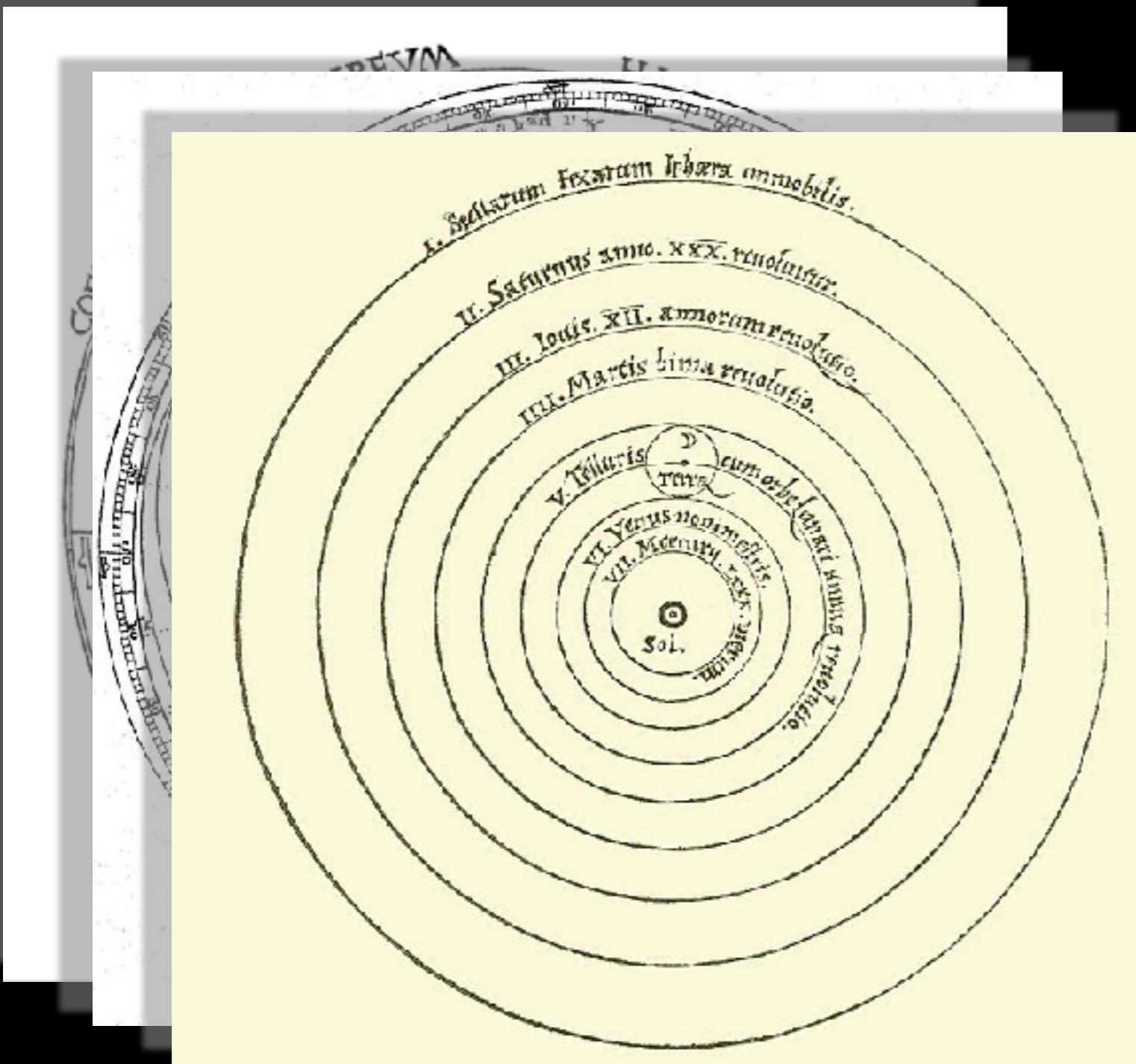


Image of heliocentric model from Nicolaus Copernicus' "De revolutionibus orbium coelestium".

A new model that is much simpler fit the data just as well (perhaps though only until better data comes...)

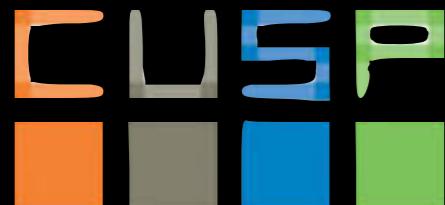
# Ockham's razor: *Pluralitas non est ponenda sine necessitate* or the law of parsimony

William of Ockham (logician and Franciscan friar) 1300ca

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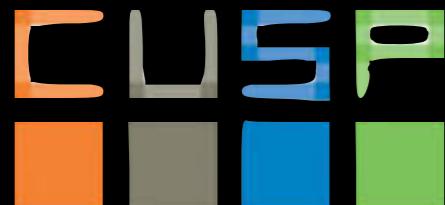


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“Complexity needs not to be postulated without a need for it”

“Between 2 models choose...”

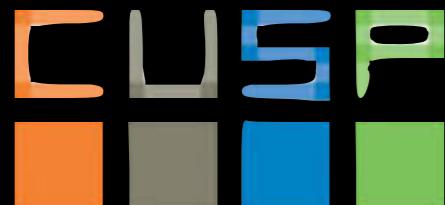


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William of Ockham (logician and Franciscan friar) 1300ca  
but probably to be attributed to John Duns Scotus (1265–1308)

“Complexity needs not to be postulated without a need for it”

“Between 2 models choose the one with fewer parameters!”



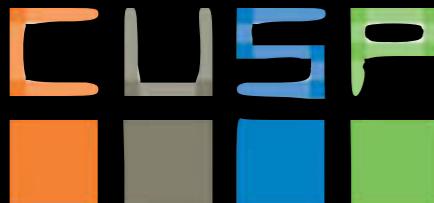
What is the question?

*the data speaks, if you know how to listen...*

Leek&Rodgers 2015 in Science

<http://www.sciencemag.org/content/347/6228/1314.full.pdf>

<https://www.d.umn.edu/~kgilbert/ened5560-1/The%20Research%20Question-2015-Leek-1314-5.pdf>



I: Good scientific practice  
& work flow

# What is the question?

## STATISTICS

# *What is the question?*

Mistaking the type of question being considered is the most common error in data analysis

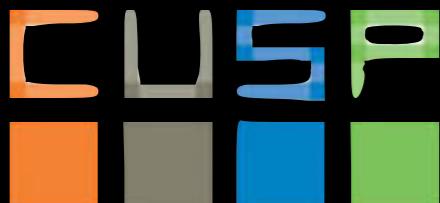
By Jeffery T. Leek and Roger D. Peng

Jeffrey T. Leek and Roger D. Peng

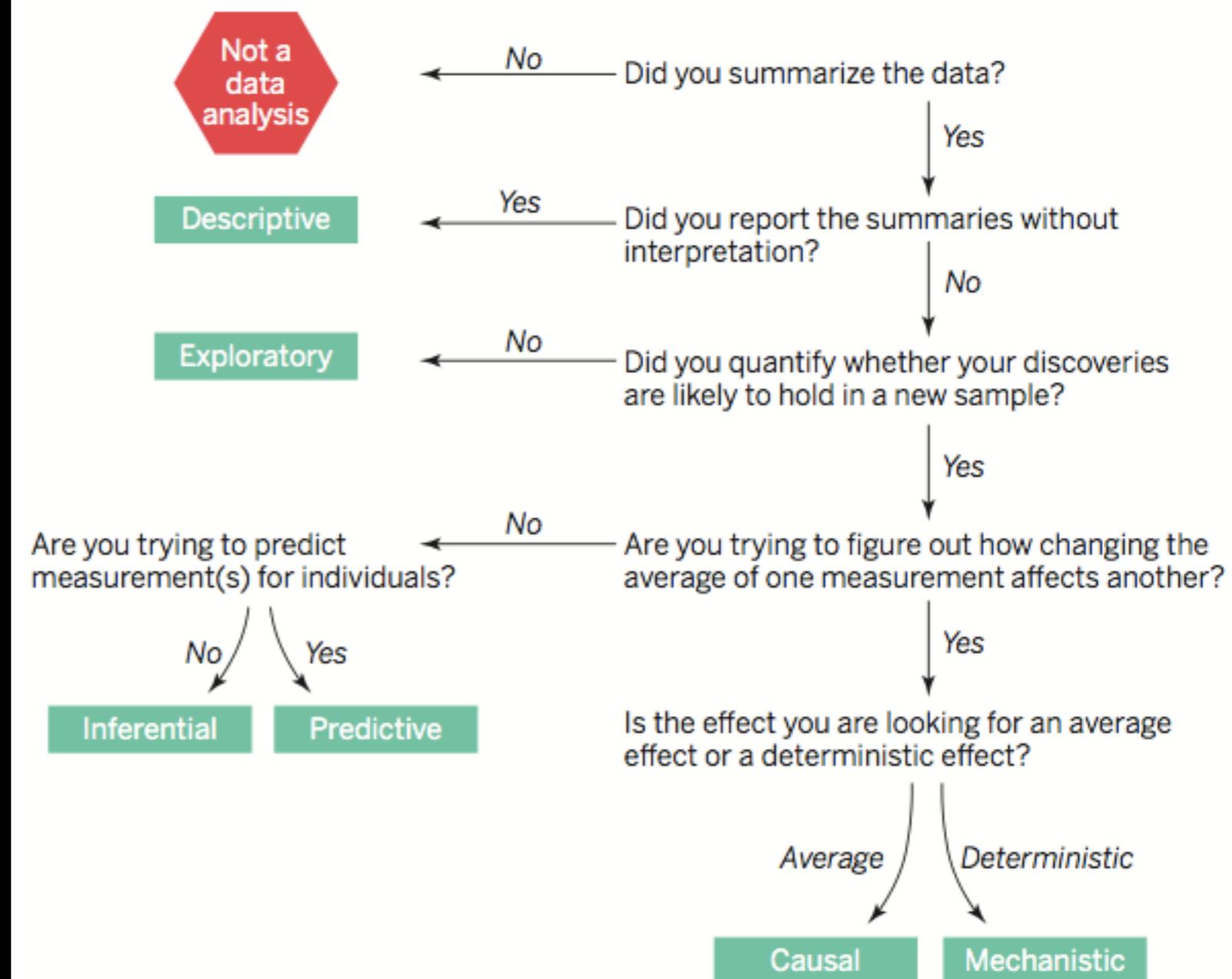
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<https://www.d.umn.edu/~kgilbert/ened5560-1/The%20Research%20Question-2015-Leek-1314-5.pdf>

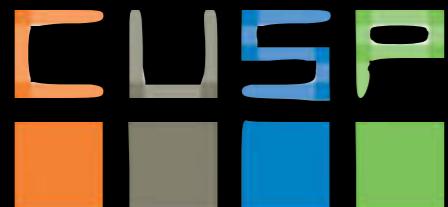


## Data analysis flowchart



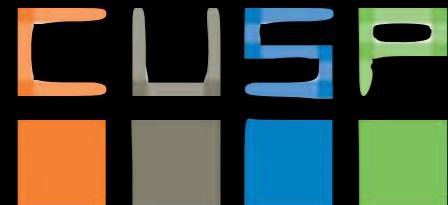
I: Good scientific practice & work flow

# *The practical side of things*



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& work flow

# workflow: your environment



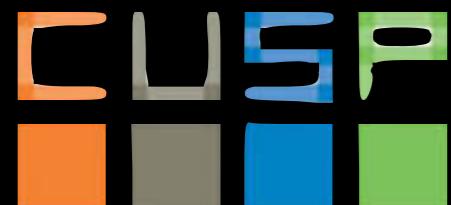
I: Good scientific practice  
& work flow

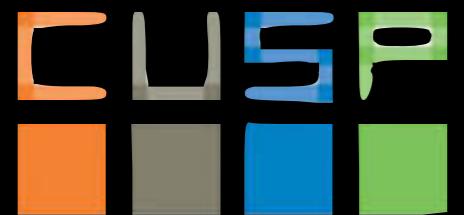
# Operating System:

Android, BlackBerry, BSD, Chrome OS, OS X, iOS, QNX, Linux  
Steam OS

Microsoft Windows, Windows Phone, and z/OS.

FreeRTOS, Micrium, and VxWorks





I: Good scientific practice  
& work flow

# Operating System:

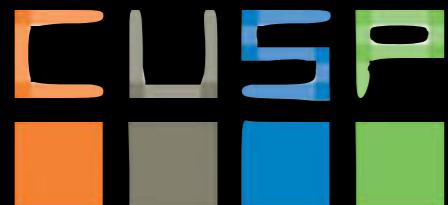
Android, BlackBerry, BSD, Chrome OS, OS X, iOS, QNX, Linux  
Steam OS



Where there is a shell, there is a way.

Microsoft Windows, Windows Phone, and z/OS.

FreeRTOS, Micrium, and VxWorks



I: Good scientific practice  
& work flow

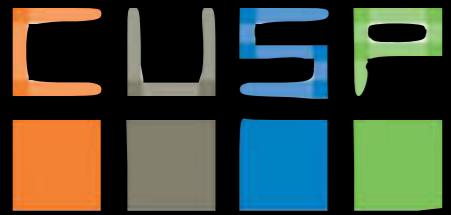
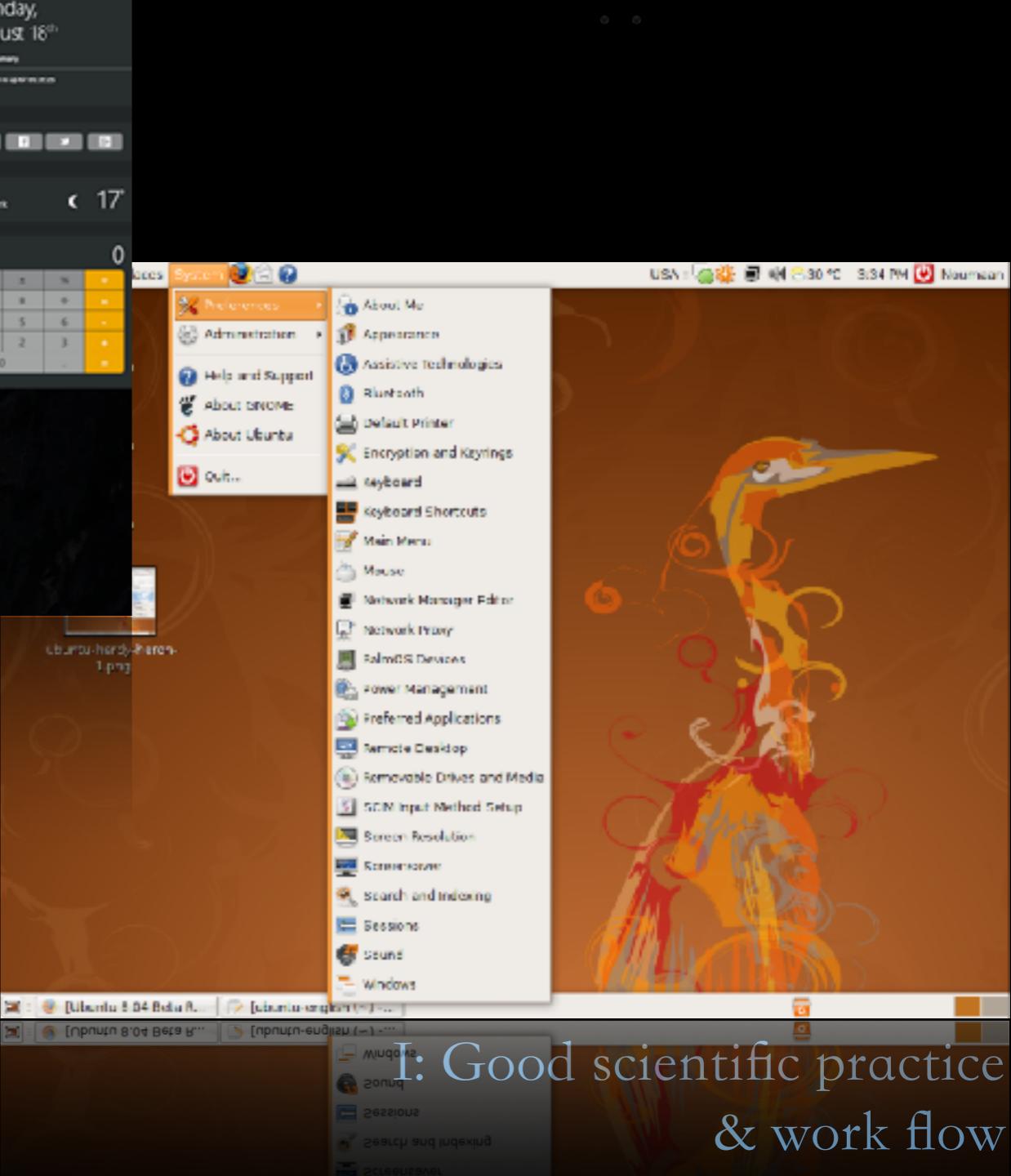
# Operating System:

OS X



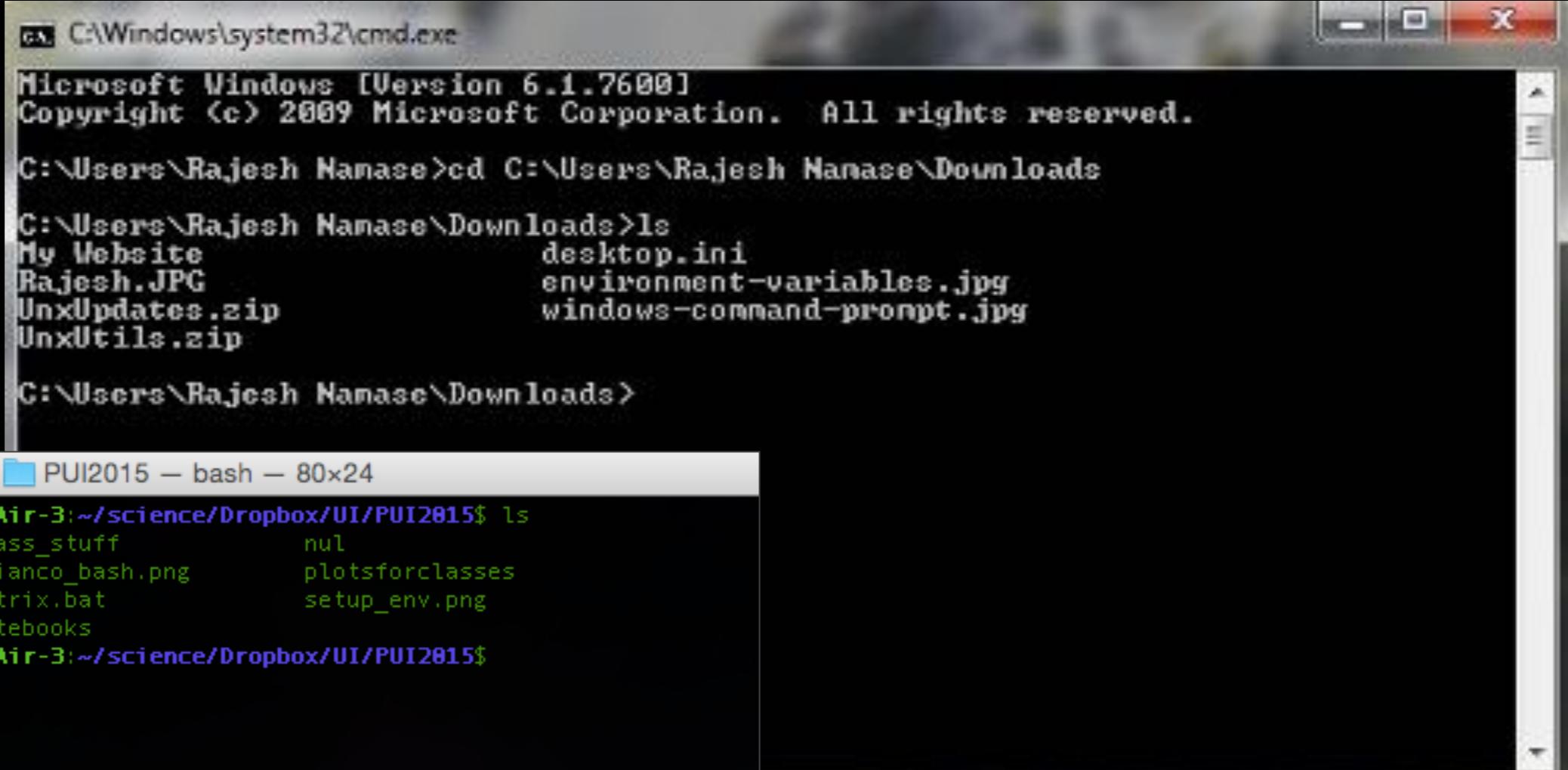
Linux **UNIX**

Where there is a shell, there is a way.



I: Good scientific practice  
& work flow

# Operating System:

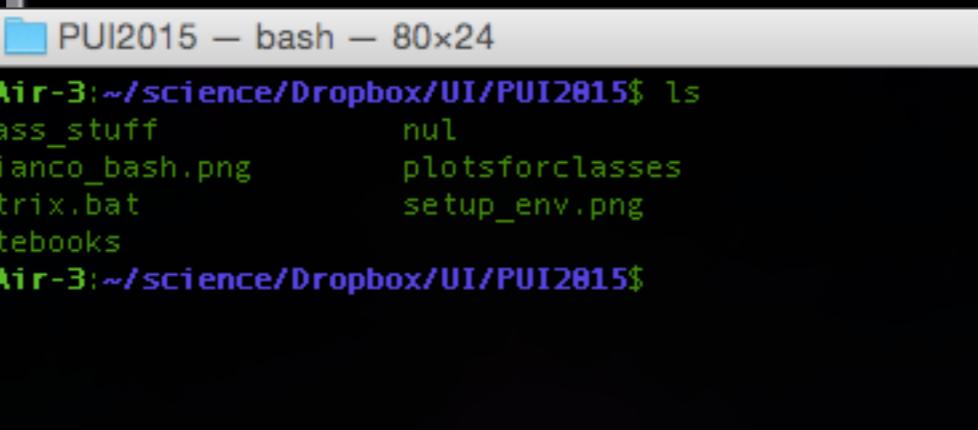


```
C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.1.7600]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\Rajesh Namase>cd C:\Users\Rajesh Namase\Downloads

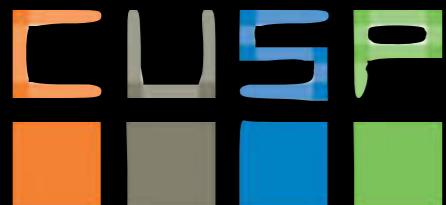
C:\Users\Rajesh Namase\Downloads>ls
My Website                               desktop.ini
Rajesh.JPG                                environment-variables.jpg
UnxUpdates.zip                           windows-command-prompt.jpg
UnxUtils.zip

C:\Users\Rajesh Namase\Downloads>
```

```
PUI2015 – bash – 80x24
fbianco@Federicas-MacBook-Air-3:~/science/Dropbox/UI/PUI2015$ ls
CityChallenge      class_stuff        nul
PUI2015labs        fbianco_bash.png   plotsforclasses
README.md          matrix.bat       setup_env.png
class_slides       notebooks
```

<https://speakerdeck.com/62gerente/bash-introduction>



I: Good scientific practice  
& work flow

# You have a *bash* shell on Compute (which is Linux)

- and you have access to compute via ssh

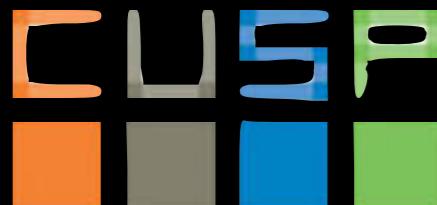
```
ssh -X -A -t cuspid@gw.cusp.nyu.edu ssh -A -X compute
```

- or in the Green Environment of the CUSP data facility via remote desktop

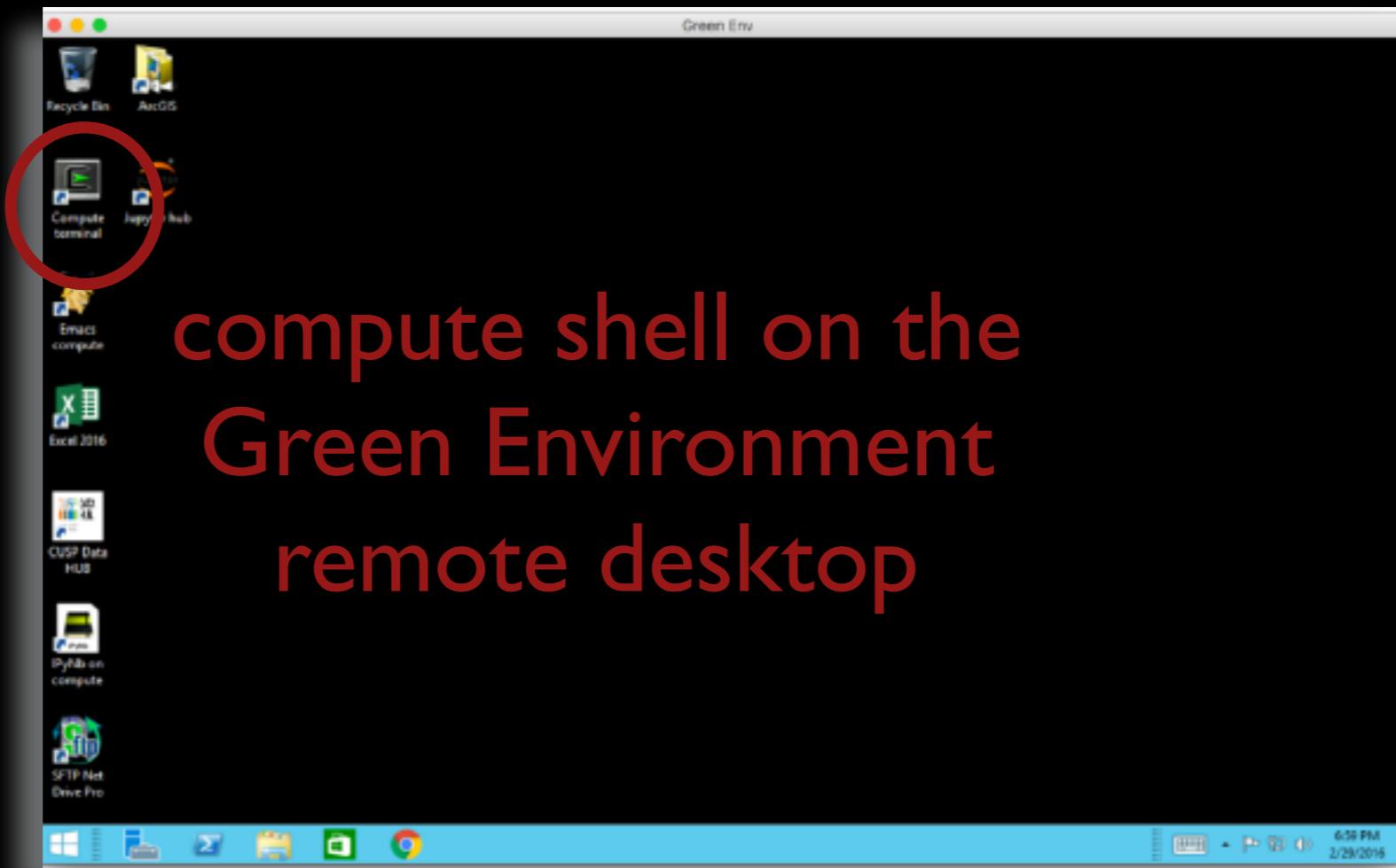
```
ssh cuspid@gw.cusp.nyu.edu -L9000:wingrdp.cusp.nyu.edu:3389
```

followed by remote desktop to localhost:9000

<https://datahub.cusp.nyu.edu/connect-data-facility>

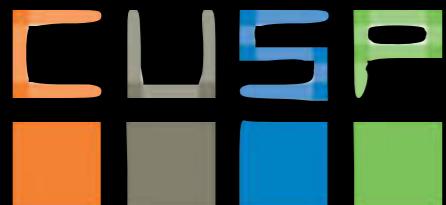


# You have a *bash* shell on Compute (which is Linux)



compute shell on the  
Green Environment  
remote desktop

Remote desktop acces in Green environmen



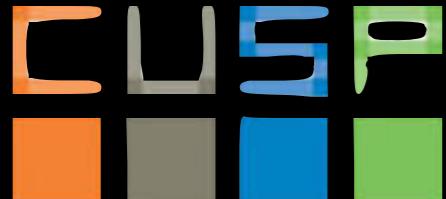
I: Good scientific practice  
& work flow

Operating System:

# Shell commands & Environmental variables demo



<https://speakerdeck.com/62gerente/bash-introduction>



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# Operating System:

## Shell commands & Environmental

### variables demo

pwd  
ls  
mkdir  
cd  
touch  
cp  
mv  
rm  
less  
echo  
head/tail  
top  
ps  
bg  
chmod  
chown  
grep

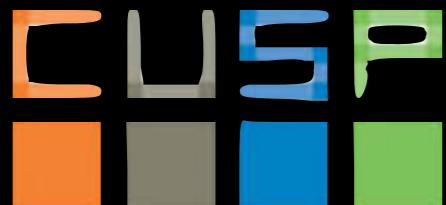
ssh  
scp  
rsync  
df  
du

alias  
export  
Wildcards

### essential commands

**I/O Redirection**  
**Standard Output**  
**Standard Input**  
**Pipes**  
**Listing your processes**  
**Killing a process**

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**getting to Code:**

**Python, iPython, iPython notebooks**

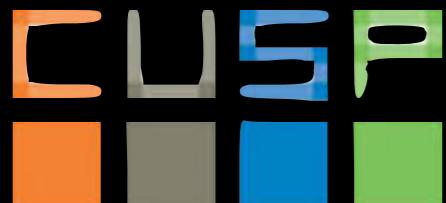
**You should be fluent in *at least Python or R***

**to be competitive on the job market**

**In this class we will only work in Python.**

**All homework should be developed in**

**python and delivered through github.**



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# getting to Code: Python, iPython, iPython notebooks

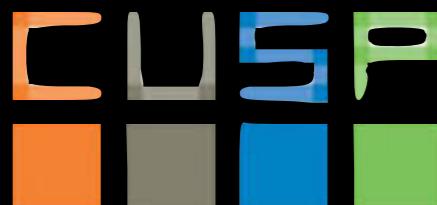
Python 2.7 vs Python 3.0

I will write in Python2.7 for compatibility (e.g. GeoPandas)

I will use the future package

```
from __future__ import print_function  
__author__ = "Federica B. Bianco, CUSP NYU 2016"
```

to make the code forward compatible with Python 3.0  
(though some lines of code may be broken in Python 3.0)



# Choosing a text Editor: Integrated or not?

**vi, nano:** basic, no-window “light weight” editors

**Emacs:** “extensible, customizable, self-documenting real-time display editor”

customizable via the .emacs file

can be run without tunneling with `emacs -nw`

the command sequences are tricky (customize emacs for python

<https://realpython.com/blog/python/emacs-the-best-python-editor/>)

**PyCharm, Sublime, Brakets:** Integrated Development

Environment: checks syntax and standard compliancy

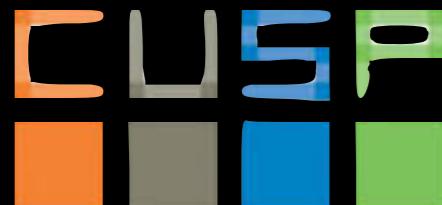
can be run directly within the developing window

recognizes the syntax for other codes (Django)

integrated with version control

**Jupyter Notebooks:** Browser-based interactive computational

environment



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# Choosing a text Editor: Integrated or not?

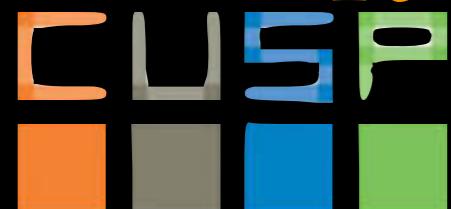
vi:

Emacs:

PyCharm:

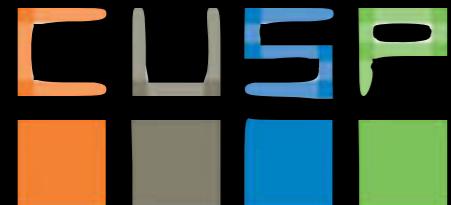
demo time!

Jupyter Notebooks:



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# reproducible research

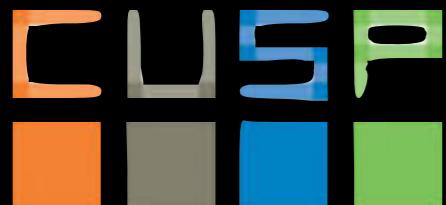


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## Reproducible research means:

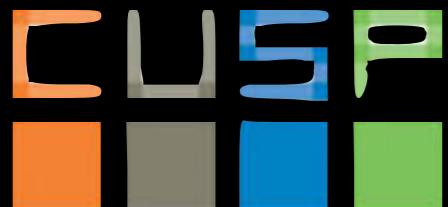
all numbers in a data analysis can be recalculated exactly (down to stochastic variables!) using the **code** and **raw data** provided by the analyst.

Claerbout, J. 1990,  
Active Documents and Reproducible Results, Stanford Exploration Project  
Report, 67, 139



# Reproducible research means:

code      raw data



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& work flow

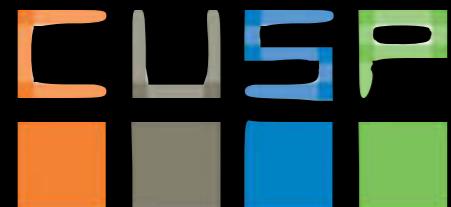
# Reproducible research means:

code

raw data



<https://github.com/>



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& work flow

## Reproducible research means:

code

raw data



<https://github.com/>

distributed version control system:  
a version of the files on your local computer is  
made also available at a central server.  
The history of the files is saved remotely so  
that any version (that was checked in) is  
retrievable.

Others can access and generate their versions  
of the files enabling collaborative work.

# Reproducible research means:

code

raw data



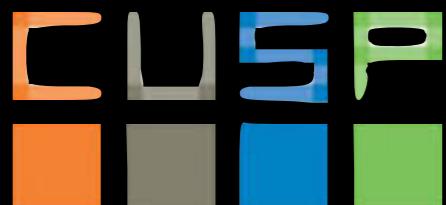
other version control systems:  
RCS

CVS (Centralized version control system)  
Subversion  
SVN

Git (<https://github.com>)

Mercurial (<https://bitbucket.org/>)

<https://git-scm.com/book/en/v2/Getting-Started-About-Version-Control>



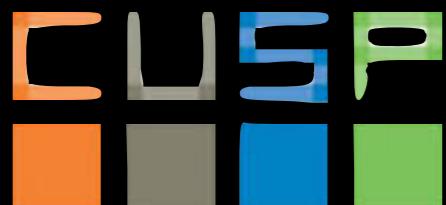
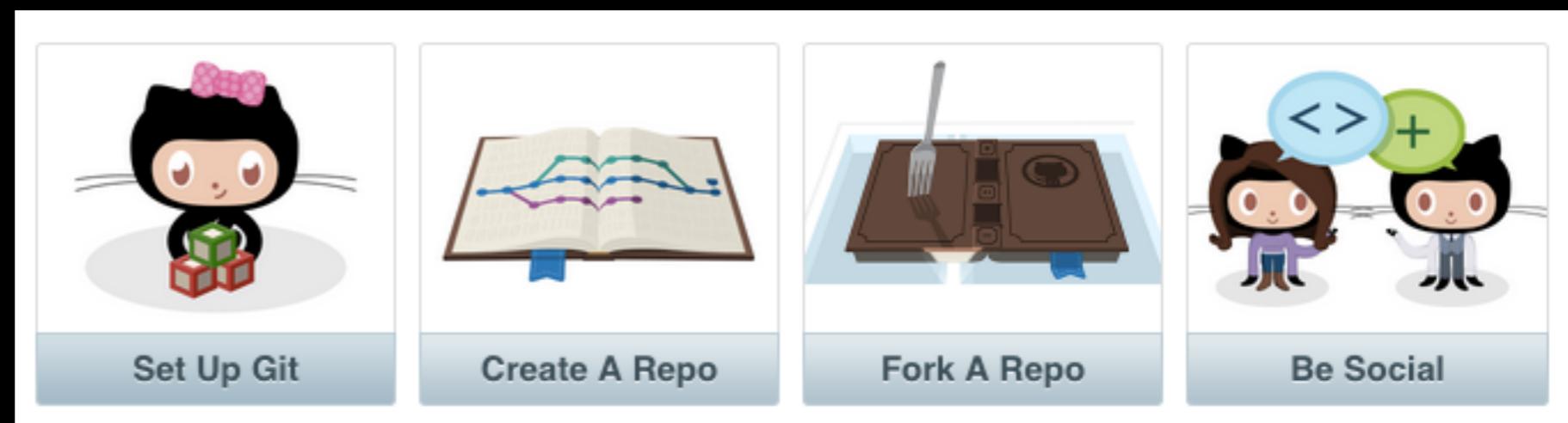
# Reproducible research means:

code

raw data



<https://github.com/>



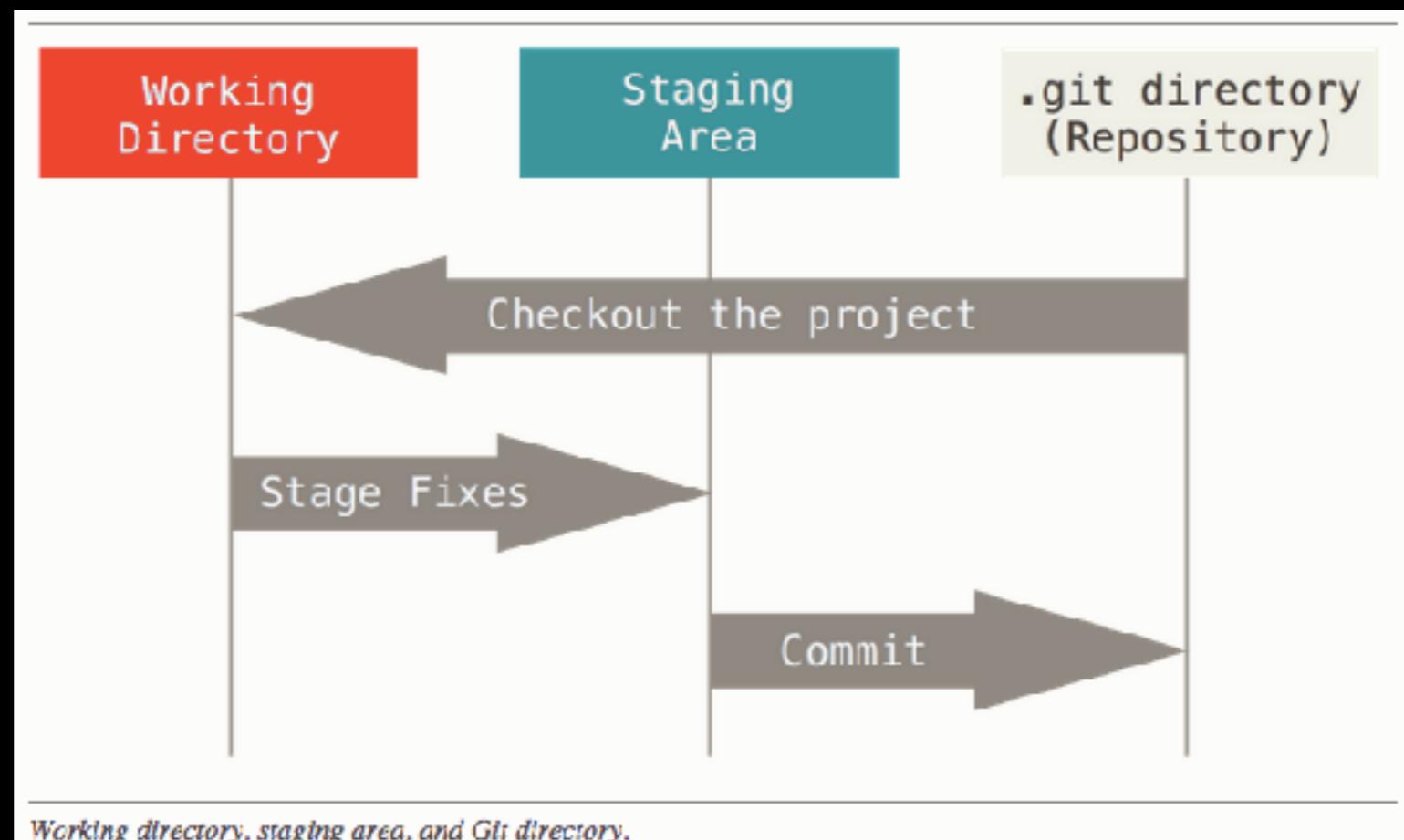
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# Reproducible research means:

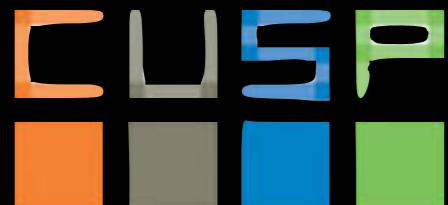
code      raw data



<https://github.com/>



*Working directory, staging area, and Git directory.  
Working directory, staging area and Git directory.*



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# Reproducible research means:

code

raw data



<https://github.com/>

markdowns & standards:

**in order for your research to be  
reproducible it has to be understandable:**

- Paper or slides
- Repository Markdown files
- Understandable (PEP8 compliant) code -  
explicit declare the version of the code!

# Reproducible research means:

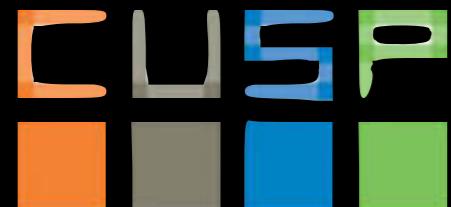
code

raw data



<https://github.com/>

markdowns & standards:



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& work flow

# Reproducible research means:

code

raw data



<https://github.com/>

markdowns & standards:



The screenshot shows a GitHub repository page for 'fedhere / PUI2017\_fb55'. The repository has one branch, 'master', which contains a single file named 'githubCreateRepoCmds.md'. The file's content is as follows:

```
This is a markdown file guiding you through the very first steps to create and manage a git repo with github.

Let's start on your bash shell

Create a directory

$ touch myfirstrepo

$ cd myfirstrepo

$ git init

$ touch index.html

$ git add index.html

$ git commit -m "Initial commit"

$ git status

# On branch master

# Initial commit

# Untracked files:
#   (use "git add" to include in versioning)

#       index.html

nothing added to commit but untracked files present (use "git add" to track)

$ cd ..

$ ls

myfirstrepo

$ cd myfirstrepo

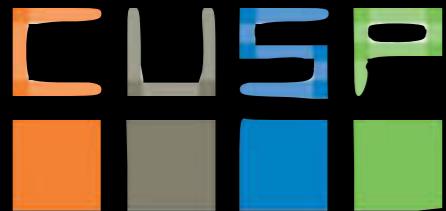
$ git status

# On branch master

# Your branch is up-to-date with 'origin/master'.

# nothing to commit, working directory clean
```

[https://github.com/fedhere/PUI2017\\_fb55/blob/master/Lab1\\_fb55/githubCreateRepoCmds.md](https://github.com/fedhere/PUI2017_fb55/blob/master/Lab1_fb55/githubCreateRepoCmds.md)



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# Reproducible research means:

code

raw data



<https://github.com/>

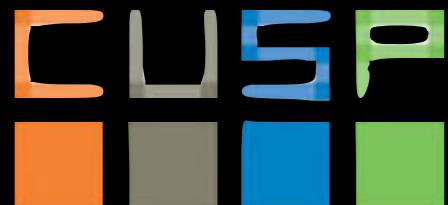
markdowns & standards:



PEP8: Python Enhancement Proposals 8

“This document gives coding conventions for the Python code comprising the standard library in the main Python distribution.”

**Readability counts.**



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# Reproducible research means:

code

raw data



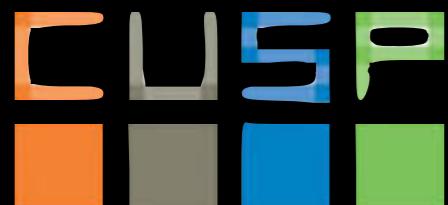
<https://github.com/>

markdowns & standards:



PEP8: Python Enhancement Proposals 8

Indentation, Tabs or Spaces?, Maximum Line Length, Blank Lines, Source File Encoding, Imports, Whitespace in Expressions and Statements, Comments Bookkeeping, Naming



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# Reproducible research means:

code

raw data

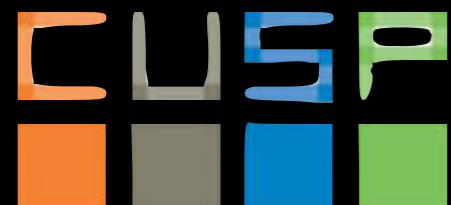


<https://github.com/>



a good video tutorial

[https://www.youtube.com/watch?v=SWYqp7iY\\_Tc](https://www.youtube.com/watch?v=SWYqp7iY_Tc)



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# Reproducible research means:

code

raw data



<https://github.com/>

let's make a repo!

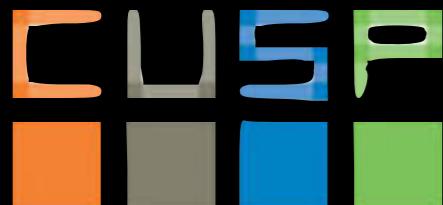


# Reproducible research means:

code      raw data

privacy concerns

in order for your research to be reproducible  
the data you use must be accessible BUT  
THAT IS NOT ALWAYS POSSIBLE:  
CUSP has access to data that has restricted  
access. Share your data when possible!



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& work flow

# Reproducible research means:

code raw data

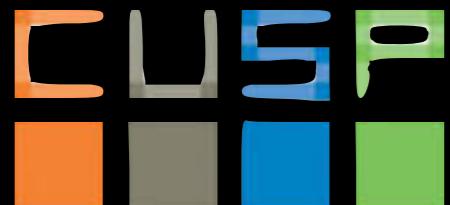
## Remove sensitive data

Some day you or a collaborator may accidentally commit sensitive data, such as a password or SSH key, into a Git repository. Although you can remove the file from the latest commit with `git rm`, the file will still exist in the repository's history. Fortunately, there are other tools that can entirely remove unwanted files from a repository's history. This article will explain how to use two of them: `git filter-branch` and the [BFG Repo-Cleaner](#).

**Danger:** Once you have pushed a commit to GitHub, you should consider any data it contains to be compromised. If you committed a password, change it! If you committed a key, generate a new one.

This article tells you how to make commits with sensitive data unreachable from any branches or tags in your GitHub repository. However, it's important to note that those commits may still be accessible in any clones or forks of your repository, directly via their SHA-1 hashes in cached views on GitHub, and through any pull requests that reference them. You can't do anything about existing clones or forks of your repository, but you can permanently remove all of your repository's cached views and pull requests on GitHub by contacting [GitHub support](#).

<https://help.github.com/articles/remove-sensitive-data/>

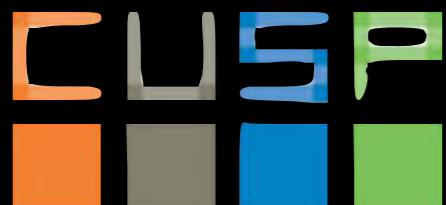


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# Reproducible research:

## How to share your data and work

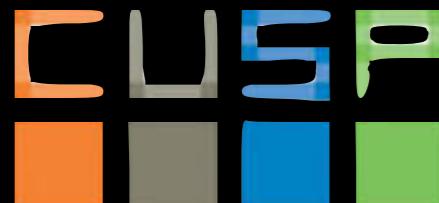
- Share/Reference the source of your raw data
- Share the “tidy” data
- Share the code used to process the data at each step



<https://services.github.com/on-demand/downloads/github-git-cheat-sheet.pdf>

example time:  
make a repo,  
check in and out  
resolve conflicts

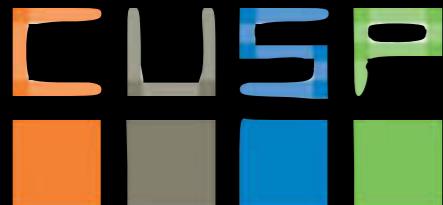
[https://github.com/fedhere/PUI2017\\_fb55/tree/master/Lab1\\_fb55](https://github.com/fedhere/PUI2017_fb55/tree/master/Lab1_fb55)



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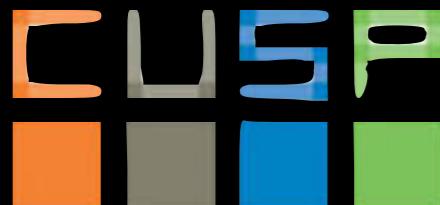
## Key Concepts:

- falsifiability and law of parsimony
- types of scientific questions
- reproducible research
- PEP8 and style standards
  
- understand how to set up your environment
- basic bash commands
- work with github
- creating and checking into github an ipython notebook



## Key Concepts:

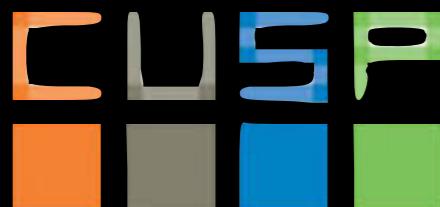
- falsifiability and law of parsimony
- types of scientific questions
- reproducible research
- PEP8 and style standards
  
- understand how to set up your environment
- basic bash commands
- work with github
- creating and checking into github an ipython notebook



## Homework:

[https://github.com/fedhere/PUI2017\\_fb55/blob/master/Lab1\\_fb55/githubCreateRepoCmds.md](https://github.com/fedhere/PUI2017_fb55/blob/master/Lab1_fb55/githubCreateRepoCmds.md)

- 0. On NYU classes's assignment, deliver your GitHub username
- 1. finish and deliver in-class lab on git and GitHub
- 2. set up your PUI environment and deliver screenshots on GitHub
- 3. Extra Credit: create and plot a reproducible “random” distribution



## Resources:

Karl Popper, J. 1934,

**The Logic of Scientific Discovery**

<http://strangebeautiful.com/other-texts/popper-logic-scientific-discovery.pdf>

Jeff Leek & Rodger Peng. 2015,

**What is the Question? ASSIGNED READING**

<http://www.sciencemag.org/content/347/6228/1314.summary>

<moscow.sci-hub.bz/4d3cf57483ccf211f66cad18440023cd/10.1126@science.aaa6146.pdf>

Claerbout, J. 1990,

**Active Documents and Reproducible Results,  
Stanford Exploration Project Report, 67, 139**

[http://sepwww.stanford.edu/data/media/public/docs/sep67/jon2/paper\\_html/](http://sepwww.stanford.edu/data/media/public/docs/sep67/jon2/paper_html/)

Jeff Leek, 2015

**The Elements of Data Analytic Style**

<https://leanpub.com/datastyle> (\$10.00) and <https://github.com/jtleek/datasharing>

Guido van Rossum, Barry Warsaw, Nick Coghlan, 2001

Proposal Enhancement for Python <https://www.python.org/dev/peps/pep-0008/>

