Class 11 - Pandas

[w200] MIDS Python Course

Agenda

Course Schedule

Project 2 - Project Team Coordination (10 minutes)

Data Exploration and Analysis

Project 2 - Team Discussions (as time allows)

Remember the guides for Numpy and Pandas in our resources area:

NumPy Pandas Review Sheet

See the various resources on GitHub!

Schedule

https://docs.google.com/spreadsheets/d/1sVV7-4OHZ-EDNqkMJ55OPUfz_QLJ4LZNuZl-cRaxgVo/edit#gid=0

Python for Data Science: Fall 2018						All due dates are tentative and may be changed by instructors. Homework due dates are 11:59pm PST the night before live session.					
Mon	**Tues**	**Weds**	**Thurs**	**Async Unit**	**Sync Week**	**Async to Review (Prior to Class)**	**Projects (20% each)**	**Exams (10% each)**	**HW Assigned (30% total)**	**HW Due**	**Notes**
Sep 3	Sep 4	Sep 5	Sep 6	1	1	Introduction to Programming, the Command Line, and Source Control			unit 1		A make-up class will be scheduled for Monday class.*
Sep 6									unit 1		[This is the make-up for Monday 4 pm session.]
Sep 10	Sep 11	Sep 12	Sep 13	2	2	Starting Out with Python			unit 2	unit 1	
Sep 17	Sep 18	Sep 19	Sep 20	3	3	Sequence Types and Dictionaries			unit 3	unit 2	9/17/2018 - Last day to add or drop a class
Sep 24	Sep 25	Sep 26	Sep 27	4	4	More About Control and Algorithms			unit 4	unit 3	
Oct 1	Oct 2	Oct 3	Oct 4	5	5	Functions			unit 5	unit 4	
Oct 8	Oct 9	Oct 10	Oct 11	6	6	Complexity	Project 1 Assigned		scrabble	unit 5	
Oct 15	Oct 16	Oct 17	Oct 18	7	7	Classes			unit 7	scrabble	
Oct 22	Oct 23	Oct 24	Oct 25	8	8	Object-Oriented Programming/<text a	Project 1 Final Proposal Due	Exam 1 Start	x	unit 7	
Oct 29	Oct 30	Oct 31	Nov 1	9	9	Working With Text and Binary Data/numpy		Exam 1 Due	x		
Nov 5 - 9 Fall Break & Immersion											
Nov 12	Nov 13	Nov 14	Nov 15	10	10	NumPy	Project 1 Presentations		unit 9 / HW10		A make-up class will be scheduled for Monday Class
Nov 19	Nov 20	Nov 21	**Nov 22**	11	11	Data Analysis With Pandas	Project 2 Assigned		unit 10 / HW11	unit 9 / HW10	A make-up class will be scheduled for the Thursday Classes
Nov 26	Nov 27	Nov 28	Nov 29	12	12	Plotting and Visualization	Project 2 Proposal Due		unit 11 / HW12	unit 10 / HW11	
Dec 3	Dec 4	Dec 5	Dec 6	13	13	Pandas Aggregation and Group Operations		Exam 2 Start	x	unit 11 / HW12	
Dec 10	Dec 11	Dec 12	Dec 13	14	14	Testing	Project 2 Presentations!	Exam 2 Due	x		Last Day of Class. bring beer Congratulations!
Last Day of Instruction - December 14											

Schedule | Where we're going - projects & exam

- Discuss final project
- Next week: Proposal finalized
- Week 13: Final Exam distributed
- Week 14: Final Exam is due; presentation *showcase!*

Schedule

Quick romp thru Pandas
Project 2
  Your ideas
  Chat among yourselves to create teams
Activities

Just FYI: here's a 10 min guide… may help with tonight's activities

https://pandas.pydata.org/pandas-docs/stable/10min.html

Optional! see https://www.tutorialspoint.com/python_pandas/python_pandas_visualization.htm

Assignment Review | NumPy

How did the homework go this week?

What was the hardest? What was easiest?

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Data Exploration and Analysis

Project 2 - Team Discussions (as time allows)

Project 2 | Grading

1-2 page proposal: 10%

8 page paper: 60%

Final class presentation: 30%

Confidential peer review and task performance itemization

Instructions: **https://github.com/UCB-INFO-PYTHON/assignments-instructors/blob/master/project_2/Project2Fall17.md**

Teams: https://docs.google.com/spreadsheets/d/1BK1E7BxYBo5eVU2Vq7N6vOaKiWkZ8tRKdSukUWAp4KM/edit#gid=0

Project Breakouts

Talk with your team about your project

1. Create your team repository!
2. What do you hope to get out of the project?
3. When would you like to meet next?
4. Discussion

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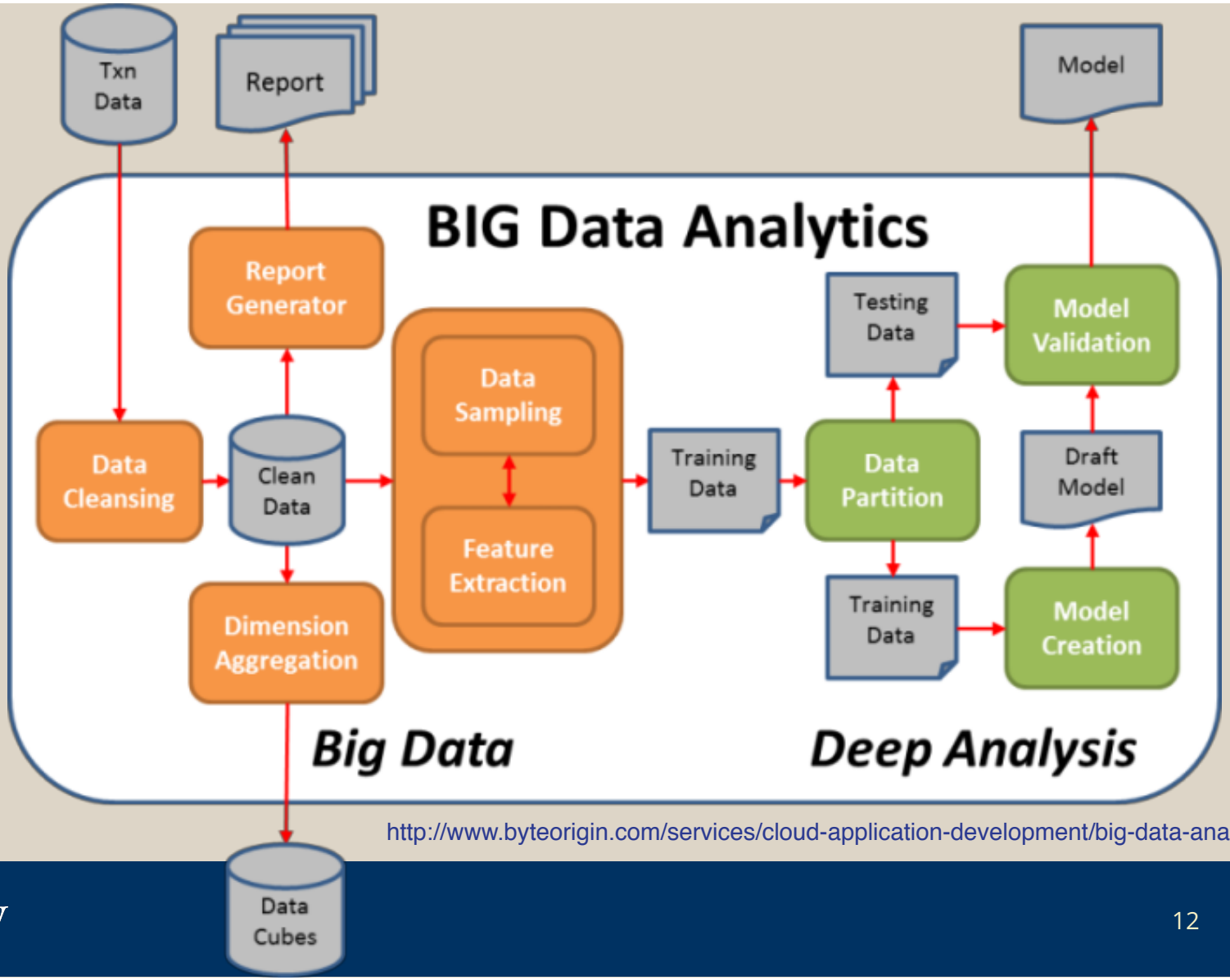
Data Analysis | Two Thoughts

Data Exploration Basics

Data Analysis Basics



http://www.byteorigin.com/services/cloud-application-development/big-data-analytics/

Data Analysis | Exploration vs. Analysis

Data *Exploration*

- Used to ensure data integrity (what is data integrity?)
- Develop questions based on the variables you have
- Try to break things (better now than in production!)

Data *Analysis*

- Seeks to answer a research question or hypothesis
- May involve complex math, modeling, statistics
- More likely to combine multiple dataset
- Collapse and group data in various ways

Some functions are useful for both exploration and analysis!

Data Analysis | Data Exploration Basics

Real World Data Are Messy.

No, really. They're very messy.

If anything can be wrong in your data, it probably is.

Your Mindset: … GOAL!

Data Analysis | How to Explore?

Simple commands - but think deeply!

- value_counts()
- describe()
- max(), min(), isnull()
- basic plots,
  - histogram, scatter plot, bar chart

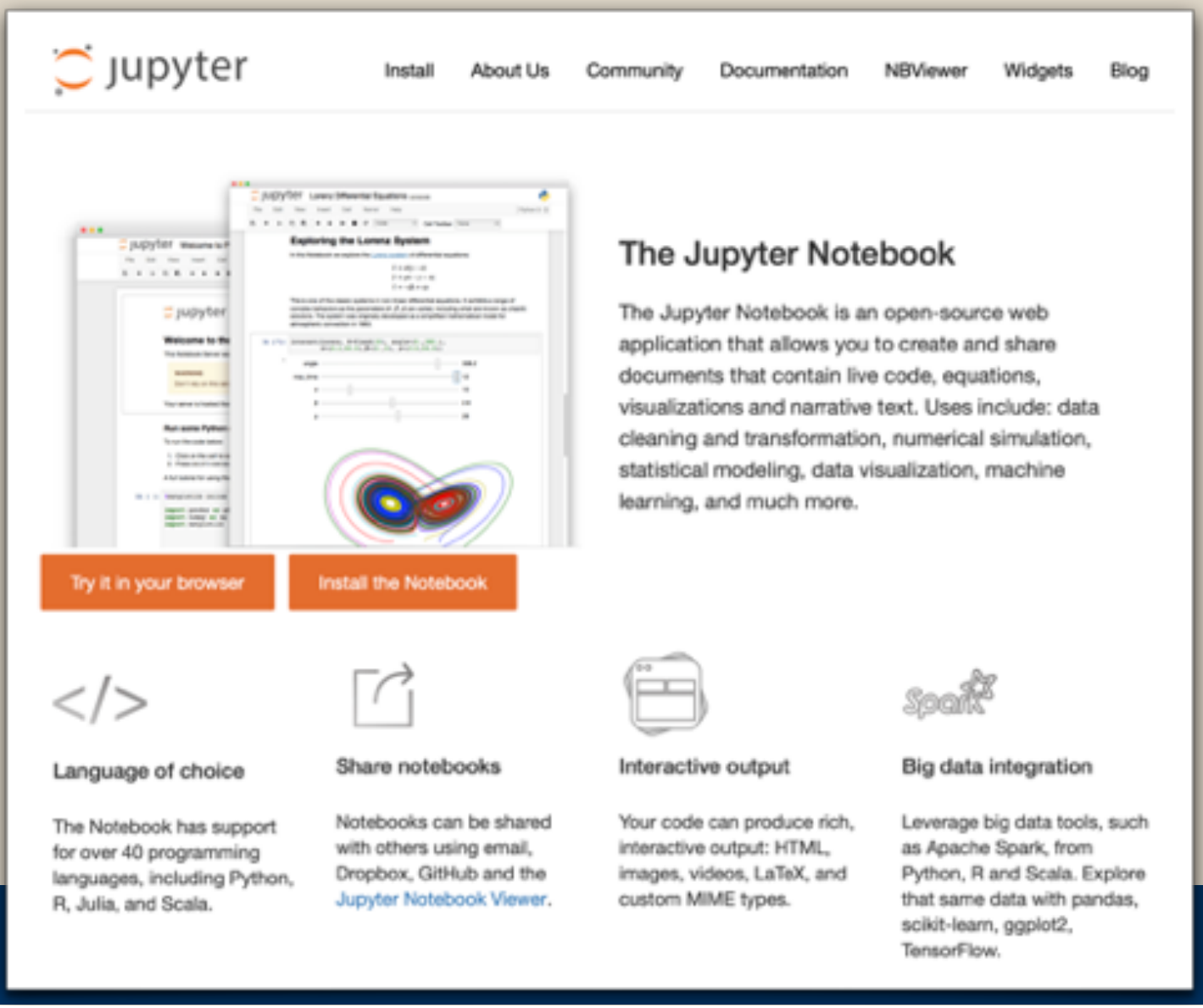
Data Analysis | How to validate?

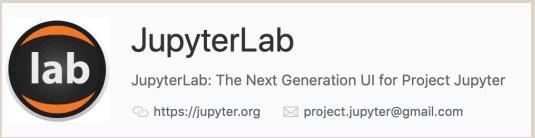
By the way, for a good intro/ review of all the students in research, see this book …

1. Dataset documentation
2. Research (or even Google searches; library)
3. Cross-validation within your data
    a. E.g., if the variable “hospital_los” means “length of stay”, we should be able to compare it to variables “admit_date” and “discharge_date”
4. Cross-validation outside of your data
    a. E.g., We expect power to cost the most on the hottest days of the year (demand is highest). Let’s find the maximum power cost in our dataset, and compare it to the daily temperature to ensure it makes sense.

How much data validation is “enough” ?

Data Analysis | JupyterLab





https://github.com/jupyterlab

http://jupyter.org

https://www.zdnet.com/article/can-data-science-notebooks-get-real-jupyter-lab-releases-to-users/

Pandas | Pseudo-coding

How do I think about pseudo-coding for data analysis?

Remember, good pseudo-coding (aka Structured English) should identify & detail the functionality of your work (modules), the relationships of functionalities (not unlike how objects call each others), and most of all represents a logical process suited for both humans to follow and with sufficient details that computers can execute.

First step towards good code and better documentation.

Pandas | Analysis Design

You can think about an analysis as a **series of dataset transformations**

You might filter **out rows based on conditions**

You might **create new columns**

You might **aggregate** or **collapse by groups**

You might **join two (or more) datasets together**

		Description	example

Series	1	1D labeled homogeneous array, sizeimmutable.	`#import the pandas`
			`import pandas as pd`
			`import numpy as np`
			`data = np.array(['a','b','c','d'])`
			`s = pd.Series(data)`
			`print s`

Data Frames	2	General 2D labeled, size-mutable tabular structure with potentially heterogeneously typed columns.	`import pandas as pd`
			`data = [1,2,3,4,5]`
			`df = pd.DataFrame(data)`
			`print df`

Panel	3	General 3D labeled, size-mutable array.	`# creating an empty panel`
			`import pandas as pd`
			`import numpy as np`
			
			`data = np.random.rand(2,4,5)`
			`p = pd.Panel(data)`
			`print p`

Data Analysis | Analysis Breakout

Using your dataset, answer these questions:

1. What is the maximum donation in the data?
2. What is the most common occupation of people who donate this amount?
3. In what zip code do the most people in part (2) live?

Boolean Selection | some demos

`data = pd.Series([1,2,4,6,0,85,45,7,53,321,4,32,2355,6])`	# Let's experiment with this series
`data[data < 10]`	# are there values < 10?
`data[(data < 10) & (data > 5)]`	# how 'bout a range with keywords

`data[data < 10][data > 5]`	# same result but "chained"
	`>>> data[(data < 10) & (data > 5)]`
	`3  6`
	`7  7`
	`dtype: int64`
	`>>> data[data < 10][data > 5]`
	`3  6`
	`7  7`
	`dtype: int64`

`# using booleans as counter: (data > 5).sum()`	# True = 1; False = 0

Slice and mutate | by index

Slicing & Manipulating	
`d5 = data.head().copy()`	# make a copy … for safety!
`d6 = data.head(70).copy()`	# specify the size of the head (ceiling, e.g., up to 70)
`data[0:10:2]`	$ standard slicing - [start:end (exclusive):step]
`data[0] = 10000`	# value replacement
`d5_6 = pd.concat([d5, d6])`	

Check content | quick test for series

any and **all** tests for series	
`data[data < 10].any()`	# true
`data[data < 10].all()`	# false
`(data > 10000).any()`	# Alternatives … false
`(data > 0).all()`	# false

Stats | quick descriptive stats for series

`len(data)`	

`data.mean()`
`data.mode()`
`data.median()`
`data.count()`
`data.std()`
`data.unique()`
	# can get individual "measures of
	# central tendency … or use
	# **describe()** for the whole thing!
	`>>> data.describe()`
	`count 16.000000`
	`mean 640.312500`
	`std 2496.070718`
	`min 0.000000`
	`25% 2.000000`
	`50% 4.000000`
	`75% 16.500000`
	`max 10000.000000`
	`dtype: float64`

`data.value_counts()`	# super useful … experiment
`data.shape`	# note that this is an *attribute*, # not a *method*.

Index | lookup methods

`data[10]`	# by single index names
`data[ [10,20] ]`	# by multiple index names
	# if the index is not numeric, pandas interprets numbers as row number
`d5.iloc[ [0,3] ]`	# lookup by **index location** "dict style[]"
`data.index = range(100, len(data) + 100)`	# set new **index names**
`data.loc[ [100, 103] ]`	# we can use **`.loc`** to call by **index names**
`data.iget( [0,3] ), data.ix( [0,3] )`	# Depreciated - don't use, 'k?

Reindexing and combining | Fill in values

`data.index = New_Index`	# overwrite the existing index
`new_data = data.reindex([0,2,15,21])`	# slide out rows and use their indices; missing values get “NaN”
`data.reindex([0,2,15,21], fill_value=0)`	# specify the missing values

Missing data | Fill in values

`combo.reindex([0,2,15,21], fill_value=0)`	# set fill value
`new_combo.fillna(0)`	# fill those NaNs!
Forward and backward fill - guess at missing values - common in practice	
`new_combo.ffill()`	# take *forward* fills …
`new_combo.bfill()`	# take *backward* fills
`new_combination.interpolate()`	# fills missing values with linear interpolation *Note! There are several important techniques for missing values.

Mapping methods

`s1 = pd.Series(['1', '3'])`	
`s1 = s1.astype(int)`	# what does this do?
`s1.map(lambda x: x**2)`	# pass a series to a lambda function
`s1.map({'1':2, '2':3, '3': 12})`	# basic mapping with a dictionary

DataFrames | create and mutate

`pd.DataFrame([upcase, lcase])`	# make a DataFrame from a series
`pd.DataFrame({'lowercase': class, 'uppercase':upcase})`	# can pass column names
`letters.columns = ['LowerCase', 'UpperCase']`	# explicitly set the columns
`letters.index = lcase`	# change the indices
`letters.sort('Number'), letters.sort()`	# sort by column or by index
`letters[ ['LowerCase', 'UpperCase'] ]`	# slide columns by name

DataFrames | groupby

Viewing your data by a category can yield critical insights

```
In [114]: df.groupby('Day_of_week').mean()
```

Out[114]:

	Miles	Minutes	Min_per_mile
Day_of_week			
Friday	2.786000	24.308333	7.747657
Monday	2.607143	22.243333	7.463291
Saturday	3.246429	46.708333	8.184961
Sunday	2.422727	19.762500	7.463840
Thursday	6.315000	84.530000	8.039543
Tuesday	2.428182	21.770833	7.659706
Wednesday	3.315000	28.021429	7.829348

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With the time left in the course, it is critical you start your project this week

1. Pick a time to meet next
2. Exchange contact information
3. Establish a communication plan. Email, text, both?
4. Give everyone “something to do” before you meet again.

Good luck with your projects!

Your presentations focus on your *communication* of your project, not the tech notes.

がんばろう！

¡Buena suerte!

!حظا سعيدا

सौभाग्य!

Удачи!

祝好运！

Viel Glück!

!اچھی قسمت

ખુશકિસમતી!

સારા નસીબ!