Resources, Capabilities, and Strategies for Data Science Learners

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CSU Northridge
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This presentation is available at (.odp, .pptx, .pdf):
https://github.com/wsphd/datajam2018

Overview

- *Thinking* as a Data Scientist
  - Positioning Yourself in the Contemporary Paradigm
- *Learning* as a Data Scientist
  - What the Best Autodidacts (self-learners) Know
- *Acting* as a Data Scientist
  - Earning Career Success

- Q&A
- Give away some goodies…

Motivating Question

Are you a *data science* learner?

…quantitative reasoning…

…big data…

…statistical computing…

…applied math…

…business intelligence…

…predictive analytics…

…decision support modeling…

…machine learning…

…artificial intelligence…

Information Dynamics

- *Wisdom*
  - Extraordinary Insight (Explanation) for Foresight (Prediction)
  - ***Restaurant*: How should our menu change in the future to best optimize nightly sales?**
- *Knowledge*
  - Combination of Explicit Information and Tacit Information
  - ***Restaurant*: What action led to the change in last night's sales?**
- *Information*
  - Meaningful Data
  - ***Restaurant*: How does last night's sales compare to that night the previous year? How does last night's sales compare to our goals?**
- *Data*
  - Raw, atomic, basic
  - ***Restaurant*: What were the total sales for last night?**

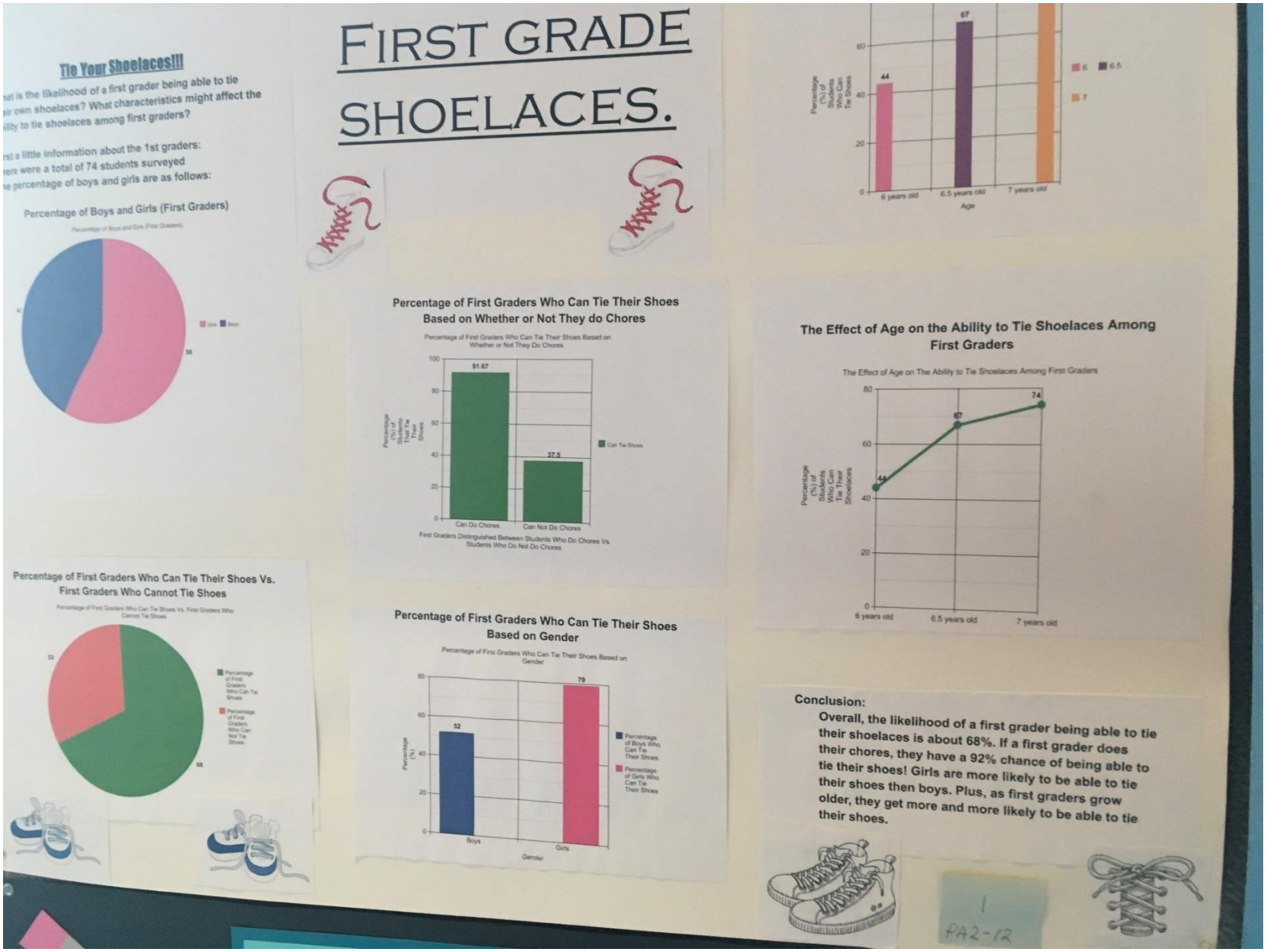
Analytics for Decision-making

- *Prescriptive* Analytics
  - What should we do?
  - ***HR Department*: What should we (the HR Department) do to meet or exceed the organization's hiring and retention goals for next year? What data/information/knowledge/wisdom should we provide to our hiring and technical managers to help? What are we missing?**
- *Predictive* Analytics
  - What is likely to happen?
  - ***HR Department:* How many new employees will our organization need next year? How will the mix change? What is our competition likely to do?**
- *Diagnostic* Analytics
  - Why did it happen?
  - ***HR Department:* Did our emphasis on recruiting from campus A (over campus B, etc.) matter? What do the managers of these entry-level employees think?**
- *Descriptive* Analytics
  - What happened?
  - ***HR Department:* How many entry-level professionals did we hire last year? How many of them are still with us now?**

Common Core (e.g., a graph in Grade 3)

ASA ID	award	Category	Title	LocalID	City
4-3550	1	GR10-12	Charting Chart Toppers	4-3550	Andover
MI4-194	2	GR10-12	Influenza 2018	MI4-194	
PA 4- 75	3	GR10-12	The Pen is Mightier than the Mouse	PA 4- 75	Glen Mills
CT10-12D13	HM	GR10-12	The Cost of Milk Production	CT10-12D13	Higganum
PA 2- 12	1	GR4-6	First Grade Shoelaces	PA 2- 12	Abington
2-3654	2	GR4-6	Screen Time	2-3654	Appleton
DC 2-3718	3	GR4-6	Sugary Soda Showdown	DC 2-3718	Columbia
PA 2- 61	HM	GR4-6	Duck...Duck...Rabbit?	PA 2- 61	Abington
OH 7-9 10	1	GR7-9	Pressure for Good Grades: Does It Exist?	OH 7-9 10	Lyndhurst
3-3712	2	GR7-9	Do High School Students Perform Acts of Kindness?	3-3712	West Nyack
DC 3-3729	3	GR7-9	Starbucks Consumption = mmm!	DC 3-3729	Williamsburg
MI3-121	HM	GR7-9	What's Up with Binge Watching?	MI3-121	
1-3635	1	GRK-3	Which Hand Rules	1-3635	Bar Harbor
OH K-3 9	2	GRK-3	Are You a Square or a Rectangle	OH K-3 9	Chagrin Falls
1-3552	3	GRK-3	Do You Know that Orangutans Are Endangered?	1-3552	Plano
DC 1-3939	HM	GRK-3	Speedcubing Statistics	DC 1-3939	Fairfax VA

“First-Grade Shoelaces” (Grades 4-6)



“First-Grade Shoelaces” (Grades 4-6) (results)

Conclusion:

Overall, the likelihood of a first grader being able to tie their shoelaces is about 68%. If a first grader does their chores, they have a 92% chance of being able to tie their shoes! Girls are more likely to be able to tie their shoes then boys. Plus, as first graders grow older, they get more and more likely to be able to tie their shoes.

Next-Generation Science Standards

There are *seven* "cross-cutting" skills to support *four* core subject domains: Physical Science, Life Science, Earth and Space Science, and Engineering.

	Cross-cutting skill	*Data Science* analogue
1	Patterns	Observations, Variables, and Pattern Matching
2	Cause and Effect	Causality
3	Scale, Proportion, and Quantity	Measure Theory
4	Systems and System Models	Model Building
5	Energy and Matter	Systems Dynamics, Moments, and Entropy
6	Structure and Function	Hierarchical, Structural, and Latent Variable Analysis
7	Stability and Change	Variation, Complexity, and Interactions

Persistent Tensions

Analytics	⟷	Automation
Explanation	⟷	Prediction
Desktop	⟷	Cloud
Base R	⟷	Tidyverse
SQL	⟷	Spark
Equation	⟷	Algorithm
Hypothesis-driven	⟷	Discovery-driven
Bias	⟷	Variance
Precision/Recall	⟷	Specificity/Accuracy
p-value	⟷	fit
Frequentist	⟷	Bayesian

What is Data Science?

- Data Science is "the science of planning for, acquisition, management, analysis of, and inference from data."

- Data science is case-based, hands-on, and interdisciplinary.

- Building upon experimentation, modeling, and computation, there are some that believe that data science *is, in fact, a new, type of scientific discovery*.

- Data scientists demonstrate mastery of skills and concepts, including many traditionally associated with the fields of Mathematics, Statistics, and Computer Science and. *Data Science blends much of the pedagogical content from all three disciplines, but it is* ***neither the simple intersection, nor the superset of the three****.*

- There is a fourth area of demonstrated mastery too: Subject-Domain expertise.

Math/Stat/CompSci/Subject Domain

- What can we leverage well for data science success?

Evidence-Based…	*…Language*	*…Approach*	*…Operational Scale*	*…Truth in Action*
Practice	Equations, Theorems	Parametric tests, Regressions	Algorithms, Literate Programming	Various—Professional Standards
Theory	Probability, Matrices	General Linear Model	Computa-tional Thinking	Various—Research-based
Discipline	Math	Statistics	Computer Science	Subject Matter (Domain)

Practical Applications III: Deep (Machine) Learning

Mt. Sinai Hospital (NY) 2015 Research Program: "Deep Patient"

1. Tested on 700,000 patient records

Able to predict disease far better than traditional methods

2. Better than humans at predicting onset of schizophrenia

Not even physicians can accurately predict that psychiatric disorder

3. Algorithm was able to detect a pattern never before discovered

Not only is pattern latent, so is its detection method ("black-box")

Balance Breadth & Depth (Software Tools)

OLS Regression	lm, glm	Statsmodels (sm.OLS)	Juliastats, GLM, linreg
t-test for ind. groups	t.test, wilcox.test, MASS	numpy, scipy(stats)	Juliastats (pvalue, confint)
Data Visualization	Base R, lattice, ggplot2	pandas, matplotlib	Plots, Gadfly, JuliaGraphs
Software	R	Python	Julia

Software Tools (cont.)

- Development Environments
  - R (RStudio)
  - Python (Spyder, PyCharm)
  - Julia (JUNO, Atom)
  - Jupyter Notebooks (for all of the above)
- Text editors (e.g., Notebook++, VIM, or just plain Notepad)
- Weave documentation, code, and output together to make dynamic documents (e.g., knitr, sweave)
- Generate publication-quality, reproducible results (e.g., markdown, LaTex)
- Many, many other software (and many packages for each)
  - FOSS: STAN, QGIS, Gephi, Gretl, Scala, Apache Spark, KNIME…
  - COTS: SPSS, SAS, Stata, Matlab, Nvivo, Gurobi, Tropes, ArcGIS…

Balance Breadth & Depth (Analytical Techniques)

- More *general*?
  - GIS
  - effect sizes
  - logistic regression , *k*-means clustering, classification
  - supervised learning/resampling
  - LP/IP/MIP optimization
- More *nichey*?
  - spatial analytics
  - penalty-based regression
  - neural networks
  - unsupervised learning/topic modeling
  - convex optimization
- Text analysis, network analysis, genomic analysis, Bayesian analysis
- CranViews
  - https://cran.r-project.org/web/views/

Reproducibility
("*academic* perspective")

more

Results reproducible?	assumptions, interpretations, platforms, equivocality
Code available?	versioning, documentation, dialects, code "rot"
Data available?	curation, archival, funding fiats, data format "rot"
Paper (public)?	access scope, licensing/rights, journal rules, tenure
Paper (traditional)?	keep our own drafts, updates, data, and code

less

Workflow ("*professional* perspective") How does Disney do it?

Personas: Business

- Information Worker
  - Excel, Powerpoint
  - Prepared BI reports
  - Light Statistics

- Business Analyst
  - Excel, Powerpoint
  - COTS Reporting tool
  - Light Statistics

- Data Analyst
  - Excel, Powerpoint
  - COTS Reporting tool
  - SQL

Workflow ("How does Disney do it?")
Personas: Data Scientist

- Data Scientist
  - Required: Python & SQL; Nice to have: Java, Scala
  - Machine Learning, Statistics, Deep Learning
  - Data wrangling skills
  - Distributed systems & algorithms
  - Data Sampling, approximate aggregations, extrapolation
  - Scientific Method - Notebooks
  - Data communication, visualization
  - Cloud services, Linux CLI
  - Bonus: NLP, image recognition

Workflow ("How does Disney do it?")

Personas: Technical

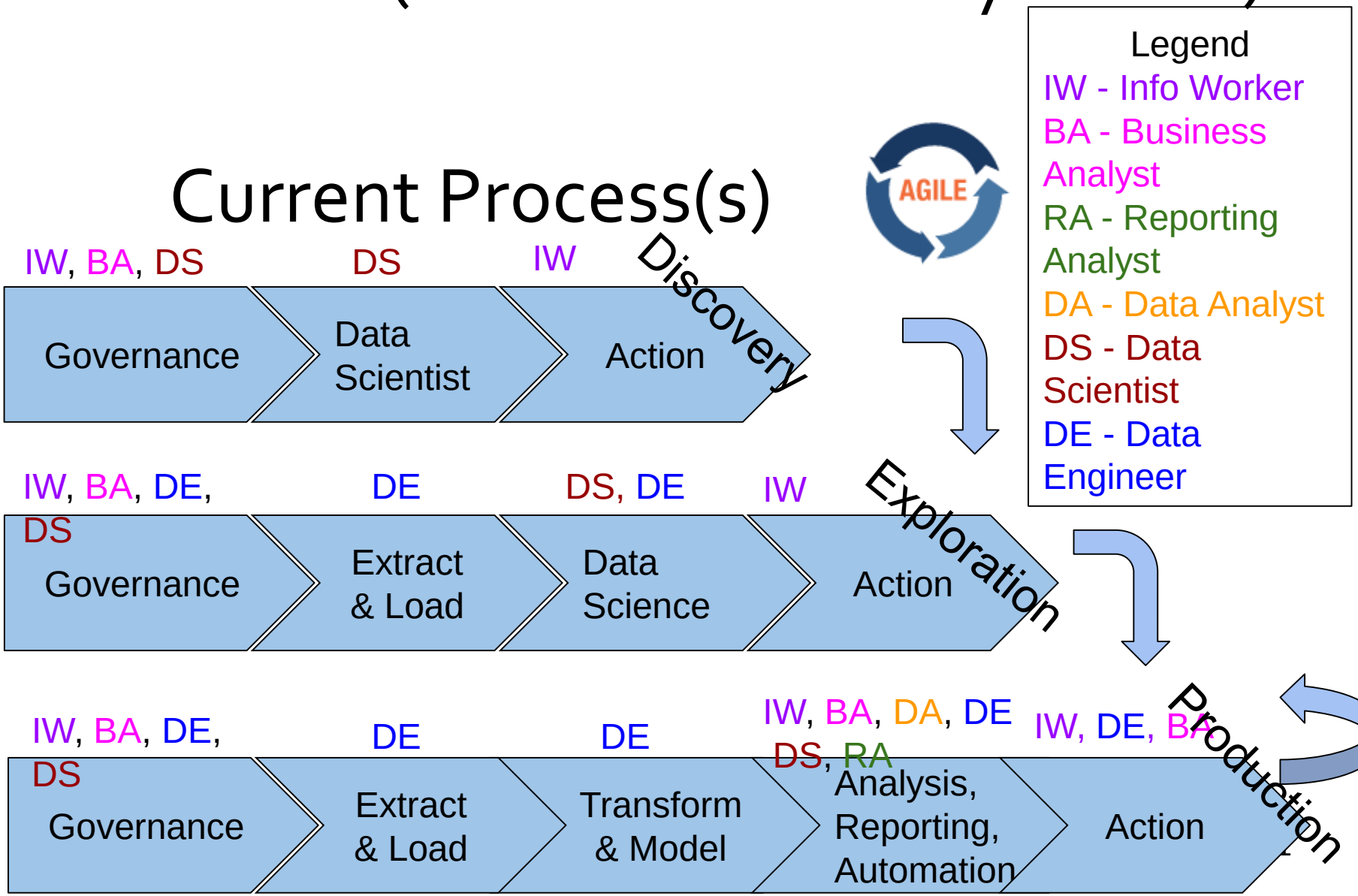
- Data Engineer
  - Distributed Systems, Stream Processing
  - Tools, Infrastructure, Frameworks, Services
  - Java, Scala, SQL, Python, R, Bash/Zsh
  - Linux, Git, DevOps, Cloud
  - Medium Stats
  - Medium ML/DL
  - Hadoop, Yarn, HDFS, ElasticSearch
- Reporting Programmer Analyst

  COTS Reporting tool

  SQL

Workflow ("How does Disney do it?")

Current Process(s)



References, more…

- Twitter
  - #rstats
- Podcasts
  - https://www.analyticsvidhya.com/blog/2018/01/10-data-science-machine-learning-ai-podcasts-must-listen/
- Tutorials
  - http://tutorials.iq.harvard.edu/R/Rintro/Rintro.html
  - lynda.csun.edu
- Niche-specific (e.g., "Psycho")
  - Blog (https://neuropsychology.github.io/psycho.R/)
  - Papers (http://joss.theoj.org/papers/10.21105/joss.00470)
  - Packages (https://github.com/neuropsychology/psycho.R)

- More references:
  - https://smithw.org/datajam

About Meetups Members Photos Discussions More

You're a member

6
SEP

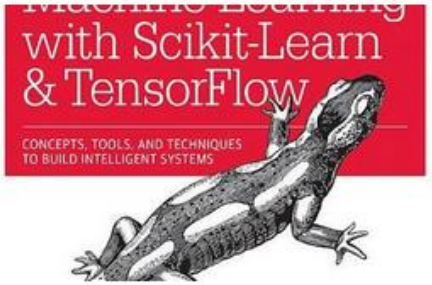
Thursday, September 6, 2018, 7:00 PM

Book Club: Hands-On Machine Learning with Scikit-Learn and TensorFlow

Hosted by Cassie Borish

Join our biweekly meetup as we work through Hands-On Machine Learning with Scikit-Learn & TensorFlow (https://amzn.to/2jpUoiN). Jupyter notebooks accompanying the text can be found here: https://github.com/ageron/handson-ml ***** Tonight we are discussing and working through exercises from Chapter 8: Dimensionality Reduction. ***** Haven't done the previous readings? That's ok! Summaries of previous chapters are posted here:

8 going



Attend

Zappbuddy Technologies
25000 Avenue Stanford · Santa Clarita, CA

7 comments

What we're about

This meetup is designed to create a meeting point in Santa Clarita for those

Upcoming Meetups

See all

Meetup

Start a new group | Explore | Messages

25
JAN

Past Meetup

Join Persian Women In Tech LA for our January 2018

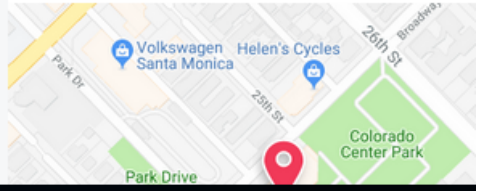
This Meetup is past 12 people went

Hosted by Kevin Mehrabi and Elno
From Deep Learning | Los Angeles
Public group

PERSIAN WOMEN

Thursday, January 25, 2018
6:30 PM to 9:00 PM

Hulu Santa Monica HQ
2500 Broadway Street Suite 200 ·
Santa Monica, ca



Career Homework

- TechFest (CSUN Career Center)
  - Marketed mostly to Eng/CompSci, but a data science learner goes…
- Career Fairs (various) (CSUN Career Center and off-campus)
  - Also, if a display sign doesn't list "data science" (or whatever) on the sign, *you ask about it…*
- Indeed.com
  - "data science intern", "data science entry level"
  - E.g., 25 miles from CSUN
  - Do your homework from at least 20 job descriptions
    - What skills do I have? What skills don't I have but I can get? What skills don't I have that I don't even know what the skill is?

Cloud Services

- Free-tier
  - IBM Watson Cloud (you want the "no time restrictions" option)
  - https://console.bluemix.net/registration/free/
  - Amazon Web Services (you want the "non-expiring" offer)
  - https://aws.amazon.com/free/
  - Google Cloud (you want the "always free" option)
  - https://cloud.google.com/free/
  - Microsoft Azure (you want the "start free" option)
  - https://azure.microsoft.com/en-us/free/
- CSUN too (https://www.csun.edu/it/ibm-cloud-services-csun)
- Amazon certificate (https://laedc.org/2018/08/09/amazon-los-angeles-colleges-cloud/)
  - SMC (http://www.smc.edu/NewsRoom/Pages/Cloud-Computing-Certificate.aspx)

- But keep in mind threats to both *reproducibility* and *workflow*

Canvas API Example

```
# do once
install.packages( “devtools” )
library( devtools )
install_github( “daranzolin/rcanvas” )
library( rcanvas )
set_canvas_token( “your-40-character-token-from-Account-Settings-here” )
set_canvas_domain( “https://canvas.csun.edu” )

# get course items
get_user_items( course_id = 12345, item = “assignments” )
get_user_items( course_id = 12345, item = “missing_submissions” )

# get course analytics
get_user_items( course_id = 12345, item = “activity” )

# upload a file
upload_course_file( course_id = 12345, file_name = “testfile.pdf” )
```

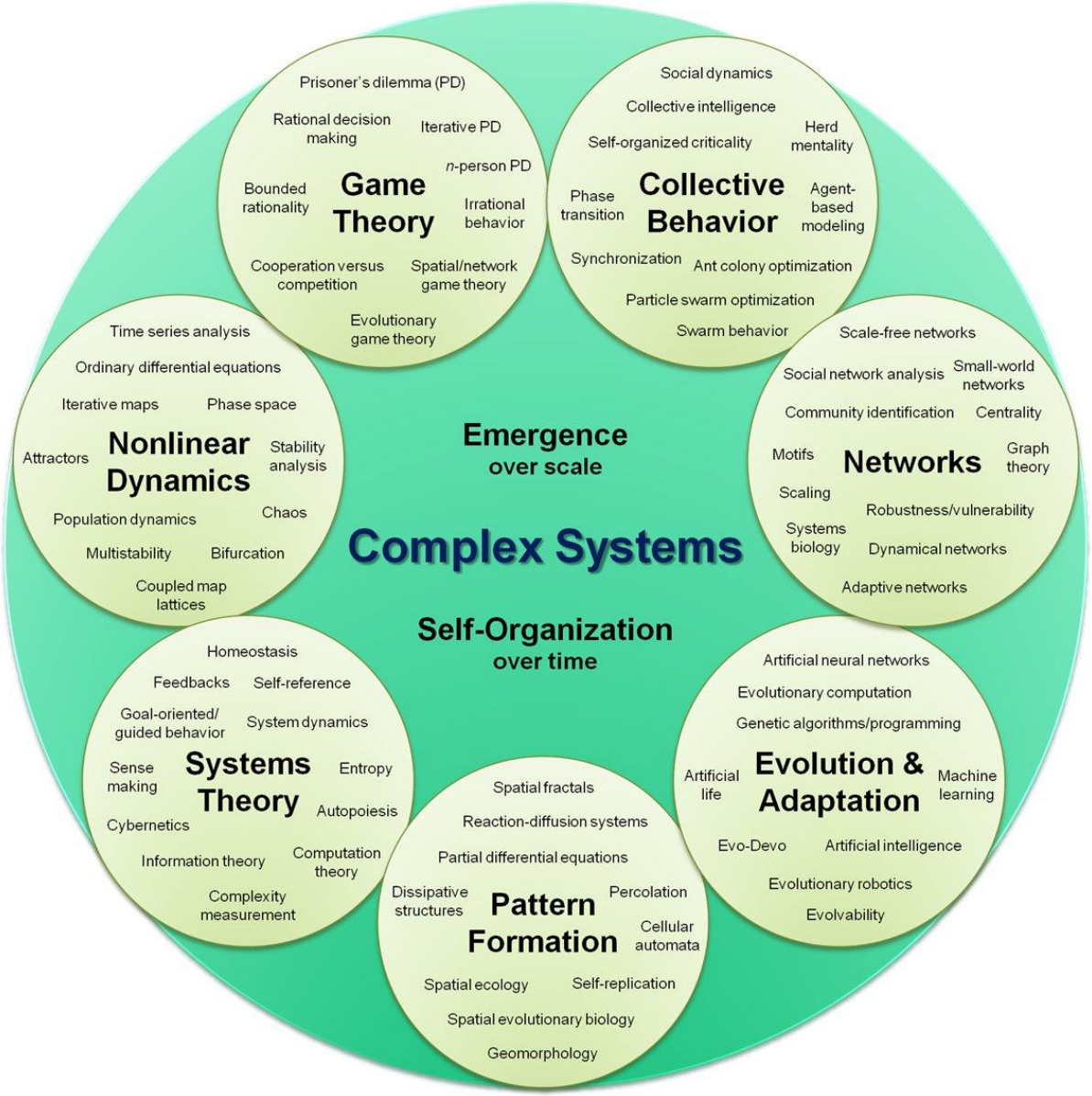
Some Examples

- LA Crime
  - https://datascienceplus.com/analysis-of-los-angeles-crime-with-r/
- LA Homelessness
  - https://source.opennews.org/articles/how-we-found-new-patterns-la-homeless-arrest/
- LA Reduce Vehicle v. Pedestrian Deaths
  - http://visionzero.lacity.org/wp-content/uploads/2015/08/VisionZero_LosAngeles.pdf
- You can do this yourself:
  - LA City (https://data.lacity.org/)
  - LA County (https://data.lacounty.gov/)
  - CA (https://data.ca.gov/)
  - US (https://www.data.gov/)
  - Data Science for the Social Good (https://dssg.uchicago.edu/projects/)

Counterpoint

- Hernandez, D., and Greenwald T. (August 11, 2018), "IBM Has a Dilemma", *Wall Street Journal*.
- Muller, J. (2018), *The Tyranny of Metrics*, Princeton University Press.
- O'Neill, C. (2017), *Weapons of Math Destruction: How Big Data Increases Inequity and Threatens Democracy*, Broadway Books.
- Pearl, J. (2018), *The Book of Why: The New Science of Cause and Effect*, Basic Books.
- Tenner, E. (2018), *The Efficiency Paradox: What Big Data Can't Do*, Alfred A. Knopf.

Macro-level (Complexity)



Micro-level (A New Language for conversations)

- Student peers
- Professional contacts

- Most important in the short-run—Professors
  - What kinds of *research questions* have you worked on?
  - What kinds of *data* have you used?
  - What kinds of *analytical methods* have you used?
  - What kinds of *software tools* have you used?
  - What would you like to learn in the near future?
  - How do you learn new things related to using data?

fin

- Again: Are you a data science learner?

- Questions?

- Goodies

References

- Automation vs. Analytics
  - Davenport, T. (2009), "Make Better Decisions", *Harvard Business Review*, Nov. 87(11), p. 117-123.
- Curriculum Guidelines for Undergraduate Programs in Data Science
  - https://www.stat.berkeley.edu/~nolan/Papers/Data.Science.Guidelines.16.9.25.pdf
- Complex Systems chart
  - By Hiroki Sayama, D.Sc. - Created by Hiroki Sayama, D.Sc., Collective Dynamics of Complex Systems (CoCo) Research Group at Binghamton University, State University of New York, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=12191267