

WELCOME!

INTRO TO DATA SCIENCE

LECTURE 1: DATA SCIENCE OVERVIEW

Rob Hall

DAT9 SF // August 5, 2014

TODAY'S AGENDA

1. Course producer introduction
2. Instructor introductions
3. Student introductions
4. Lecture: Introduction to Data Science
5. Tutorial: Introduction to iPython
6. Q&A

Meet Your Course Producer



Alex Hamady

- ▶ Course Producer, GA
- ▶ alexh@ga.co



Course expectations:

BE PRESENT

PARTICIPATE

DO THE ASSIGNMENTS

MAKE FRIENDS

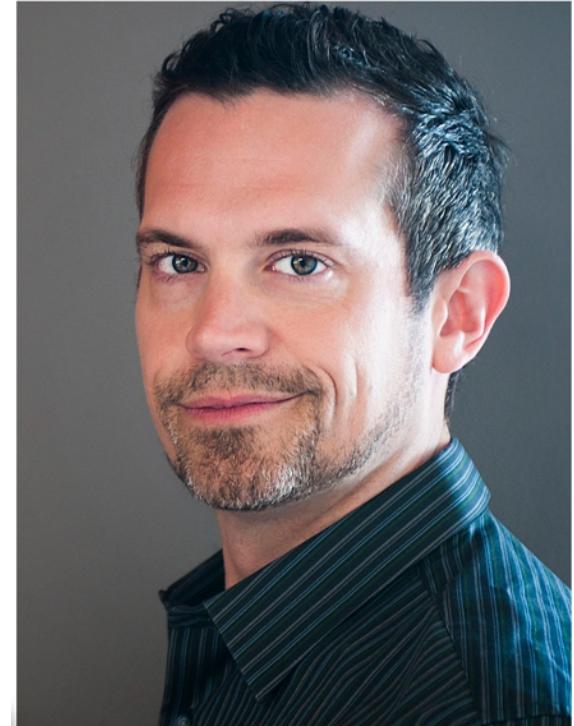
Meet Your Instructional team

Rob Hall

Rob Hall is a product leader and data scientist who creates business value from data.

Rob leads the Product Management team at Jut, a big data analytics startup backed by Accel, Lightspeed Venture Partners, and Wing. Prior to Jut, Rob led software product strategy at Stem, an energy startup at the nexus of real-time data, predictive analytics, and energy storage.

In addition to enterprise software, Rob has deep consumer Internet experience. At Overture and Yahoo!, Rob drove significant increases in monetization, relevance, and user engagement by applying machine learning algorithms. He has also launched search and social media products used by tens of millions of people every month. Rob graduated from Cornell University with a BS in Engineering and earned his MBA in Finance from the Wharton School of the University of Pennsylvania.



Meet Your Instructional team

*

Leo Garver

Leo Garver graduated from Pomona College with a degree in Chemistry. He has done early-stage research for treatments of HIV, Hepatitis C and Cancer at Genentech and Gilead Sciences. Leo has recently shifted from using his talents in analytical chemistry to data analytics and now does analytics and business intelligence consulting for a variety of bay area startups and non-profits. Leo learned many skills in statistics and data analysis from his passion for working with baseball stats and sabermetrics.



Genentech

 **GILEAD**

 **GENERAL ASSEMBLY**

 **digitalmunch**

 **spark**
igniting global change

But enough about us...

Introductions

- Your name
- A brief summary of your background (e.g. work, school, etc.)
- What you hope to get out of the class
- One interesting / surprising / random factoid about yourself

RESOURCES

Instructor: Rob Hall (robhall.ga@gmail.com)

Expert-in-Residence: Leo Garver (leogarver@gmail.com)

Course Producer: Alex Hamady (alexh@ga.co)

Course Times: 6:30pm-9:30pm, Tuesdays & Thursdays (580 Howard #302)

Office Hours: To Be Scheduled

Class Dates: August 5, 2014 - October 23, 2014 (NO CLASS on 8/26 & 8/28)

RESOURCES

Internal:

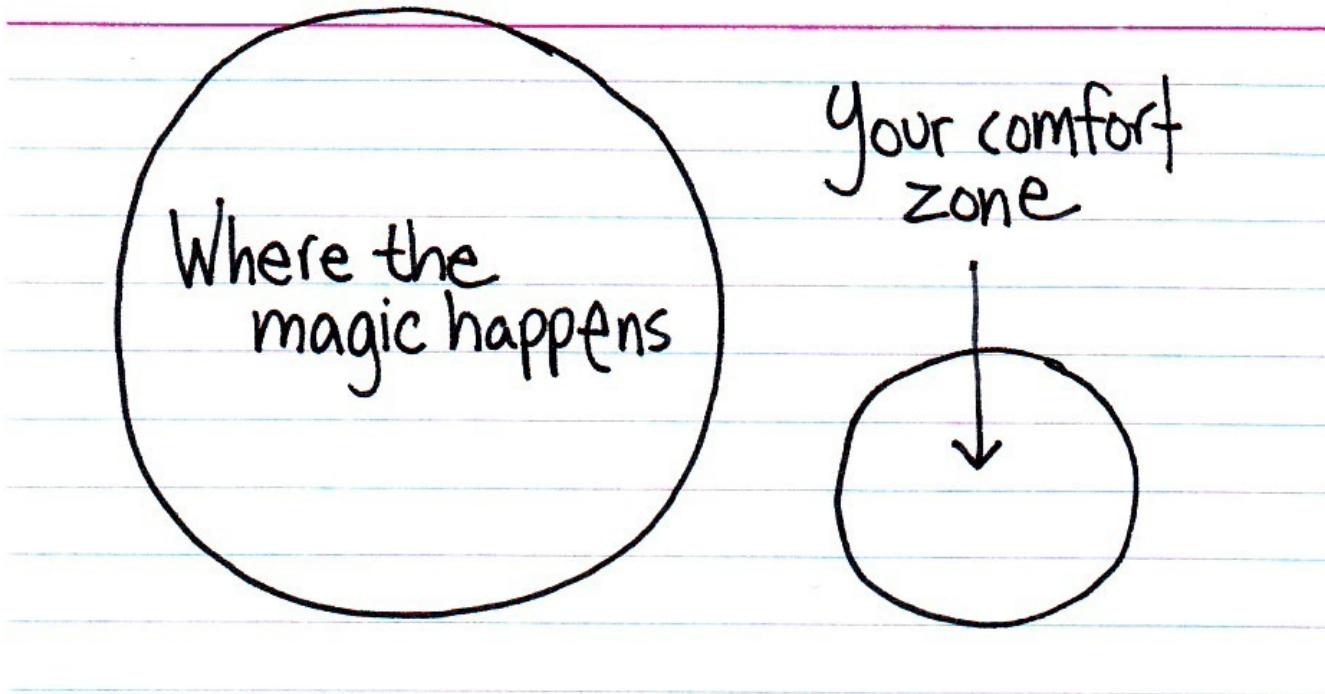
- Schoology - course website, course communications, discussion board
- Github - code for tutorials, homework submission, social coding
- Office Hours - additional material, discussions, specific questions
- Email - specific questions, any concerns, etc.

External:

- Google
- [STACKOVERFLOW.COM](#)

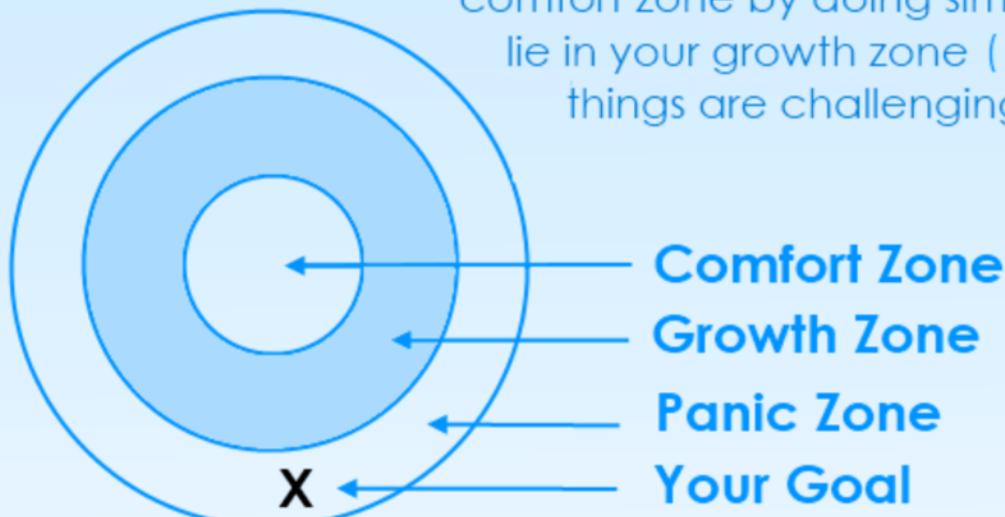
CONGRATULATIONS...

...for getting out of your comfort zone!



How to Grow Your Comfort Zone

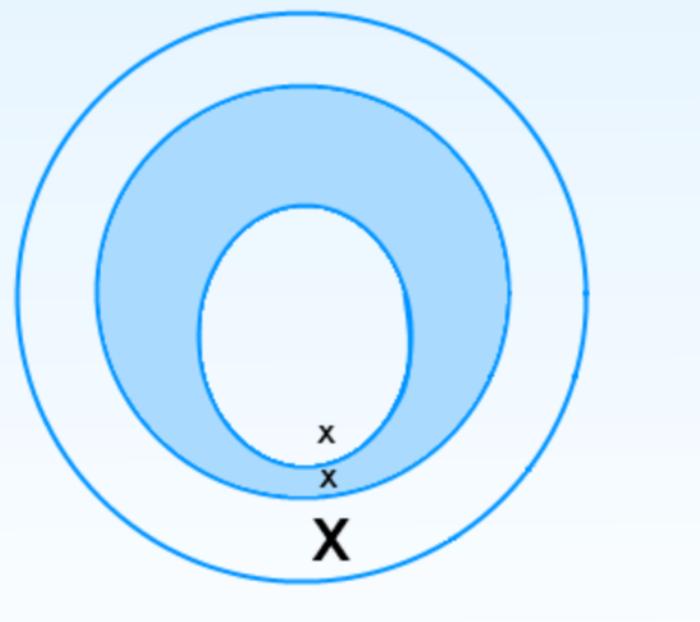
Any goal or challenge may fall into one of three zones - your comfort zone, growth zone, or panic zone. If your goal is currently in your panic zone, i.e. it would be too scary to do now, you will need to grow your comfort zone by doing similar challenges that lie in your growth zone (the zone in which things are challenging or scary, but do-able).



How to Grow Your Comfort Zone

As you pursue challenges in your growth zone, those challenges become easier and your comfort zone expands.

Eventually, challenges that were previously in your panic zone begin to fall into your growth zone, and ultimately within your comfort zone.



AGENDA

**I. WHAT IS DATA SCIENCE?
II. THE DATA SCIENCE WORKFLOW
III. VISUALIZATIONS AS A MEDIUM**

LAB:

**IV. WORKING AT THE UNIX COMMAND LINE
V. INTRO TO I-PYTHON**

I. WHAT IS DATA SCIENCE?

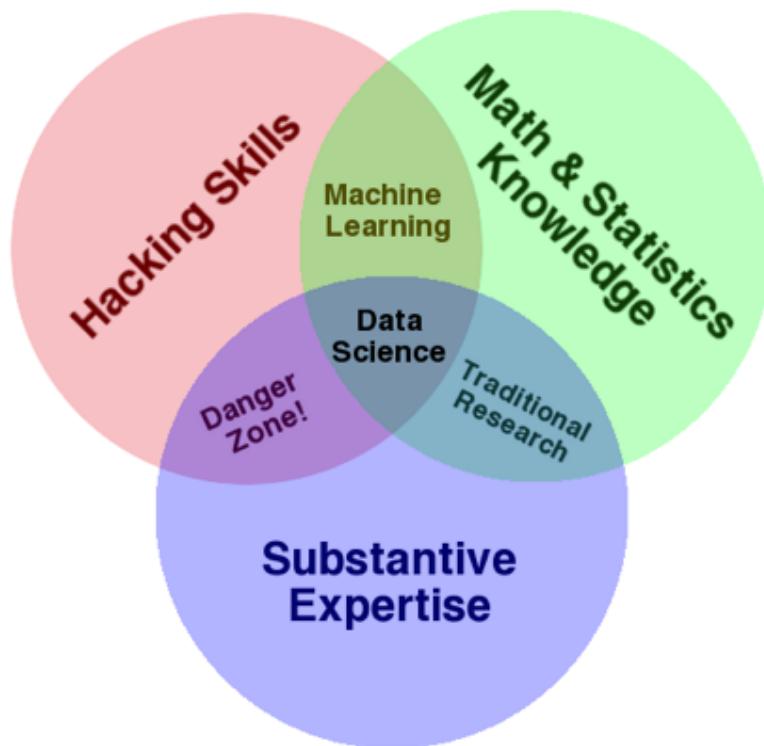
WHAT IS DATA SCIENCE?

- A set of tools and techniques used to extract useful information from data.

WHAT IS DATA SCIENCE?

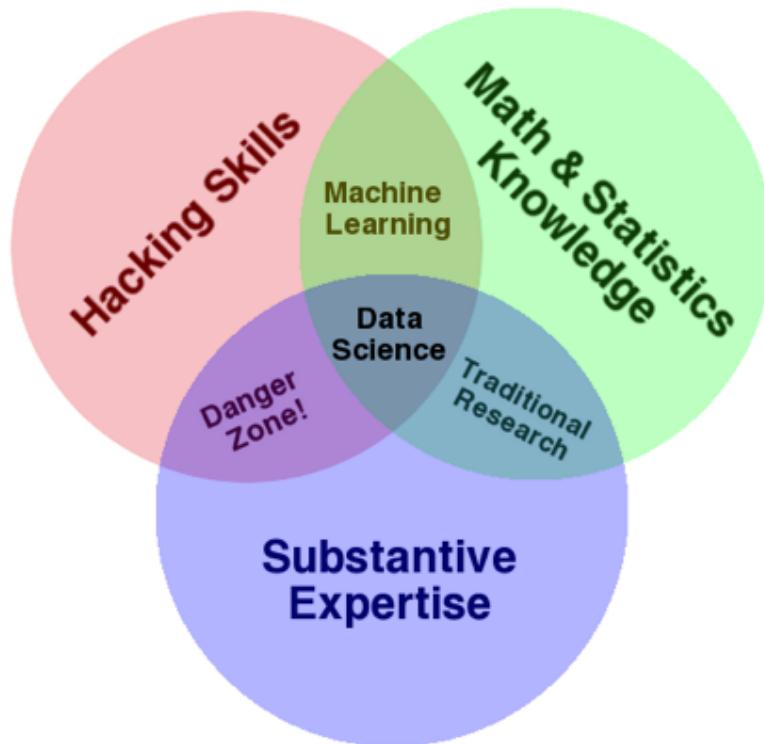
- A set of tools and techniques used to extract useful information from data.
- An interdisciplinary, problem-oriented subject.

THE QUALITIES OF A DATA SCIENTIST



source: <http://www.dataists.com/2010/09/the-data-science-venn-diagram/>

THE QUALITIES OF A DATA SCIENTIST



ONE MORE THING!

Communication skills

WHAT IS DATA SCIENCE?

- A set of tools and techniques used to extract useful information from data.
- An interdisciplinary, problem-solving oriented subject.
- The application of scientific techniques to practical problems.

WHAT IS DATA SCIENCE?

- A set of tools and techniques used to extract useful information from data.
- An interdisciplinary, problem-solving oriented subject.
- The application of scientific techniques to practical problems.
- A rapidly growing field.

WHO USES DATA SCIENCE?



WHAT MAKES A GOOD DATA SCIENTIST?



Michael E. Driscoll

@medriscoll



Following

Data scientists: better statisticians than
most programmers & better programmers
than most statisticians bit.ly/NHmRqu
[@peteskomoroch](https://twitter.com/peteskomoroch)

Reply

Retweet

Favorite

More

Pocket

WHAT MAKES A GOOD DATA SCIENTIST?

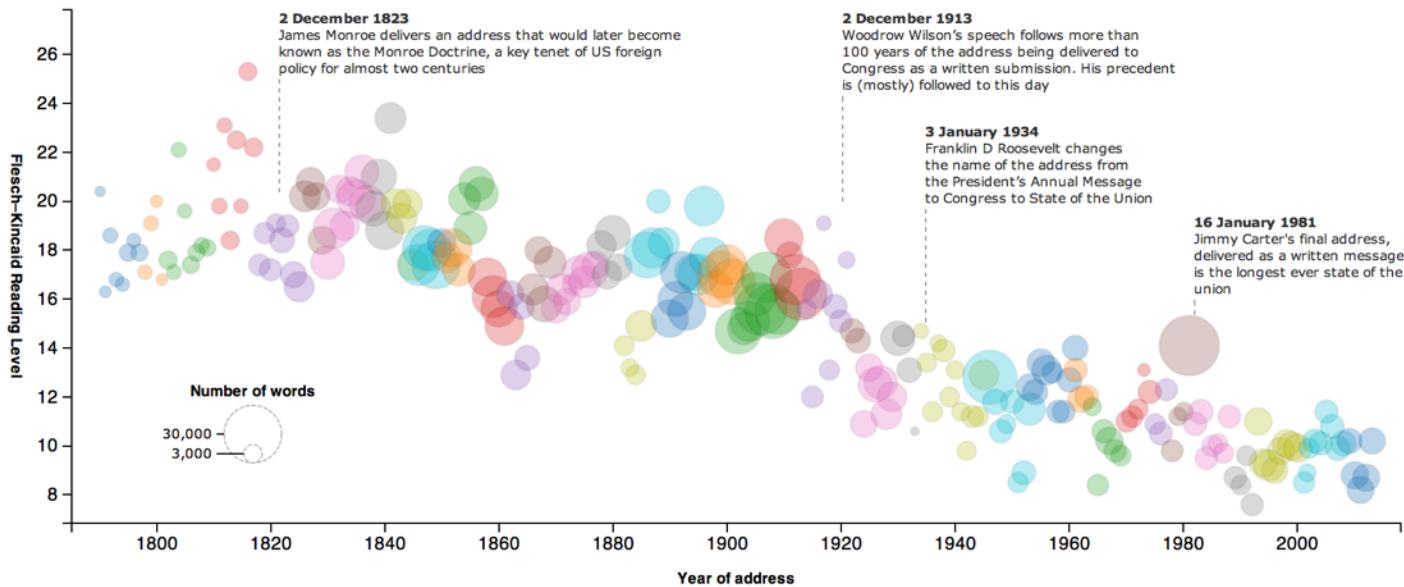
- Statistical and machine learning knowledge
- Engineering experience
- Curiosity
- Product sense
- Storytelling
- Cleverness

WHO USES DATA SCIENCE?

The state of our union is ... dumber:

How the linguistic standard of the presidential address has declined

Using the [Flesch-Kincaid readability test](#) the Guardian has tracked the reading level of every state of the union



WHO USES DATA SCIENCE?

Music + Data:

<http://bit.ly/echonest>

WHO USES DATA SCIENCE?

- Stack Overflow tag recommendation and response time prediction
- Locating ethnic food in ethnic neighborhoods
- Building optimal NBA teams
- Recommending new musical artists
- Prioritize emergency calls in Seattle
- Finding the right job for you (Bright / now LinkedIn)

II. THE DATA SCIENCE WORKFLOW

THE DATA SCIENCE WORKFLOW

Dataists (Hilary Mason & friends)

- 1. Obtain
- 2. Scrub
- 3. Explore
- 4. Model
- 5. Interpret

THE DATA SCIENCE WORKFLOW

Dataists (Hilary Mason & friends)

- 1. Obtain - pointing and clicking does not scale (APIs, Python, shell scripting)
- 2. Scrub - “Scrubbing data is the least sexy part of the analysis process, but often one that yields the greatest benefits” (Python, sed, awk, grep)
- 3. Explore - look at the data (visualizing, clustering, dimensionality reduction)
- 4. Model - “All models are wrong, but some are useful” / models are built to predict and interpret
- 5. Interpret - “The purpose of computing is insight, not numbers”

THE DATA SCIENCE WORKFLOW

Jeff Hammerbacher (Facebook, Cloudera)

- 1. Identify problem
- 2. Instrument data sources
- 3. Collect data
- 4. Prepare data (integrate, transform, clean, impute, filter, aggregate)
- 5. Build model
- 6. Evaluate model
- 7. Communicate results

THE DATA SCIENCE WORKFLOW

Ben Fry

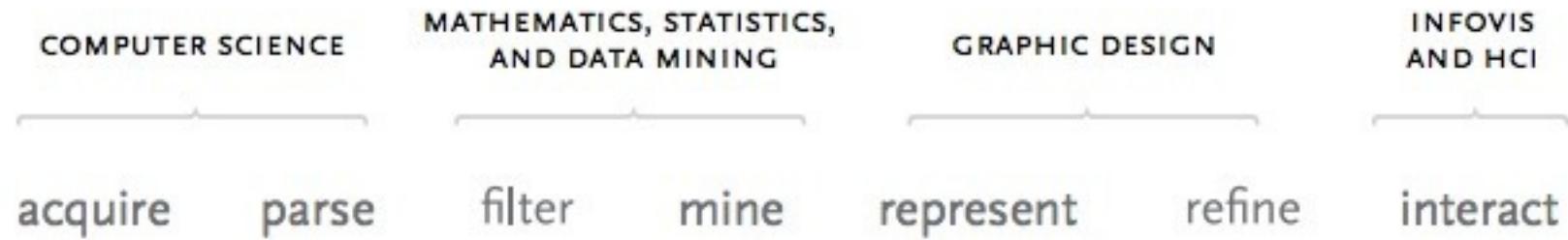
- 1. Acquire
- 2. Parse
- 3. Filter
- 4. Mine
- 5. Represent
- 6. Refine
- 7. Interact

THE DATA SCIENCE WORKFLOW

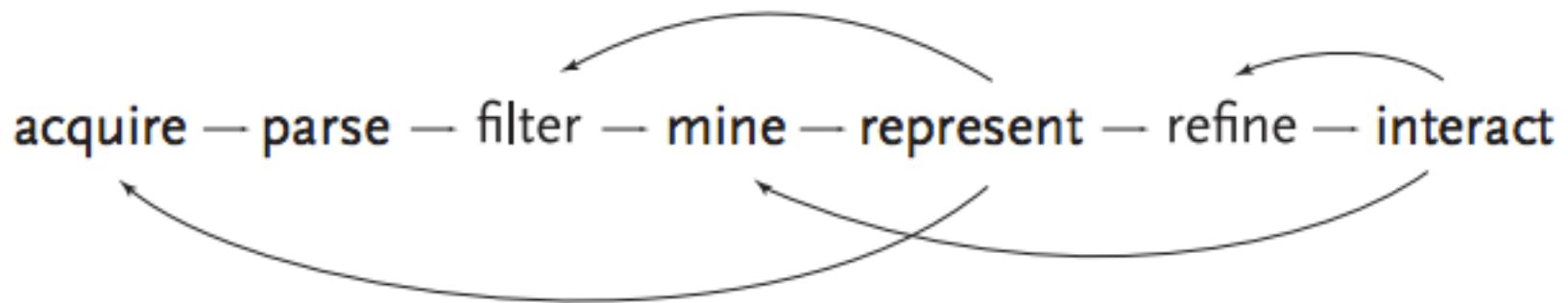
Ben Fry

- 1. Acquire - the matter of obtaining the data
- 2. Parse - providing some structure around what the data means
- 3. Filter - removing all but the data of interest
- 4. Mine - the application of methods from statistics or data mining, as a way to discern patterns or place the data in mathematical context
- 5. Represent - determination of a simple representation (e.g. graphing)
- 6. Refine - improvements to the basic representation to make it clearer and more visually engaging
- 7. Interact - the addition of methods for manipulating the data or controlling which features are visible

THE DATA SCIENCE WORKFLOW



THE DATA SCIENCE WORKFLOW



NOTE

This diagram illustrates
the *iterative* nature of
problem solving

THE DATA SCIENCE WORKFLOW

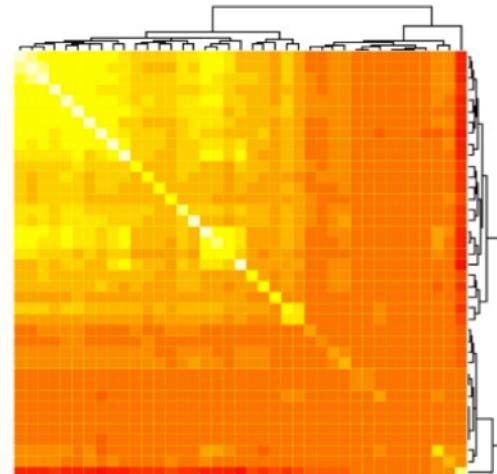
What is needed most?

approximately **80% of the costs** for data-related projects gets spent on data preparation – mostly on **cleaning up** data quality issues: ETL, log files, etc., generally by socializing the problem

unfortunately, data-related budgets tend to go into frameworks that can only be used *after clean up*

most valuable skills:

- ▶ learn to use programmable tools that prepare data
- ▶ learn to understand the audience and their priorities
- ▶ learn to socialize the problems, knocking down silos
- ▶ learn to generate compelling **data visualizations**
- ▶ learn to estimate the confidence for reported results
- ▶ learn to automate work, making process repeatable



THE DATA SCIENCE WORKFLOW

Modeling

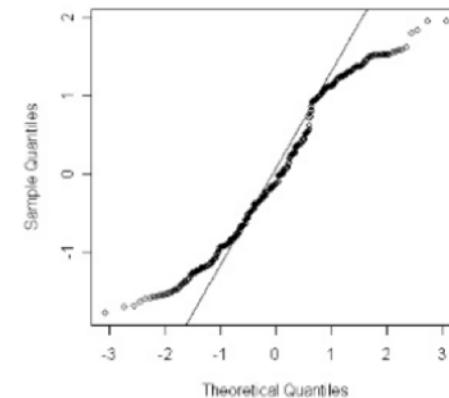
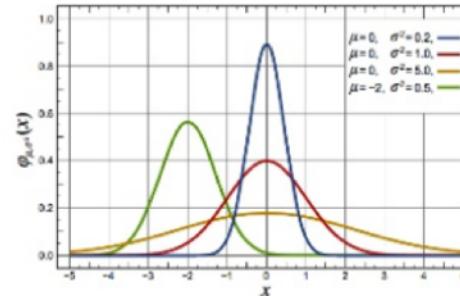
back in the day, we worked with practices based on
data modeling

1. sample the data
2. fit the sample to a known distribution
3. ignore the rest of the data
4. infer, based on that fitted distribution

that served well with ONE computer, ONE analyst,
ONE model... just throw away annoying "extra" data

circa late 1990s: machine data, aggregation, clusters, etc.
algorithmic modeling displaced the prior practices
of data modeling

because the data won't fit on one computer anymore



THE DATA SCIENCE WORKFLOW

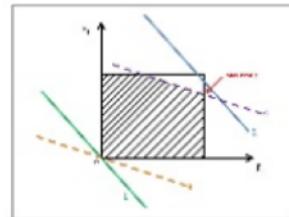
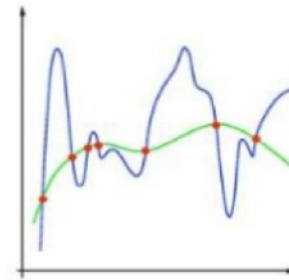
Learning Theory

in general, apps alternate between learning patterns/rules and retrieving similar things...

machine learning – scalable, arguably quite ad-hoc, generally “black box” solutions, enabling you to make billion dollar mistakes, with oh so much commercial emphasis (i.e. the “heavy lifting”)

statistics – rigorous, much slower to evolve, confidence and rationale become transparent, preventing you from making billion dollar mistakes, any good commercial project has ample stats work used in QA (i.e., “CYA, cover your analysis”)

once Big Data projects get beyond merely digesting log files, **optimization** will likely become the next overused buzzword :)



THE DATA SCIENCE WORKFLOW

Generalizations about Machine Learning...

great introduction to ML, plus a proposed categorization for comparing different machine learning approaches:

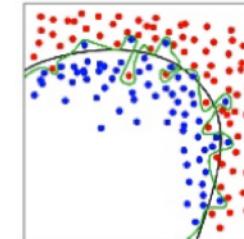
A Few Useful Things to Know about Machine Learning

Pedro Domingos, U Washington

homes.cs.washington.edu/~pedrod/papers/cacm12.pdf

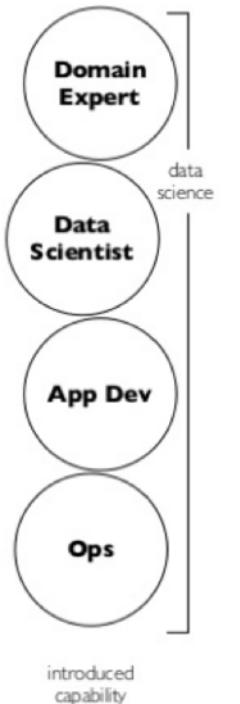
toward a categorization for Machine Learning algorithms:

- **representation**: classifier must be represented in some formal language that computers can handle (algorithms, data structures, etc.)
- **evaluation**: evaluation function (objective function, scoring function) is needed to distinguish good classifiers from bad ones
- **optimization**: method to search among the classifiers in the language for the highest-scoring one



THE DATA SCIENCE WORKFLOW

Team Composition = Roles



*business process,
stakeholder*

*data prep, discovery,
modeling, etc.*

*software engineering,
automation*

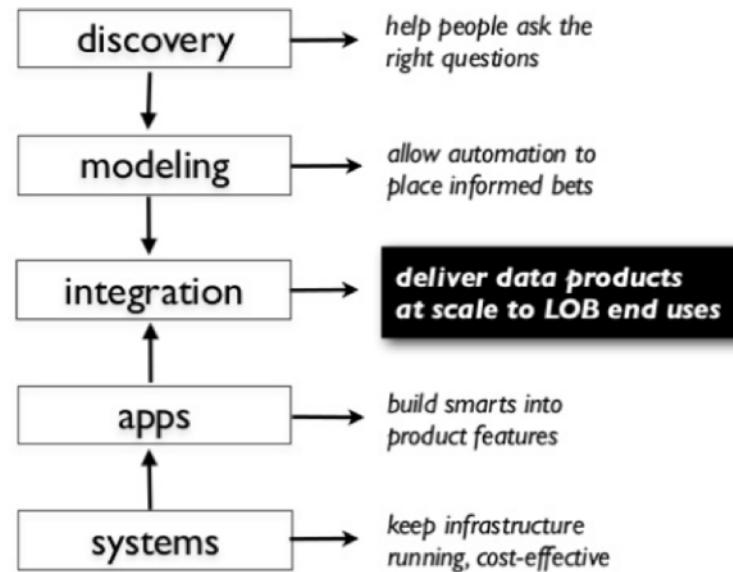
*systems engineering,
availability*



**leverage non-traditional
pairing among roles, to
complement skills and
tear down silos**

THE DATA SCIENCE WORKFLOW

Team Process = Needs



THE DATA SCIENCE WORKFLOW

Alternatively, Data Roles × Skill Sets



Harlan Harris, et al.

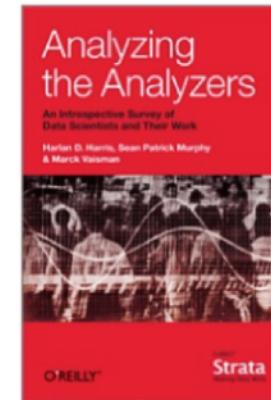
datacommunitydc.org/blog/wp-content/uploads/2012/08/SkillsSelfIDMosaic-edit-500px.png

Analyzing the Analyzers

**Harlan Harris, Sean Murphy,
Marck Vaisman**

O'Reilly, 2013

amazon.com/dp/B00DBHTE56



THE DATA SCIENCE WORKFLOW

Just Enough Mathematics?

having a solid background in **statistics** becomes vital,
because it provides formalisms for what we're trying
to accomplish at scale

along with that, some areas of math help – regardless
of the “calculus threshold” invoked at many universities...

linear algebra	e.g., calculating algorithms for large-scale apps efficiently
graph theory	e.g., representation of problems in a calculable language
abstract algebra	e.g., probabilistic data structures in streaming analytics
topology	e.g., determining the underlying structure of the data
operations research	e.g., techniques for optimization ... in other words, ROI

THE DATA SCIENCE WORKFLOW

Trendlines

Big Data? we're just getting started:

- ~12 exabytes/day, jet turbines on commercial flights
- Google self-driving cars, ~1 Gb/s per vehicle
- National Instruments initiative: **Big Analog Data™**
- 1m resolution satellites **skyboximaging.com**
- open resource monitoring **reddmetrics.com**
- Sensing XChallenge **nokiasensingxchallenge.org**

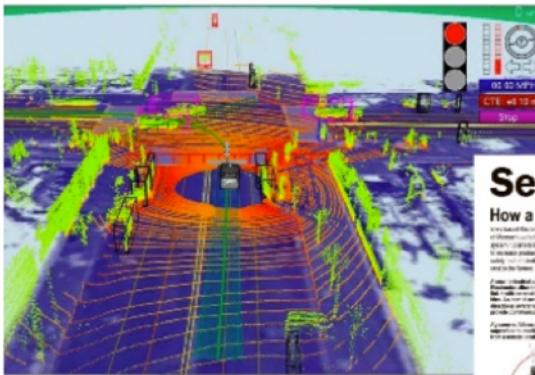
consider the implications of Jawbone, Nike, etc.,
plus the effects of Google Glass...



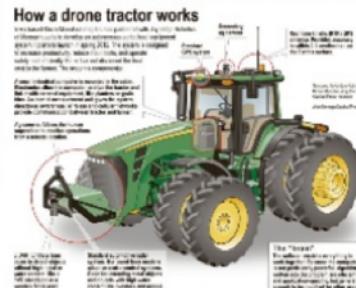
[technologyreview.com/...](http://technologyreview.com/)

THE DATA SCIENCE WORKFLOW

Internet of Things



Send in the drones

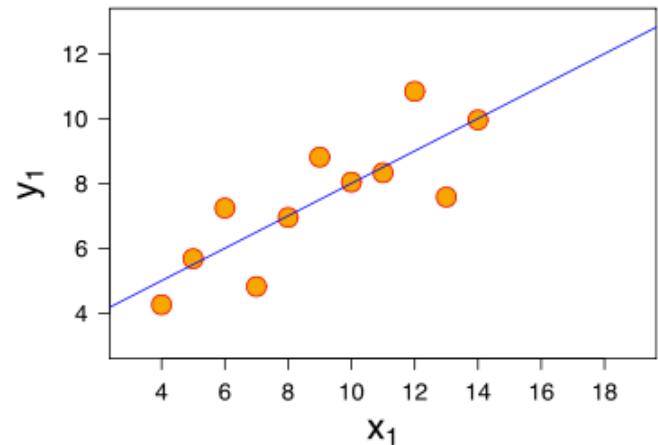


III. VISUALIZATIONS AS A MEDIUM

EXERCISE – WHY VISUALIZE DATA?

Consider the following dataset:

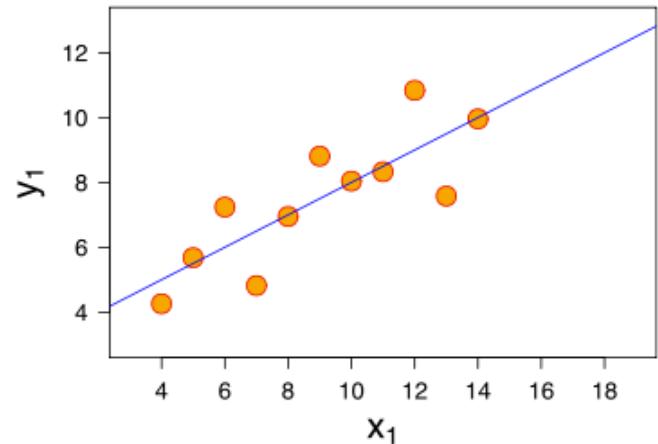
- *eleven (x, y) points*



EXERCISE – WHY VISUALIZE DATA?

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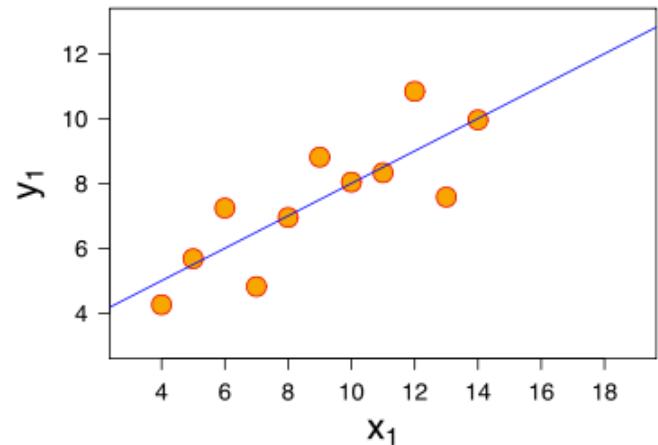
- *eleven (x, y) points*
- *mean of x = 9, mean of y = 7.5*



EXERCISE – WHY VISUALIZE DATA?

Consider the following dataset:

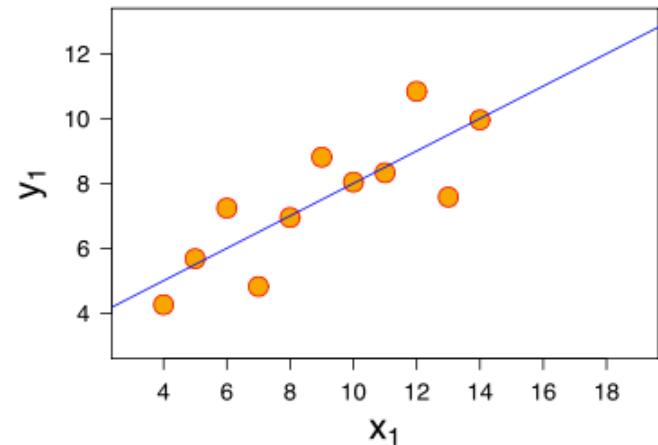
- *eleven (x, y) points*
- *mean of x = 9, mean of y = 7.5*
- *variance of x = 11, variance of y = 4.1*



EXERCISE – WHY VISUALIZE DATA?

Consider the following dataset:

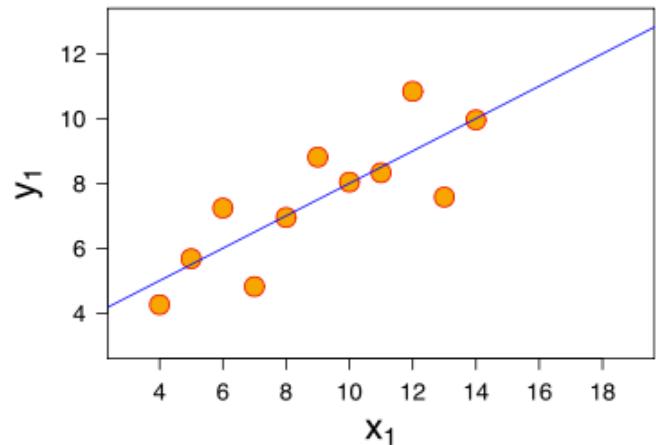
- *eleven (x, y) points*
- *mean of $x = 9$, mean of $y = 7.5$*
- *variance of $x = 11$, variance of $y = 4.1$*
- *correlation of x and $y = 0.8$*



EXERCISE – WHY VISUALIZE DATA?

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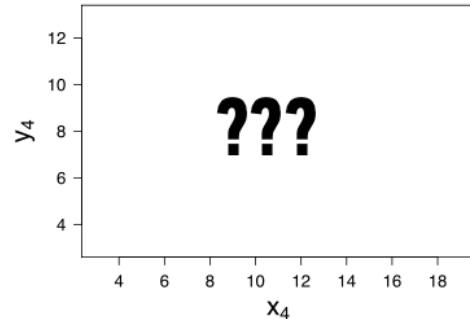
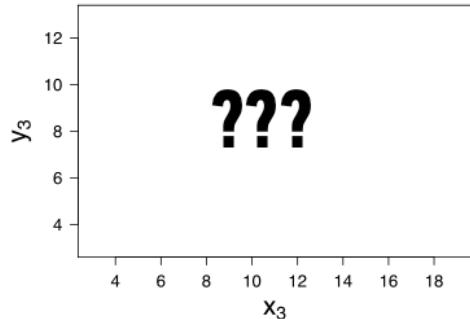
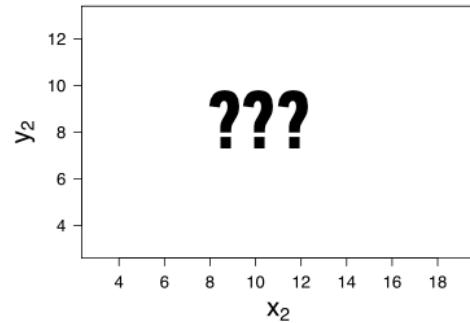
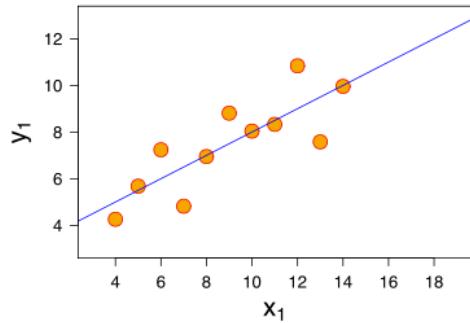
- *eleven (x, y) points*
- *mean of x = 9, mean of y = 7.5*
- *variance of x = 11, variance of y = 4.1*
- *correlation of x, y = 0.8*
- *line of best fit: $y = 3.00 + 0.500x$*



EXERCISE – WHY VISUALIZE DATA?

*Now, suppose I give you
three more datasets
with exactly the same
characteristics...*

*Q: how similar are these
datasets?*

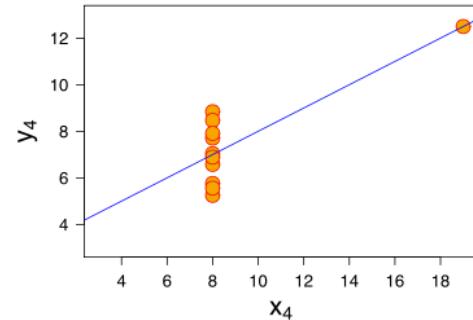
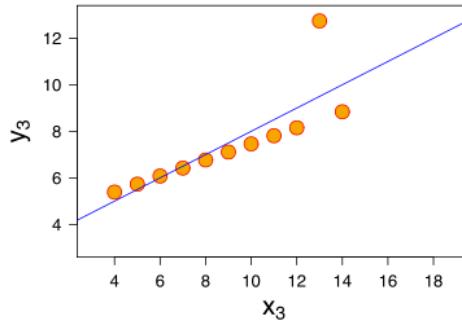
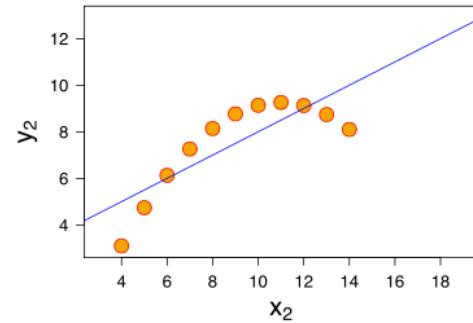
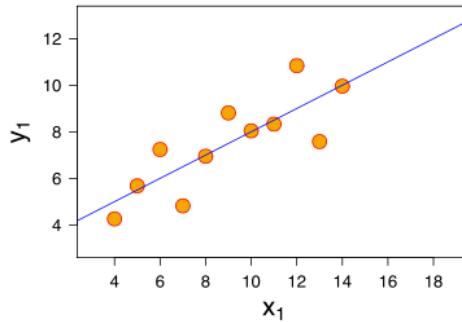


EXERCISE – WHY VISUALIZE DATA?

*Now, suppose I give you
three more datasets
with exactly the same
characteristics.*

*Q: how similar are these
datasets?*

A: not very!



EXERCISE – WHY VISUALIZE DATA?

Look at your data!

IV. WORKING AT THE UNIX COMMAND LINE

Pop Quiz!

(really :-)

EXERCISE – WORKING AT THE UNIX COMMAND LINE

KEY OBJECTIVES

- Navigate the filesystem
- Create, move, copy, and delete files & directories
- View & search files
- Edit & interact with files
- Combine steps
- Learn more

TOOLS

- ls, cd
- cat, touch, mv, cp, mkdir, rm, rmdir
- head, tail, less, cat, grep
- vim, tr, sort, uniq, wc
- pipe (|)
- man, apropos

NOTE

Being comfortable at the command line makes your life much easier!

V. INTRO TO I-PYTHON

INTRO TO DATA SCIENCE

DISCUSSION