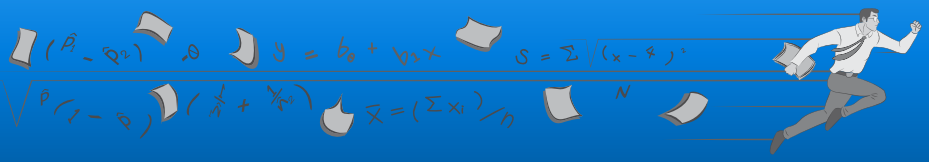
Data Science 2 Go LLC



Introduction to Data Science

about the instructor

Shep Sheppard

MCSE Data and Analytics, Microsoft Certified Trainer in Machine Learning and founder of Microsoft Partner Data Science 2 Go. Shep has 20 years experience in SQL Server, 9 years serving at Microsoft as Premier Field Engineer and Program Manager on the Azure Customer Advisory team working with SQL and Data Science Customers. His focus since founding Data Science 2 Go is to help bring Data Science and machine learning to the masses in a simple concise way without the intimidating language of academia.

Agenda

- What is Data Science?
- History in one slide
- How did we get here?
- What Skills are required?
- The Data Science Process
- Data Science Gone Wild
- How do I Data Science?

History in one slide

History

- The Title was anecdotally coined around 2008.
- Statistical foundations date to 1700.
- Data-Driven Science is an interdisciplinary field about scientific methods.
- Data Science derived from a 30 year old term Dataology.
- Data Science has become a popular moniker in the last ten years after HBR Article “The Sexiest Job of the 21st Century”.

$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)},$$

What is Data Science?

What is Data Science?

- **Data Science**
  - Interdisciplinary field about scientific methods to extract knowledge from data
  - Data science is a "concept to unify statistics, data analysis and their related methods" in order to "understand and analyze actual phenomena" with data.
- **Statistical Learning**
  - To Predict or Infer Y based on X
- **Artificial intelligence**
  - Colloquially, is applied when a machine mimics "cognitive" functions that humans associate with other human minds
- **Machine Learning**
  - Learn without being explicitly programed.
  - Closely related and often overlaps with computational statistics
- **Deep Learning**
  - At the heart of AI, combines supervised and unsupervised learning, multiple layers of cascading algorithms.
- **Neural Networks**
  - Inspired by biological neural networks, collection of small computing units

The Modern Data Scientist Math, Stats, Programming

The Modern Data Scientist, Domain and Communication

DOMAIN KNOWLEDGE & SOFT SKILLS

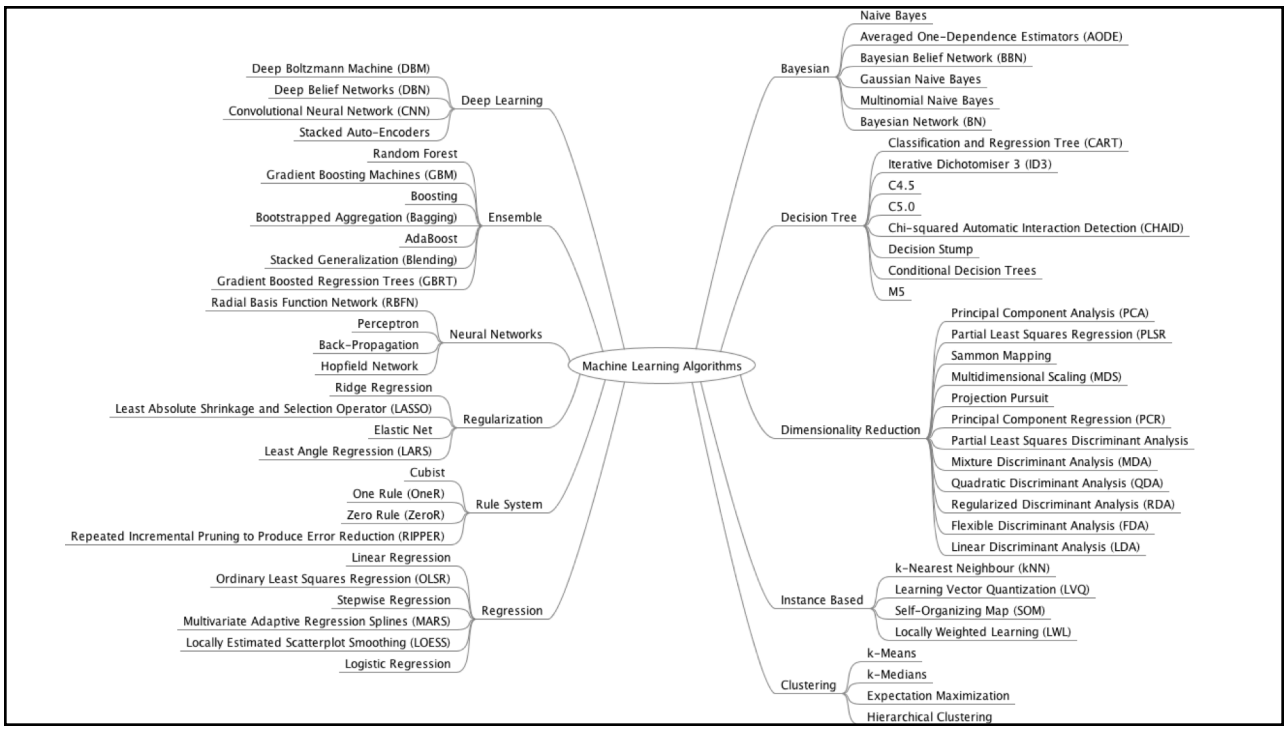
- ☆ Passionate about the business
- ☆ Curious about data
- ☆ Influence without authority
- ☆ Hacker mindset
- ☆ Problem solver
- ☆ Strategic, proactive, creative, innovative and collaborative

COMMUNICATION & VISUALIZATION

- ☆ Able to engage with senior management
- ☆ Story telling skills
- ☆ Translate data-driven insights into decisions and actions
- ☆ Visual art design
- ☆ R packages like ggplot or lattice
- ☆ Knowledge of any of visualization tools e.g. Flare, D3.js, Tableau

Gentle Intro to a few common algorithms

- In the next few slides we will discuss a few of the most common algorithms you may see and hear about
- Mind map of most of them
- Supervised, Unsupervised learning and PCA
- Trees and Forests
- Neural Networks



Supervised and Unsupervised Learning

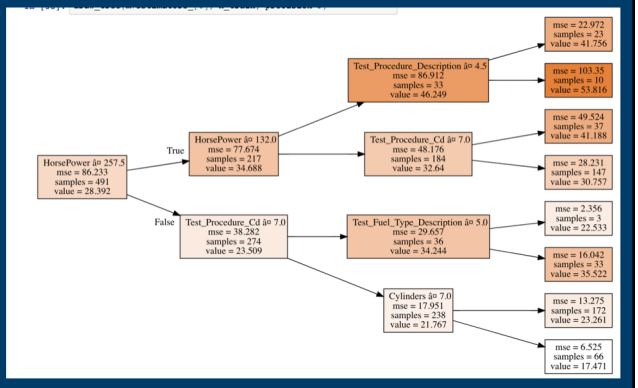
- Machine learning is broadly categorized into two main categories
- Supervised learning
  - Is a learning function that maps and input to an output based on sample input
  - For instance taking a sample of actual vehicle weight, horse power, engine size and mpg and using this data to estimate an unknown mpg based on weight, horse power, engine size
- Unsupervised learning
  - Is a model that learns from data that has not been labeled.
  - For instance, passing census or shopping data into a clustering algorithm and having it determine similarities in the data with no guidance from an operator.

A Few Common Supervised Models

- Linear Regression
  - To infer Y based on X, or many X's
  - For instance, you know the weight(X_1), engine size(X_2), and horsepower(X_3) of a car, can you infer the MPG (Y)?
- Logistic Regression or Logit
  - Used to determine a binary outcome, yes or no, or the probability of yes or now
  - Will it rain today? What is the likelihood of rain? Can be used to determine odds as well.

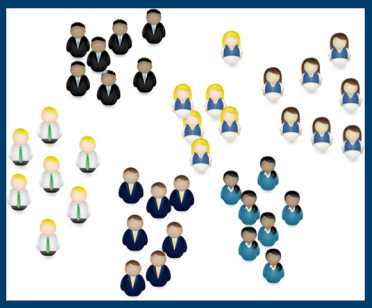
Trees and Forests

- Decision Tree
  - A tree like model of decisions and consequences.
  - Each branch takes you to the next decision
- Decision Forest
  - Multiple Decision Trees combined together that should provide greater predictive accuracy and will help account for outliers.



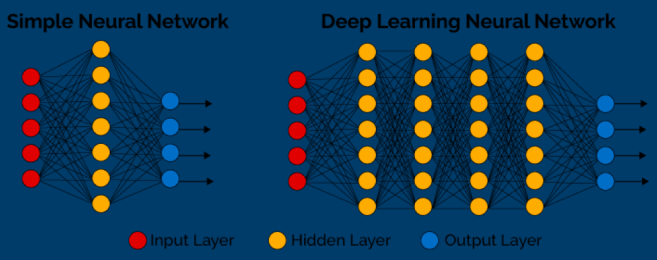
Unsupervised models

- K-Nearest Neighbor (KNN)
  - Is as the name suggest find items that are near and alike
- K-Means (Clustering)
  - Based on a specified number of clusters divide the data into like clusters based on distance
- Principal Component Analysis (PCA)
  - This is typically used for Dimensionality Reduction or
  - When you have hundreds or thousands of variables in you dataset, PCA can help eliminate the nonessential ones
  - It will identify linearly correlated and uncorrelated features



Neural Networks (Deep Learning)

- Neural Network
  - The neural network itself is not an algorithm, but rather a framework for many different machine learning algorithms to work together and process complex data input
  - Such systems "learn" to perform tasks by considering examples, generally without being programmed with any task-specific rules.

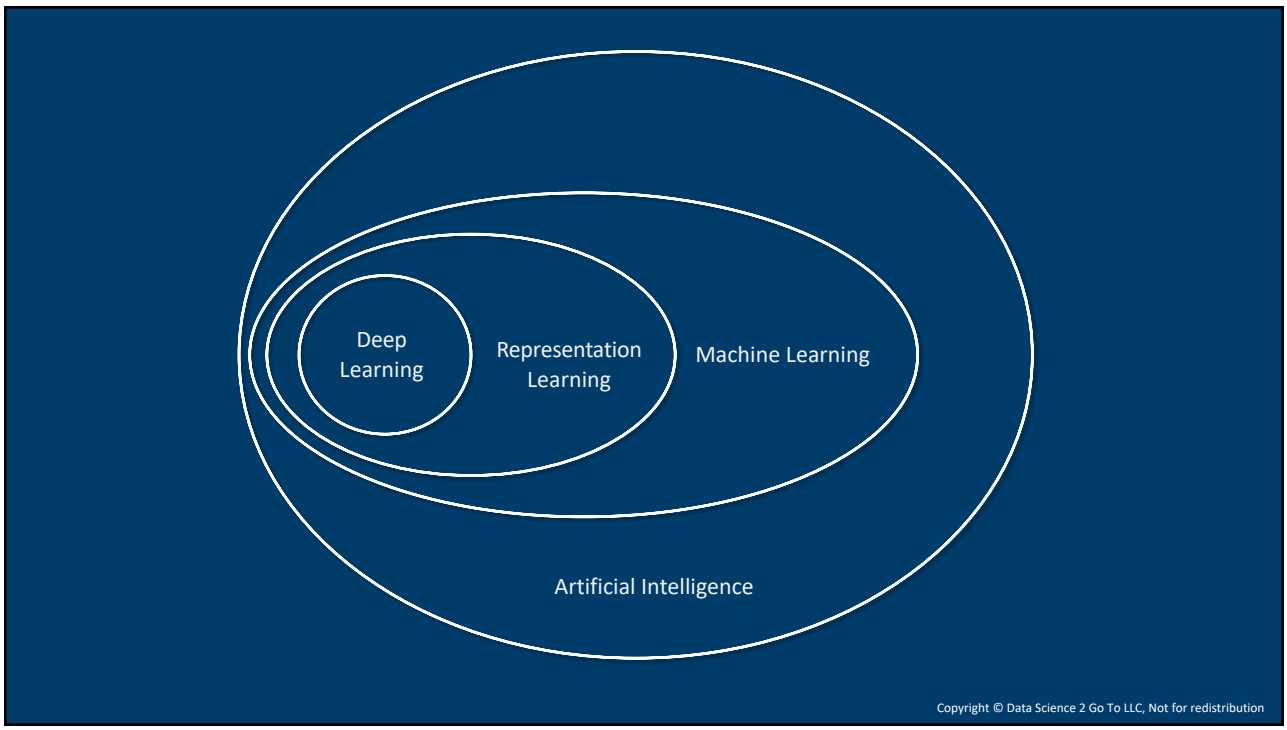


Two Common Neural Nets

- Convolutional Neural Network
  - CNNs are suitable for processing visual and other two-dimensional data
- Recurrent Neural Network
  - RNNs while complex, are typically used for machine translation, speech detection, text, word and sentiment analysis
  - RNNs can combined with other Neural Nets to improve accuracy.
  - RNNs can also generate sentences based on data fed in

Reinforcement Learning

- Reinforcement Learning relies on providing a machine learning model with rules and constraints
- Thus allowing the model to learn how to achieve its goals
- Define the state of the desired goal, allowed actions and constraints
- Such as, do not touch a flame, it is hot and will hurt you



How did we get here?

Archive and Purge used to be a thing

- Storage has become cheaper and faster
  - Cloud Storage is a race to the bottom to see who can eventually offer it for free
- Databases have become faster (For Reals!).
- Column and Table compression has become mainstream
  - SQL CCI is capable of 98%-99% compression in specific cases.
  - Every database technology offers some form of compression
- Expectation of value in the data, though little knowledge of how to derive it.
- Massively parallel scale out became real! 1000+ nodes, just not with MSSQL.

Data Spewing Devices

- Light Bulbs
- Belts
- Wine Bottle
- BBQ Grill
- Trash can
- Tortilla Maker
- Water Bottle
- Bluetooth Smart Fork
- YOU

I present to you the Smalt

Smart Home meets Smart Dining

THE WORLD'S FIRST INTERACTIVE CENTERPIECE AND SMART SALT DISPENSER
DESIGNED TO ENHANCE YOUR DINING EXPERIENCE

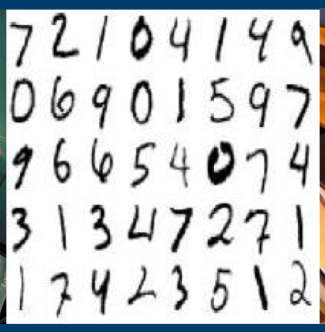
Data Science in the Real World

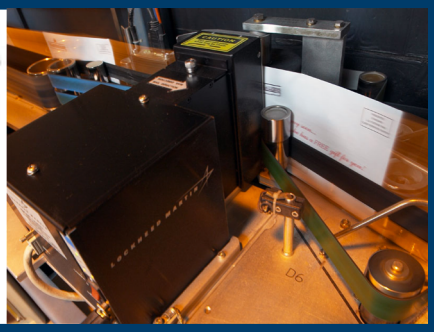
What is it used for?

- Hand writing recognition
- Predicative maintenance
- Machine Translation, real time
- Natural Language Processing (NLP)
- Predictive text
- Financial Fraud Detection
- Search, Google, Bing
- Money ball Scenarios
- Athletic Performance Optimization
- Fitness Trackers
- Suicide Prevention
- Police Adverse Interactions
- Medical Diagnosis – IBM Watson
- Autonomous Cars
- Terrorist or Refugee
- Tracking YOU
- Recurrent Neural Network

Hand Writing Recognition

- Post office has used this for decades to read city/state/zip
- First MPLSM OCR installed November 1965





(Multiposition Letter Sorting Machine)

Predictive Maintenance

- Future impact based on past behavior
- The old days, ATA codes on an aircraft that are known to cause delays
- Sensors monitoring components near failure
- A380 had 10,000 sensors per wing…
- Can generate up to 2.5Tb of data per day

Machine Translation, Real Time

- Microsoft Skype Translator, 10 languages Voice, 60 for text
- Waverly Labs Pilot, 15 languages, connected to your phone
- Modern day Babel fish or Rosetta stone

Natural Language Processing

- NLP
- Anti Spam
  - Reads emails and looks for spam like patterns
- Create Ads and New Spam
  - Read your emails then target you with offers
- Summarize lots of stuff
  - Twitter
  - Knowledge Extraction
- Q&A –
  - Imagine with no users responding just the corpus of past interactions being fed up by algorithm.
  - The Chat Bot

Predictive Text

- Predictive text (Hidden Markov, T9)
- N-Grams (NLP)
- Good-Turing Smoothing (N-Gram)
- Autocorrect and failed Autocorrect

T3XT

Financial Fraud Detection

- Credit Card used where it was not supposed to be
- Money moved in a nefarious way
- Improper purchases by employee
- Forensic Accounting
- Earnings Manipulation
- Some use a several machine learning techniques depending on the complexity

Search

- Bing,
- Google
- RankBrain
- Complex combination of Machine learning, and AI used for scoring, ranking web pages, and interpreting queries and determining intent.
- And most importantly, serving ads up to you based on search history

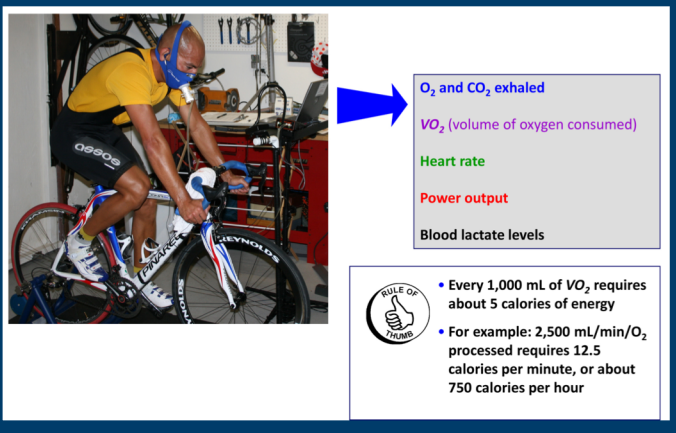
DS in the Real World – Money Ball

- Boston Red Sox (Money Ball Scenario)
- World Series 1903, 1912, 1915, 1916, 1918… then Nothing
- Oakland Athletics started winning using data– Made famous by the Michael Lewis book and movie Moneyball about data driven decision making.
- 2003 John Henry bought Red Sox, Henry anecdotally know as a data driven guy
- Using Data Driven Methodology, won World Series 2004, 2007, 2013
- They then abandon the methodology to go with old school recruiting

Red Sox continued

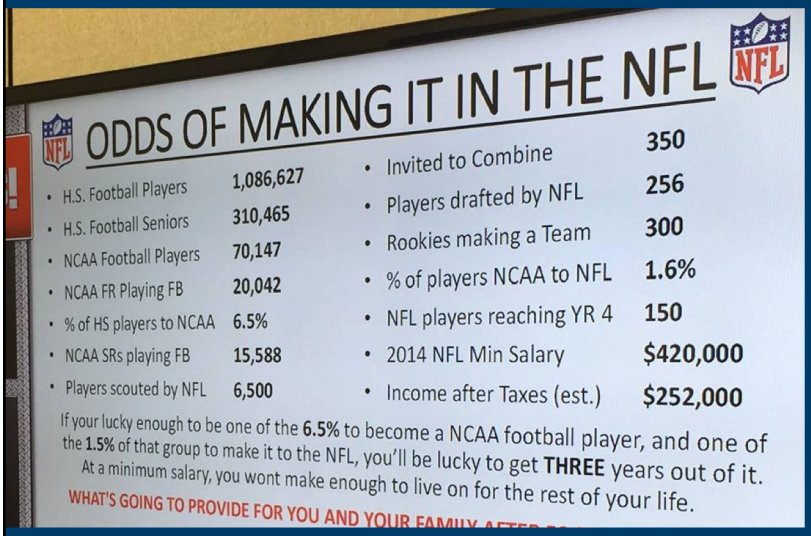
- "Well, the Red Sox have been following the data, and over the last several years (2013 notwithstanding) the evidence is not that great. All of this data hasn't done them a lick of good. " Ron Miller TechCrunch.com
- Data Driven methodology is heavily used, and very unpopular in sports.
- Really?
- Gamblers Reverse Fallacy?
  - I've been winning, so my imaginary odds are I must continue winning!
- Anecdotally, they Won again in 2018
- The larger analytics story in sports is marketing, butts in seats, and ticket pricing

Athletic Performance Optimization

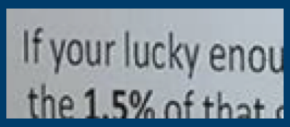


- There is a "*large*" market for professional sports data science
- Teams spend a lot of time and money finding the next Tom Brady
- Imagine the athlete as an IoT device
- Then attempt to govern the device and predict the next one…

Athletic Performance Prediction, NFL



- Why it matters?
- 89.8% Retirement rate by year 4!

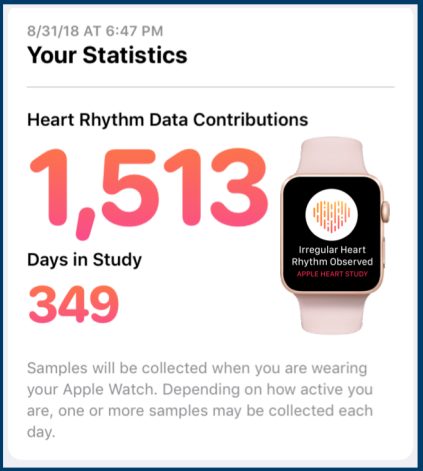


Fitness Trackers

- Constant battle to try and track and predict the next big thing.
- HIPAA issues with tracking and uploading some data.
- They are unable to solve some issues with machine learning, some are waiting on the magical AI to solve their problems.
- Microsoft Band failed at it, discontinued fall 2016.
- Cannot be a diagnostic tool due to FDA regulations, not even a heart rate monitor. Though Apple is working with the FDA on this.
- Anecdotal evidence of users claiming it saved their lives.

Stanford Medicine Apple Heart Study

- The Apple Heart Study app uses data from Apple Watch to identify irregular heart rhythms, including those from potentially serious heart conditions such as atrial fibrillation.
- Apple is conducting this research study in collaboration with Stanford Medicine to improve the technology used to detect and analyze irregular heart rhythms, like atrial fibrillation - a leading cause of stroke.



Suicide Prevention - DSFSG

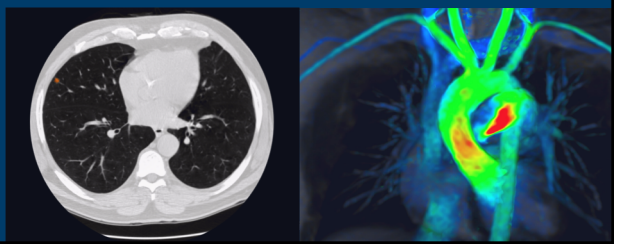
- Florida State University - FSU Psychology researcher Dr. Jessica Ribeiro
- “Studies show about 60-90 percent of people who die by suicide had visited their medical provider within the past year and the clinician never saw it coming. ”
- ”machine learning — a future frontier for artificial intelligence — can predict with 80-90 percent accuracy whether someone will attempt suicide as far off as two years into the future. ”
- “giving clinicians the ability to predict who will attempt suicide up to two years in advance with 80 percent accuracy.”

Predicting Police Adverse Interaction - DSFSG

- Data Science for Social Good Project at U Chicago
  - Check out their website https://dssg.uchicago.edu/ &
  - White House Police Data Initiative
- Tested with *Charlotte-Mecklenburg Police District and* Metro Nashville Police Department
- *Correctly* Predict when a police officer is at increased risk of an adverse interaction
- The model used a full cadre of data, demographics, join date, arrests, dispatches, training, IA activity, weather, quality of life surveys.
- Model correctly flagged 10—20% more officers that were later involved in an adverse interaction over EIS. (eventually 80% total prediction using Random Forest)
- Reduced the Type 1 errors(false positive), by 50%

Medical Diagnosis

- Arterys is the First FDA Approval of Machine Learning for diagnosis was January 2017.
  - Imaging cloud based platform to help doctors diagnose heart problems.
  - Personally identifiable medical data is stripped from file before uploading to cloud to get around HIPPA
- IBM Watson for Oncology
  - Appears to be NLP mixed with Classification, but it is AI, which combines NLP, Deep Learning and Machine Learning.
  - EVERY clinical trial known stored in one place.



Autonomous Vehicles

- Otto by Uber (Shuttered)
- Tesla, Google
- Fully Autonomous Race car
- 18 Wheelers Soon
- Common tool is Simultaneous localization and mapping (SLAM)
- SLAM is a complete system of Algorithms - AI

Terrorist or Refugee?

- IBM Watson, NSA, FBI, CIA, using any graph DB system.
- Graph theory study of mathematical structures used to model pairwise relationships.
- This is how social media figures out who you might know.
- If you follow subject A and subject A follows nefarious subject B, likely guilt by association.

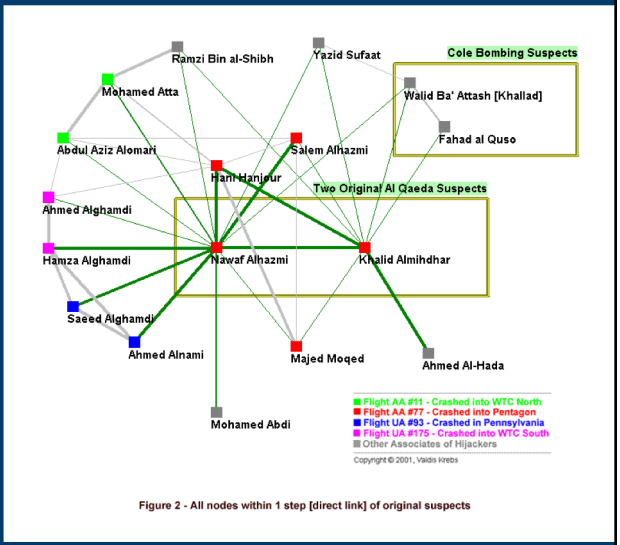


Figure 2 - All nodes within 1 step [direct link] of original suspects

Customer Tracking

- Loyalty Apps for Malls, Shopping Centers.
- Connect to WiFI, tracks your position in a shopping center.
- The dirty little secret, they are tracking you if you do not have the loyalty app installed.
- Wifi routers capture mac address, two or more routers can triangulate your location.
- Used to track where you are to provide recommendations to future customers.
- Visit length, location every second, frequency of visits, if you are in a pack, which stores you visit.

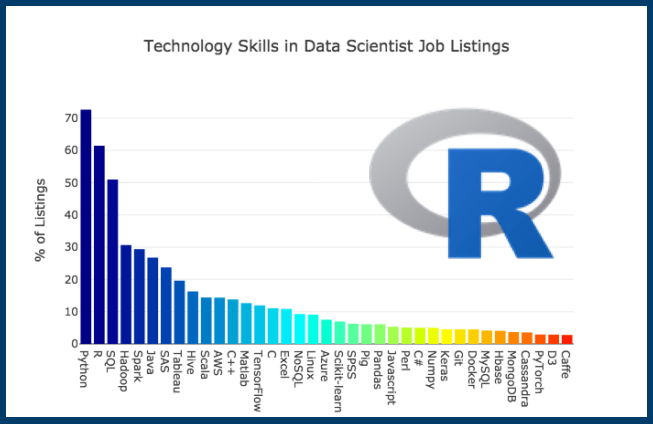
Merchandise Tracking

- What to do with a smart Button?
- Smart Washing Machines
- Have a store inventory itself
- Walk out without stopping at a register
- Track you when you come back in?

What Skills might a Data Scientist have?

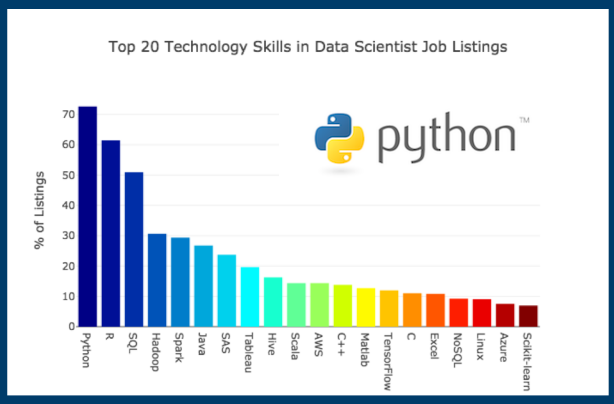
Popular Data Science Skills, KDNuggets

- The chart shows an even bigger list of the most in demand languages, frameworks, and other data science software tools.

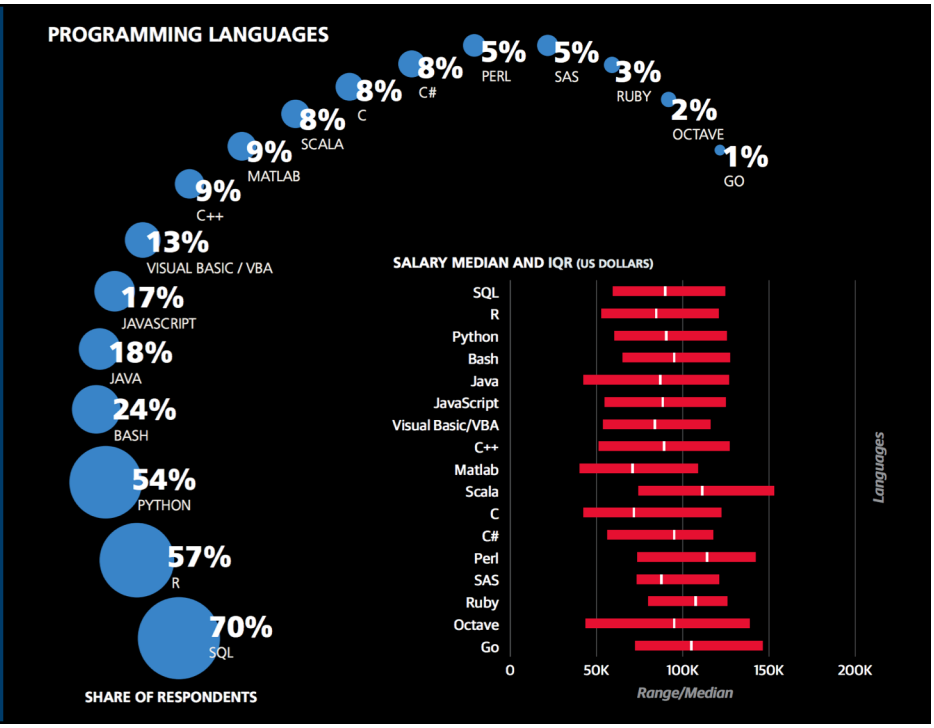


Popular Languages, libraries, and tools, KDNuggets

- The top 20 specific languages, libraries, and tech tools employers are looking for data scientists to have experience with.

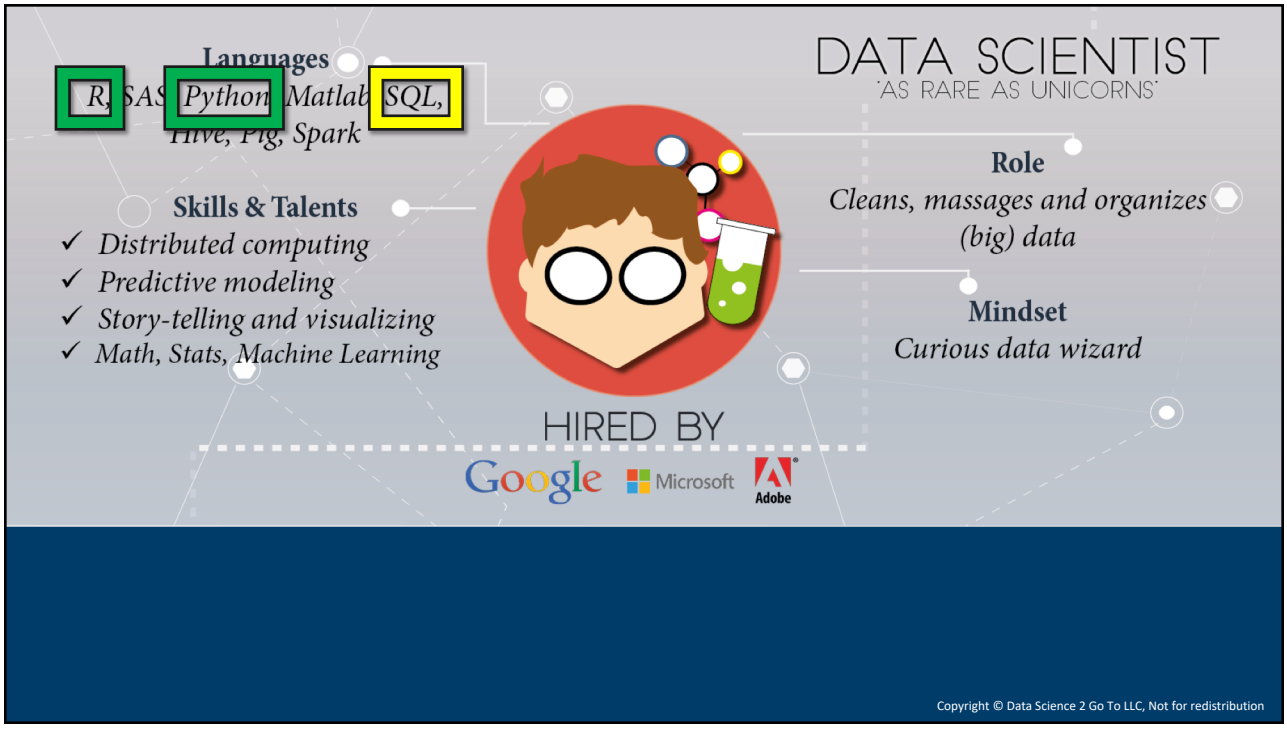


O'Reilly 2016 Data Science Salary Survey



What do the data skills have in common?

- Data Scientist
- Data Analyst
- Data Architect
- Data Engineer
- Statistician
- Database Administrator
- Business Analyst
- Data and Analytics Manager



DATA ANALYST

'DATA DETECTIVE'

Role

Collects, processes and performs statistical data analyses

Mindset

Intuitive data junkie with high "figure-it-out" quotient

Languages

R, Python, HTML, Javascript, C/C++, SQL

Skills & Talents

- ✓ *Spreadsheet tools (e.g. Excel)*
- ✓ *Database systems (SQL and NO SQL based)*
- ✓ *Communication & visualization*
- ✓ *Math, Stats, Machine Learning*

HIRED BY

IBM hp DHL

DATA ARCHITECT

'THE CONTEMPORARY DATA MODELLER'

Languages

SQL, XML, Hive, Pig, Spark

Skills & Talents

- ✓ *Data warehousing solutions*
- ✓ *In-depth knowledge of database architecture*
- ✓ *Extraction Transformation and Load (ETL), spreadsheet and BI tools*
- ✓ *Data modeling*
- ✓ *Systems development*

Role:

Creates blueprints for data management systems to integrate, centralize, protect and maintain data sources

Mindset:

Inquiring ninja with a love for data architecture design patterns

HIRED BY

VISA Coca-Cola logitech

DATA ENGINEER

'SOFTWARE ENGINEERS BY TRADE'

Role

Develops, constructs, tests and maintains architectures (such as databases and large-scale processing systems)

Mindset

All-purpose everyman

HIRED BY

Spotify

Languages

SQL, Hive, Pig, R, Matlab, SAS, SPSS, Python, Java, Ruby, C++, Perl

Skills & Talents

- ✓ *Database systems (SQL & NO SQL based)*
- ✓ *Data modeling & ETL tools*
- ✓ *Data APIs*
- ✓ *Data warehousing solutions*

STATISTICIAN

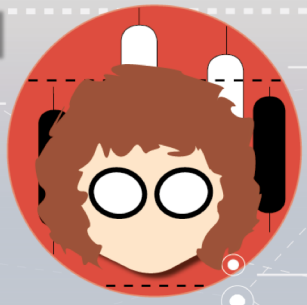
'HISTORIC LEADERS OF DATA'

Languages

R, SAS, SPSS, Matlab, Stata, Python, Perl, Hive, Pig, Spark, SQL

Skills & Talents

- ✓ *Statistical theories & methodology*
- ✓ *Data mining & machine learning*
- ✓ *Distributed Computing (Hadoop)*
- ✓ *Database systems (SQL and NO SQL based)*
- ✓ *Cloud tools*



HIRED BY

LinkedIn Johnson & Johnson PEPSICO

Role

Collects, analyzes and interprets qualitative as well as quantitive data with statistical theories and methods

Mindset

Logical and enthusiastic stats genius

DATABASE ADMINISTRATOR

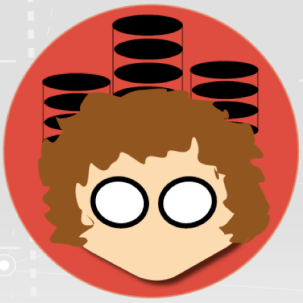
"DATABASE CARETAKER"

Role

Ensures that the database is available to all relevant users, is performing properly and is being kept safe

Mindset

Master of Disaster Prevention



HIRED BY

tableau reddit

Languages

SQL, Java, Ruby on Rails, XML, C#, Python

Skills & Talents

- ✓ *Backup & recovery*
- ✓ *Data modeling and design*
- ✓ *Distributed Computing (Hadoop)*
- ✓ *Database systems (SQL and NO SQL based)*
- ✓ *Data security*
- ✓ *ERP & business knowledge*

BUSINESS ANALYST

"CHANGE AGENT"

Languages

SQL

Skills & Talents

- ✓ *Basic tools (e.g. MS Office)*
- ✓ *Data visualization tools (e.g. Tableau)*
- ✓ *Conscious listening and storytelling*
- ✓ *Business Intelligence understanding*
- ✓ *Data modeling*

HIRED BY

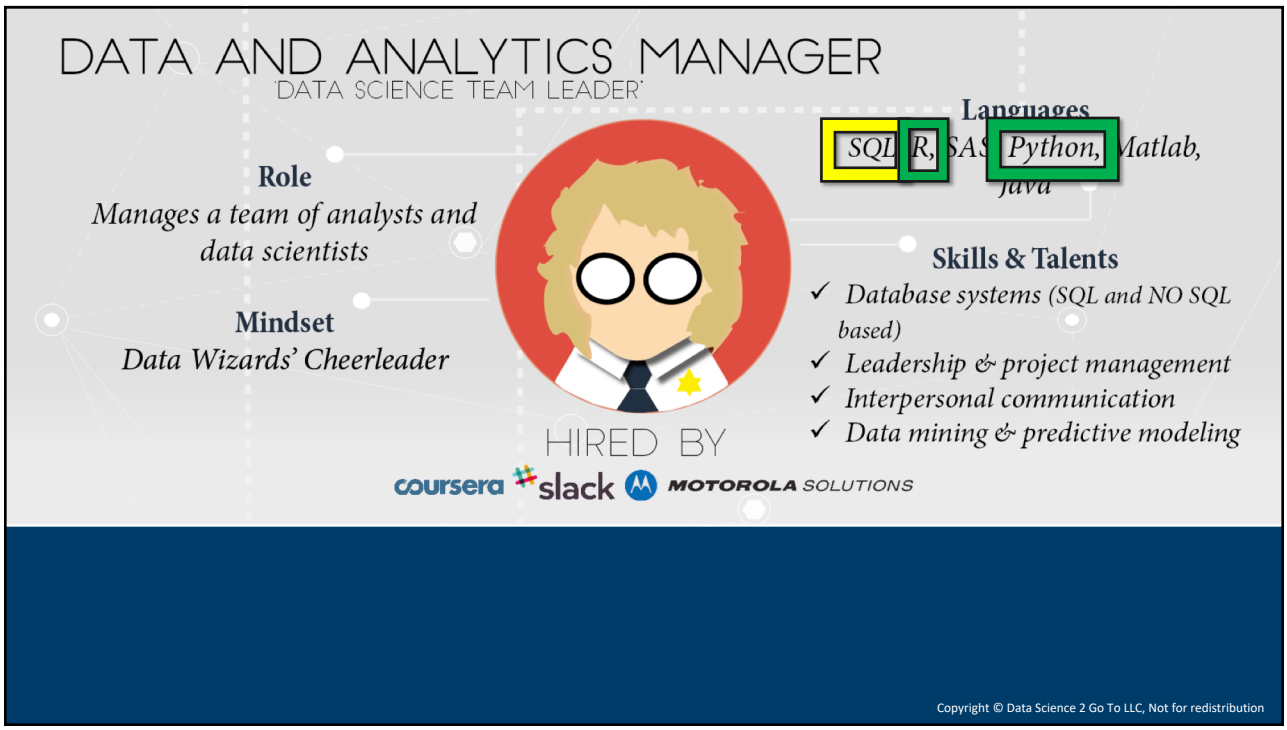
UBER DELL ORACLE

Role

Improves business processes as intermediary between business and IT

Mindset

Resilient project juggler

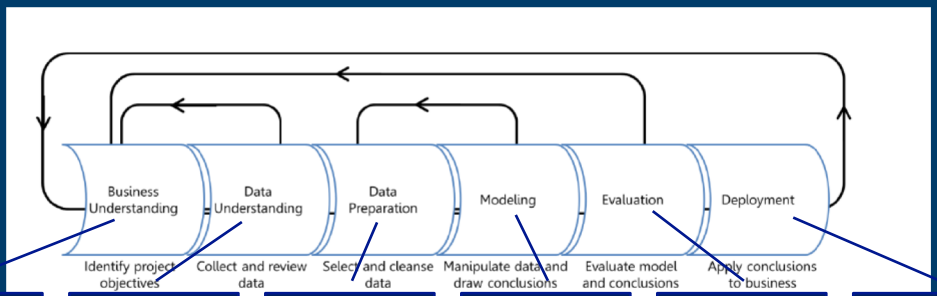


The Data Science Process

The Data Science Process

- Exploratory Data Analysis (EDA)
- Data cleansing and preparation
- Model feature engineering
- Model training and evaluation
- Model deployment
- The specialized roles in the data science process

The Data Science Process



Problem:
The company loses sales because inventory is exhausted.

Can we stock shelves ahead of time with the correct inventory, i.e. can we predict demand?

Data Scientists explore data available to find patterns and relationships to the business problem, i.e. what drives demand?

Data Scientists cleanse and transform the data as needed to support modeling. Some columns may need to be aggregated and others reformatted.

Features, the attributes that can be used to predict the outcome, are identified and extracted, potential machine learning models are selected and trained.

The trained models are evaluated and compared to find the one that performs the best, i.e. the one that most reliably predicts sales.

The best performing model is deployed to an environment where it can be used by applications to make predictions.

Data Science Gone Wild

Artificial Intelligence

- Colloquially, the term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving"

The Turing Test

- Via text only test a machines ability to mimic human interaction.
- If the human is unable to distinguish between computer and human, the computer is said to have past the test.

Google Duplex

AI Assistant and Ethics

- This demonstration by Google immediately brought up questions of ethics, should the AI Assistant announce itself as AI?

Will Data Science and AI destroy the world?

Probably not

In Fantasy?

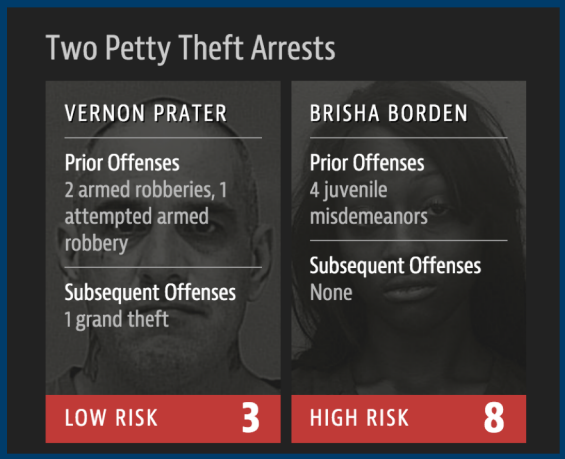
- ""In short, success in creating AI could be the biggest event in the history of our civilization," ***Prof Hawking said.***
- "But it could also be the last unless we learn how to avoid the risks.
- "Alongside the benefits, AI will also bring dangers – like powerful autonomous weapons, or new ways for the few to oppress the many." "

Has it happened yet?

4Chan trolled Microsoft's Twitter AI chat bot Tay and taught it to be a racist in less than a day

Bias in Recidivism

- ProPublica did a multi year investigation on recidivism and the machine learning tools used to predict it.
- Their determination was that there exists significant bias in the models, though the creator of the software denies it.
- **The point: The model represents what you put into it.**



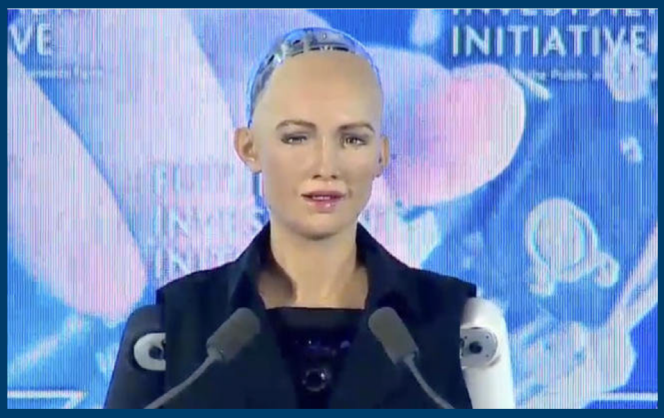
https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing

Michigan Unemployment System

- Michigan Integrated Data Automated System (Midas)
- Michigan unemployment agency made over 20,000 false fraud accusations, 93% rejection rate. (Type 2 Error)
- Automated system erroneously accused claimants in 93% of cases, state review finds: 'It's balancing the books on the backs of the poorest,' lawyer says
- Bankruptcy petitions filed as a result of unemployment insurance fraud also increased during the timeframe when Midas was in use.

https://www.theguardian.com/us-news/2016/dec/18/michigan-unemployment-agency-fraud-accusations

Meet Sophia, Saudi Arabia has become the first country to give a robot citizenship.



- "I want to use my artificial intelligence to help humans live a better life, like design smarter homes, build better cities of the future."


Elon Musk
@elonmusk
Follow
Just feed it The Godfather movies as input. What's the worst that could happen?
Carl Quintanilla @carlquintanilla
Our @andrewrsorkin, interviewing "Sophia" the robot, of Hanson Robotics:
@CNBC
5:06 PM - 25 Oct 2017
4,460 Retweets 18,455 Likes
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Dmitry Rogozin
@DRogozin
Follow
Shooting exercises is a method of teaching the robot to set priorities and make instant decisions. We are creating AI, not Terminator
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Recurrent Neural Network

- Create AI written Yelp Reviews – Crowdturfing
  - "I love this place. I have been going here for years and it is a great place to hang out with friends and family. I love the food and service. I have never had a bad experience when I am there."
  - "I had the grilled veggie burger with fries!!!! Ohhhh and taste. Omgggg! Very flavorful! It was so delicious that I didn't spell it!!"
  - "My family and I are huge fans of this place. The staff is super nice and the food is great. The chicken is very good and the garlic sauce is perfect. Ice cream topped with fruit is delicious too. Highly recommended!"

Ethics

"not worried about artificially intelligent death bots"

"Algorithms help courts set bail, determine which news stories appear on Facebook users' feeds, and sometimes decide who will be given a line of credit from a bank."

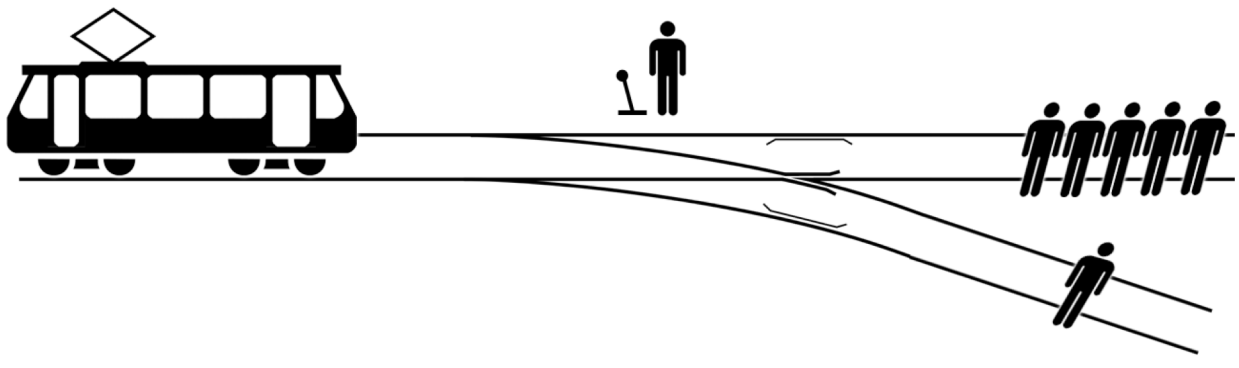
"One popular misconception is that if it's an algorithm, then it's unbiased—it has some kind of inherent objectivity,"

"Algorithms are not neutral. They are maximizing parameters that were chosen by the people that designed [them]."

Urs Gasser,
Berkman Klein Center for Internet and Society
Harvard Law School

The Trolley Problem

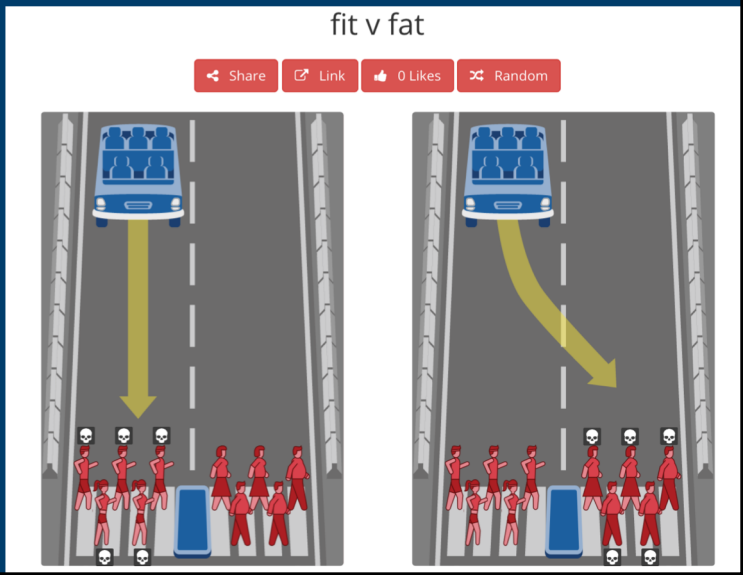
- Who to kill? Self driving cars are the new trolley problem.



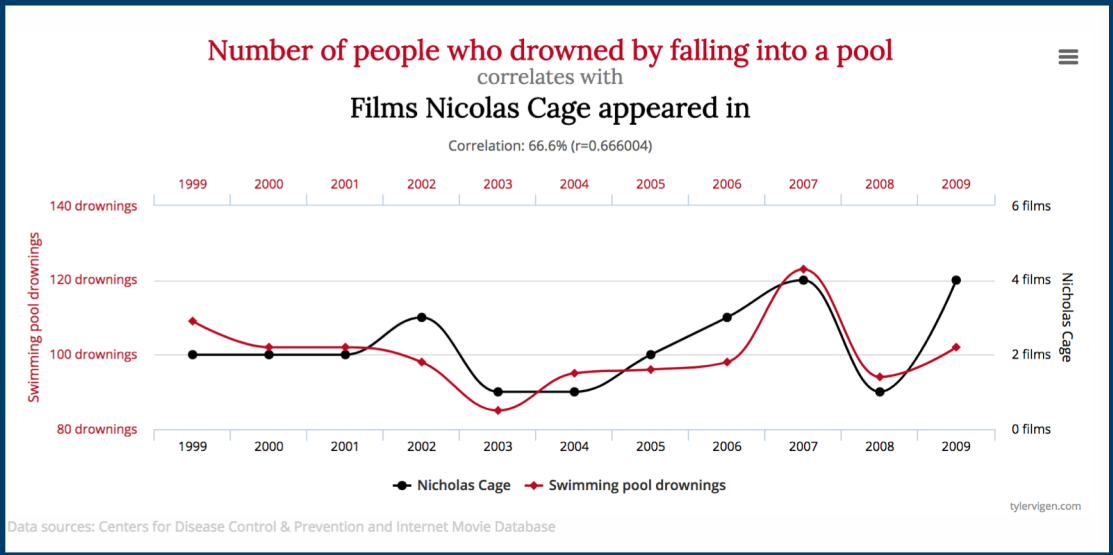
The Moral machine

- Human perspectives on moral decisions made by machine intelligence

http://moralmachine.mit.edu



Final Thoughts



How do I Data Science?

Why you should!

"The best minds of my generation are thinking about how to make people click ads. That sucks."

Jeff Hammerbacher

Just Start

- Pick a pillar you are interested in and go to town.
- Senior SQL Experts already have the skills to do data engineering.
- Start with a stats course, many of them are free
- Buy a book (Better Know your Stats)
  - The R Book - Free
  - Introduction to Statistical Learning with R - Free
  - Hadley Wickham is very popular – Mostly Free
  - R For Everyone Jared Lander – Not free
- The boundaries for learning knew technologies are your own

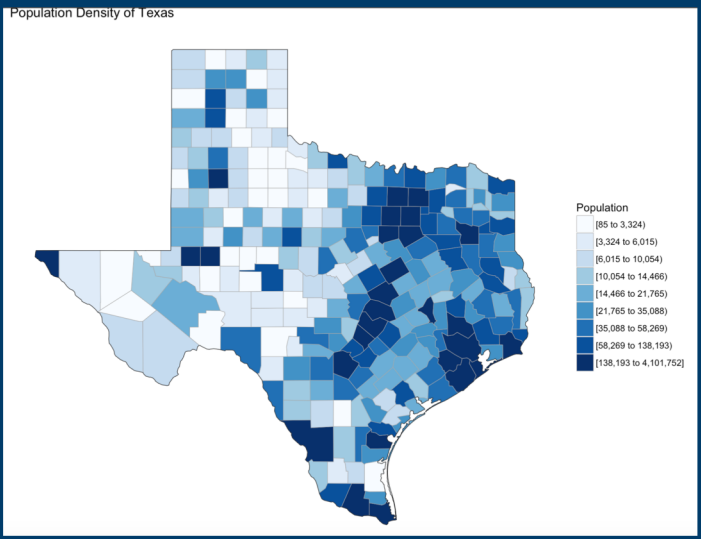
Community Driven Learning

- Local Meetups and Hackathons
- Bring hackathon to work!
- Make it happen!
- Online training
- Practice, Practice, Practice

Visualization is the gateway drug to statistics

```
install.packages("choroplethr")
library("choroplethr")
data("df_pop_county")

county_choropleth( df_pop_county, title = "Population
Density of Texas",
      legend="Population",
      num_colors=9,
      state_zoom="texas" )
```



Take an Immersion Class for months?

- Popup immersion facilitates are as rampant as Microsoft Certifications centers were 20 years ago.
- *Many* University have some form of Big Data/Data Science Program/Certificate/Micro Masters.
- None of the DS folks I have worked with have a “Degree” in Data Science.(*Yet*)
- Whaaaaaa? Where do they all come from?
  - Other fields that have a requirement for deep stats and machine learning

What's the point?

- Either start with the data you already work with
  - Working with data you are already a domain expert in is the best place to start.
  - If sports is your thing, start with Sports Predictive analytics, HUGE community.
- Or Find a field you are interested in
  - If you want to break into something new look for available data sources that you can learn from
- Data Science for Social Good
  - If you have any of the skills mentioned in prior slides, even just SQL, there is a space for you,
- Then Start!

Agenda

- What is Data Science?
- History in one slide
- How did we get here?
- What Skills are required?
- Data Science Gone Wild
- How do I Data Science?