INTRODUCTION TO DATA SCIENCE

CSC 495/663

THE UNIVERSITY of NORTH CAROLINA
GREENSBORO

DATA SCIENCE

What Data Science?

- Tools, techniques, science to solve Big Data / Data problems
  - Big data is a broad term for *data-sets* that are large and/or complex.
- Challenges include analysis, capture, data-curation, search, machine learning, statistics, sharing, storage, transfer, visualization, and information privacy.

How is it different from Data Analytics

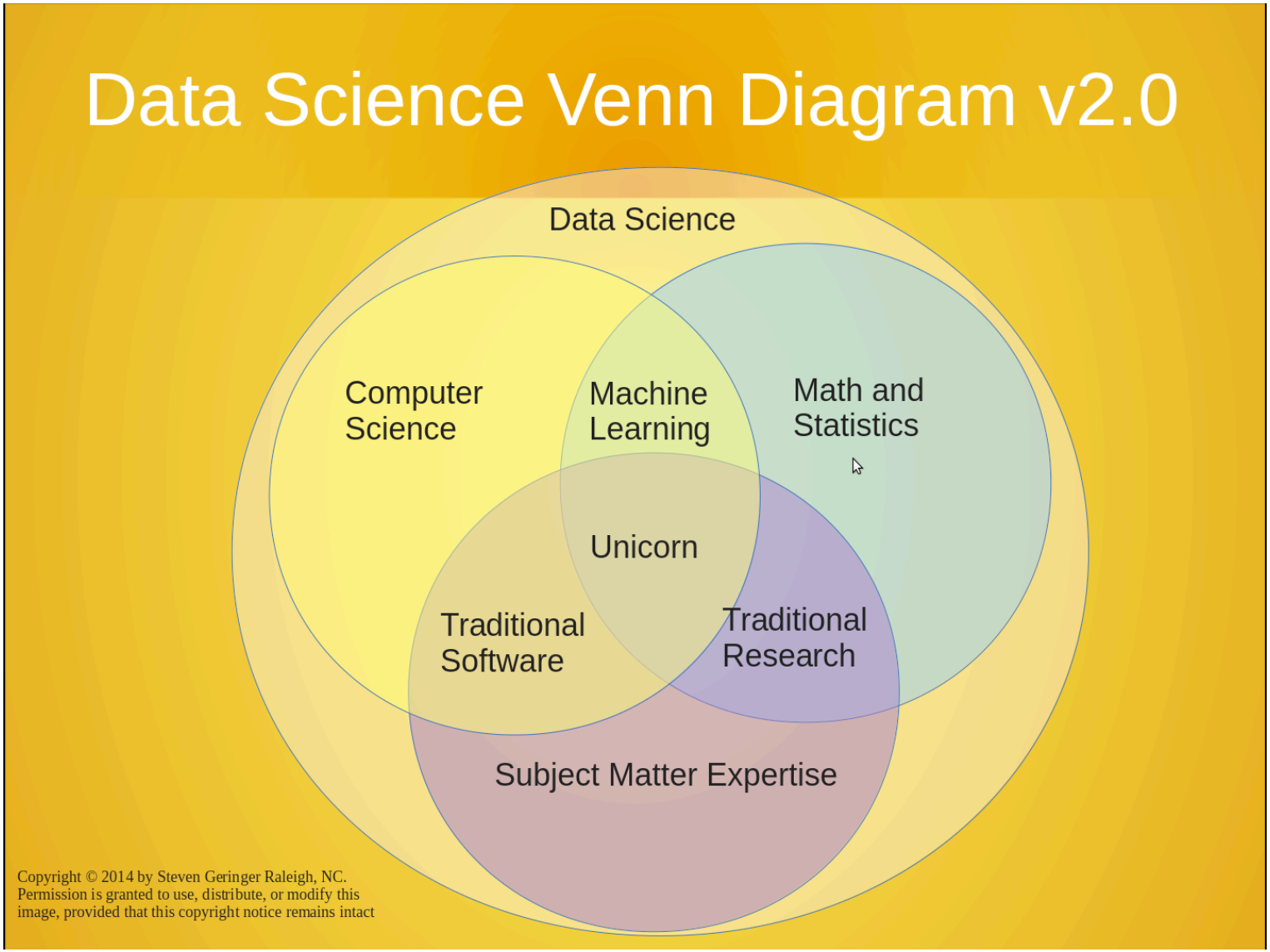
- Data Analytics is a sub-set of Data Science
- Data Analytics is mostly about using Statistical / Computational methods and enterprise software to gain insights in the data
- Does not solve all components of data problems

DATA SCIENCE

Goal of Data Science:

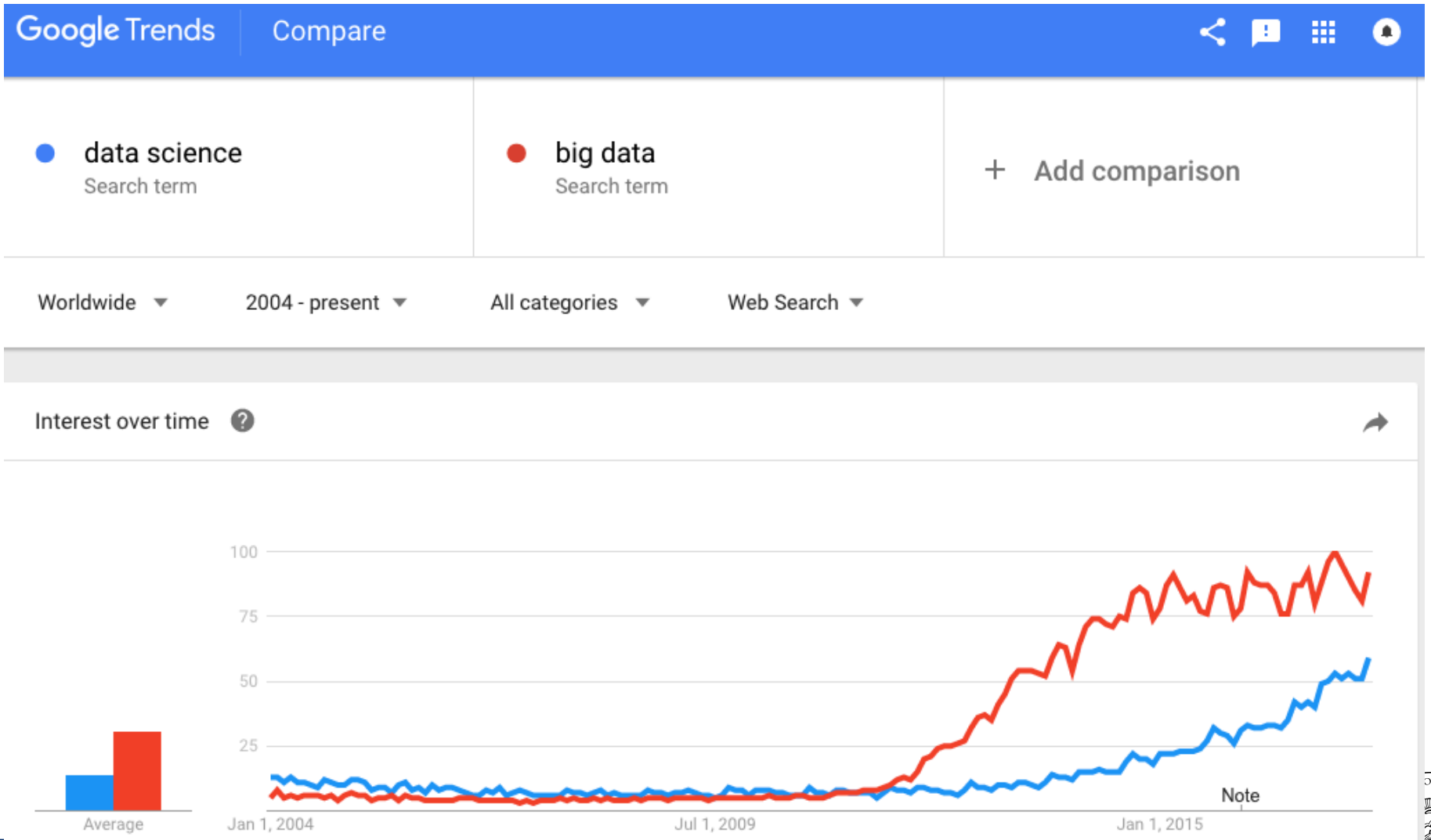
“Turn Data into Data Products”

DATA SCIENCE



DATA SCIENCE

Why is Data Science exciting? – Google trends



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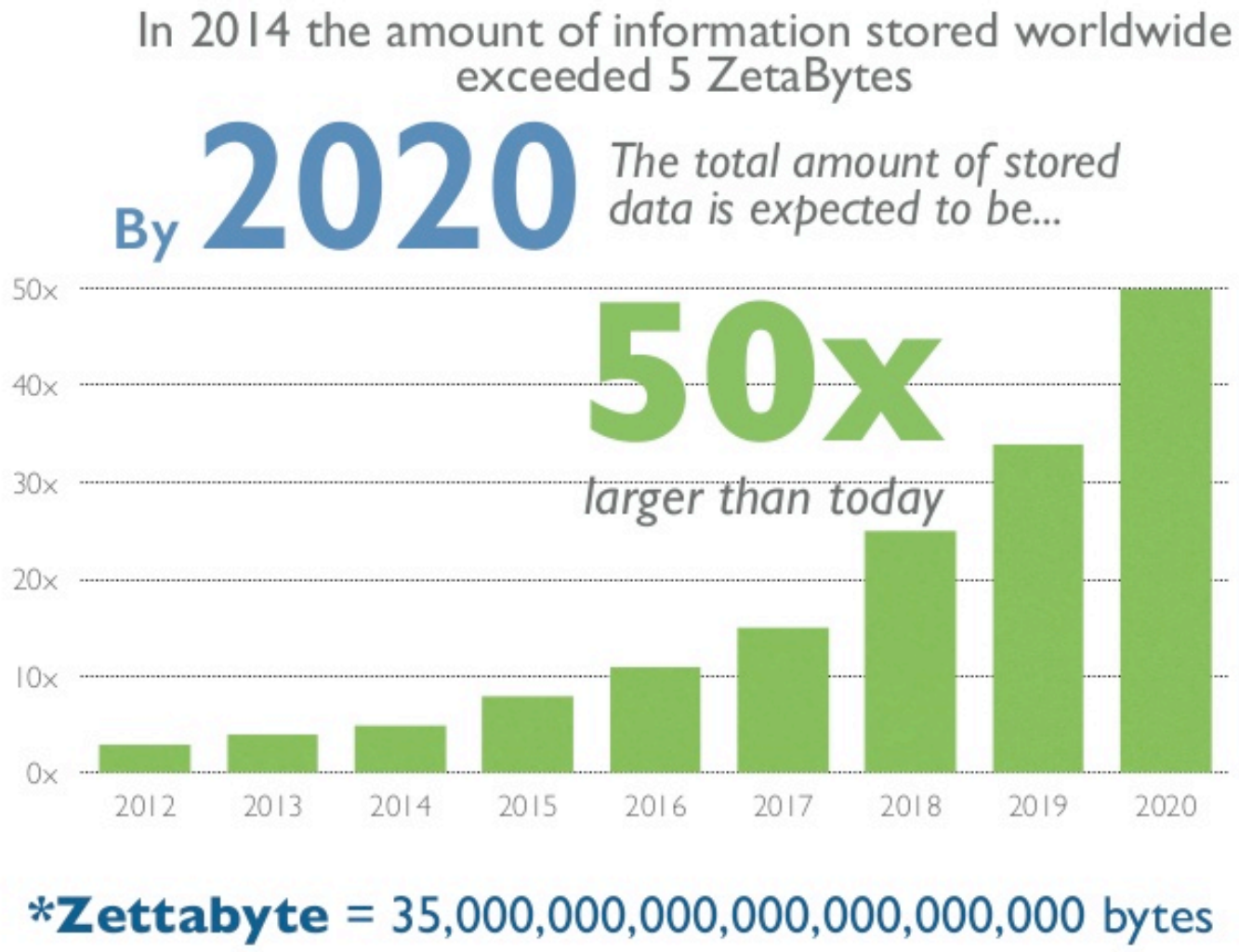
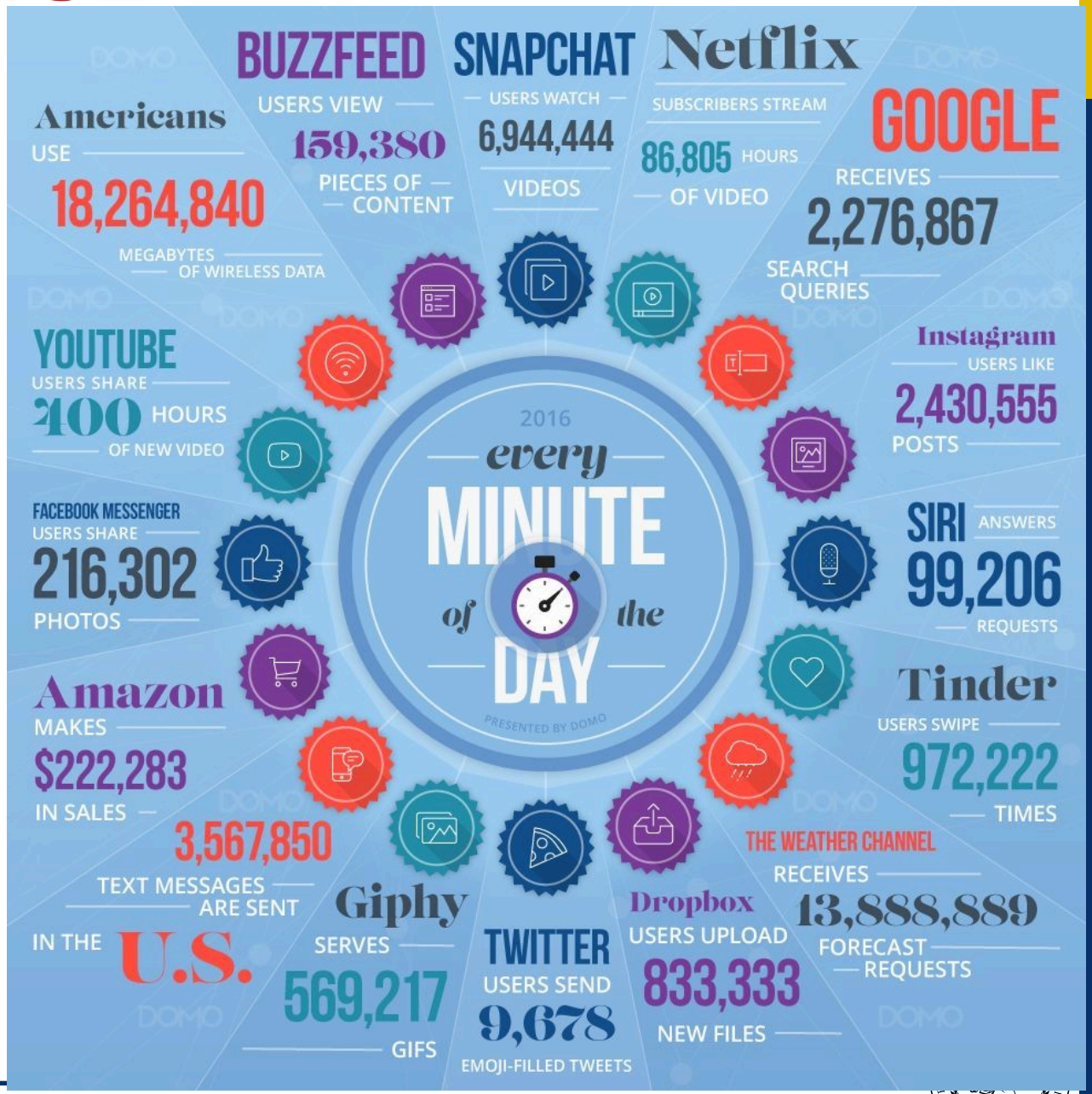
Why is Data Science exciting? – Big Data



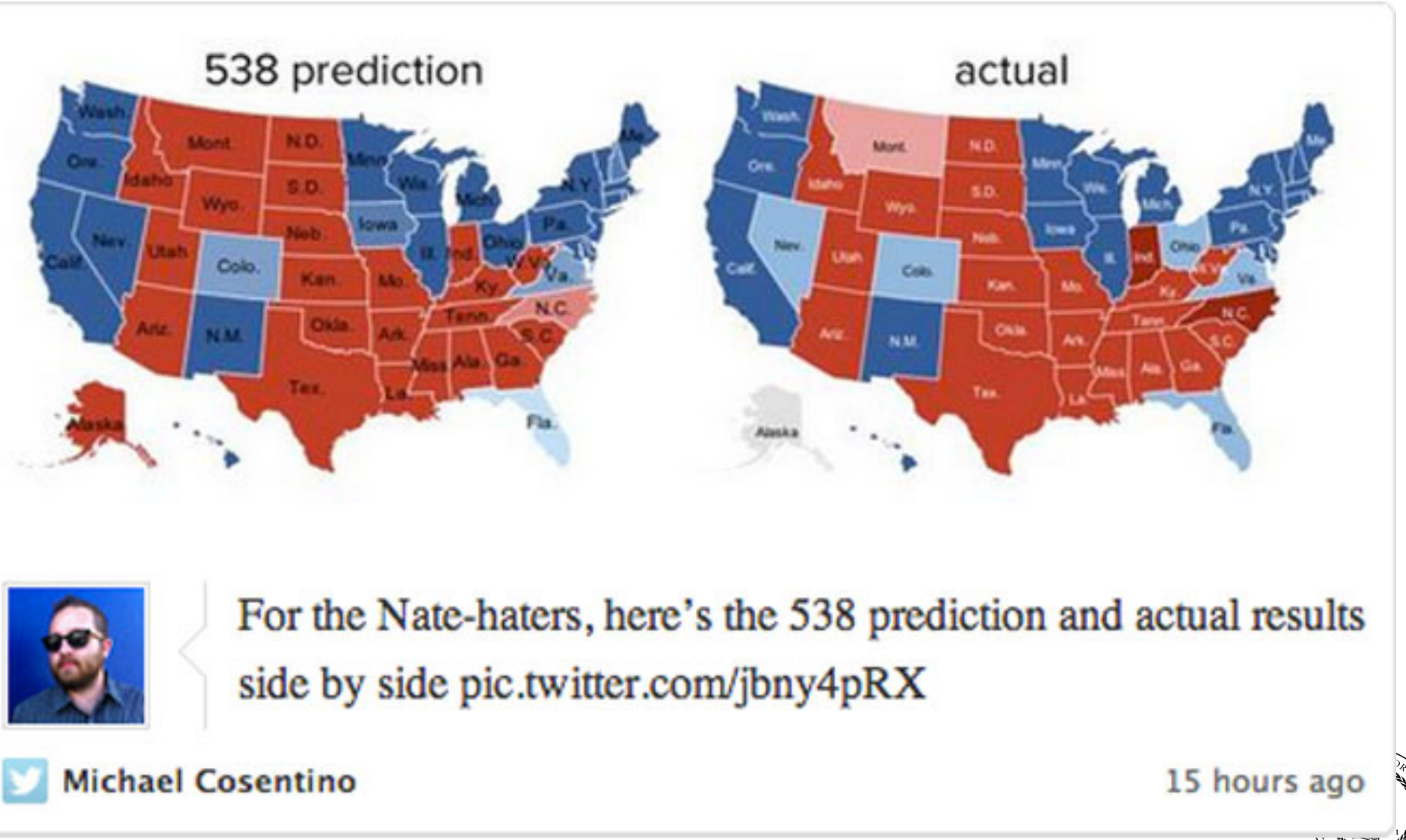
DATA SCIENCE

Why is Data Science exciting? – Big Data



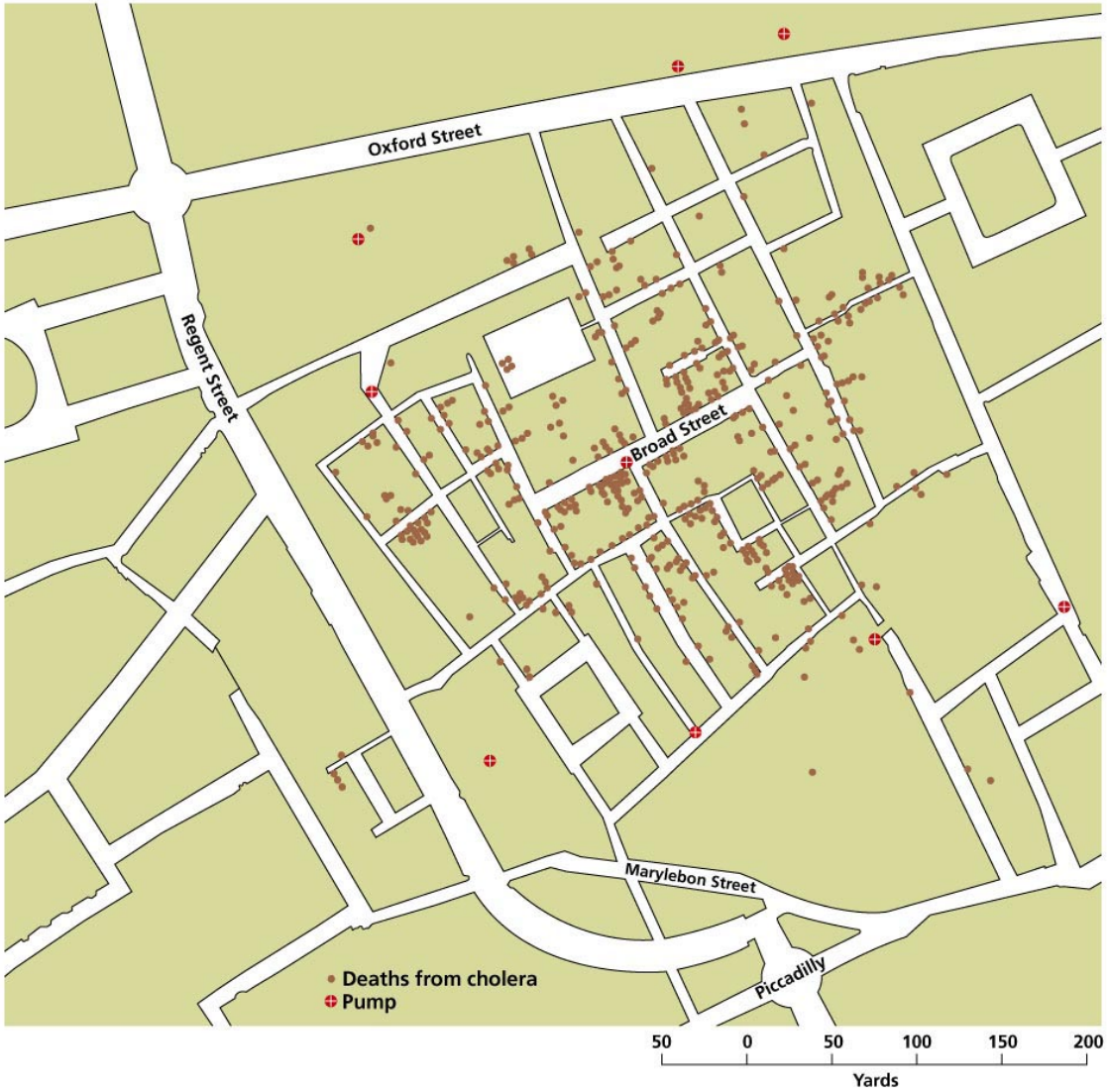
DATA SCIENCE - EXAMPLES

2012 Nate Silver's prediction of election



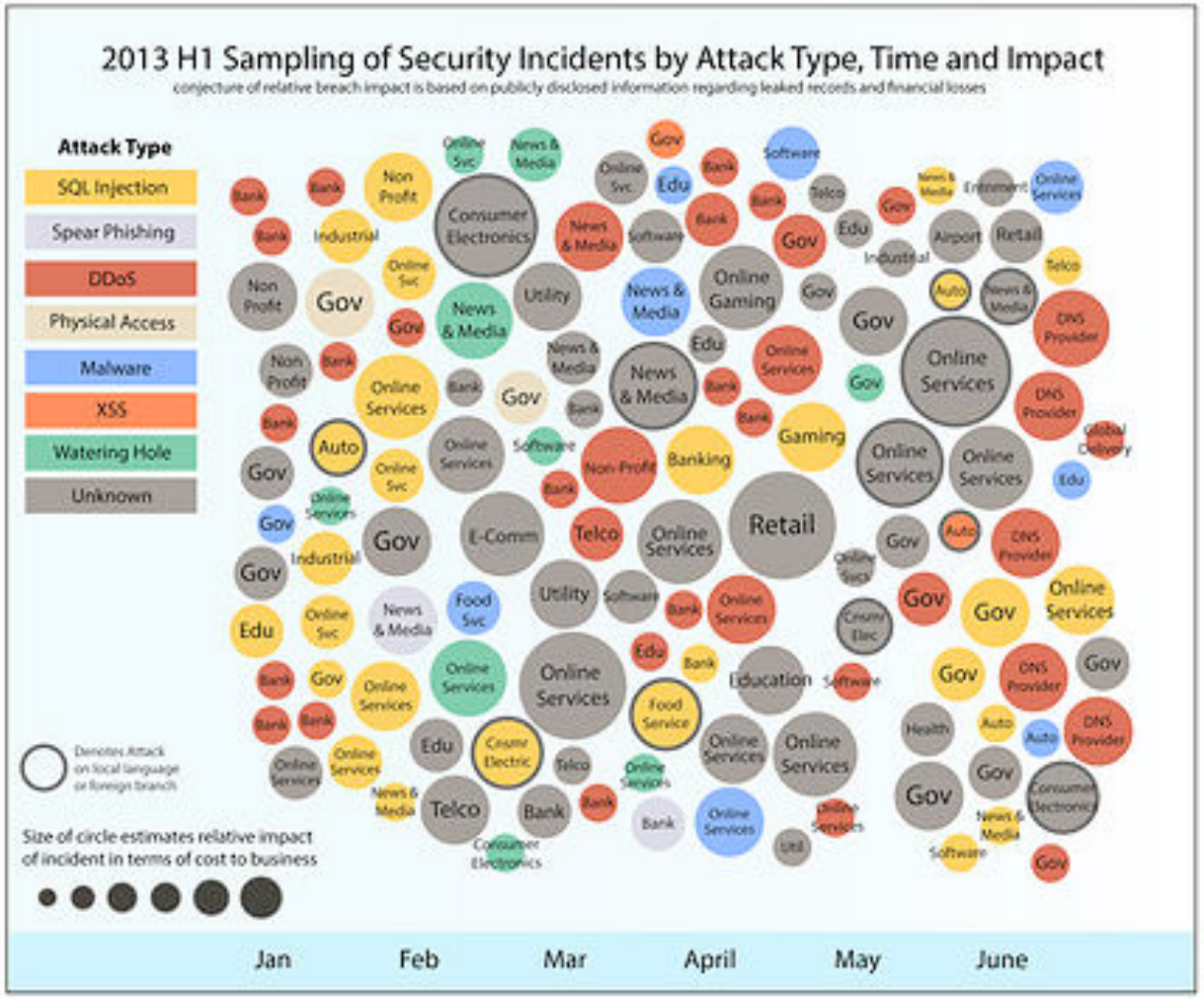
DATA SCIENCE - EXAMPLES

- **1854 Cholera Outbreak**
  - London
  - Dr. John Snow
  - Water contamination
  - Removed pump handles



DATA SCIENCE - EXAMPLES

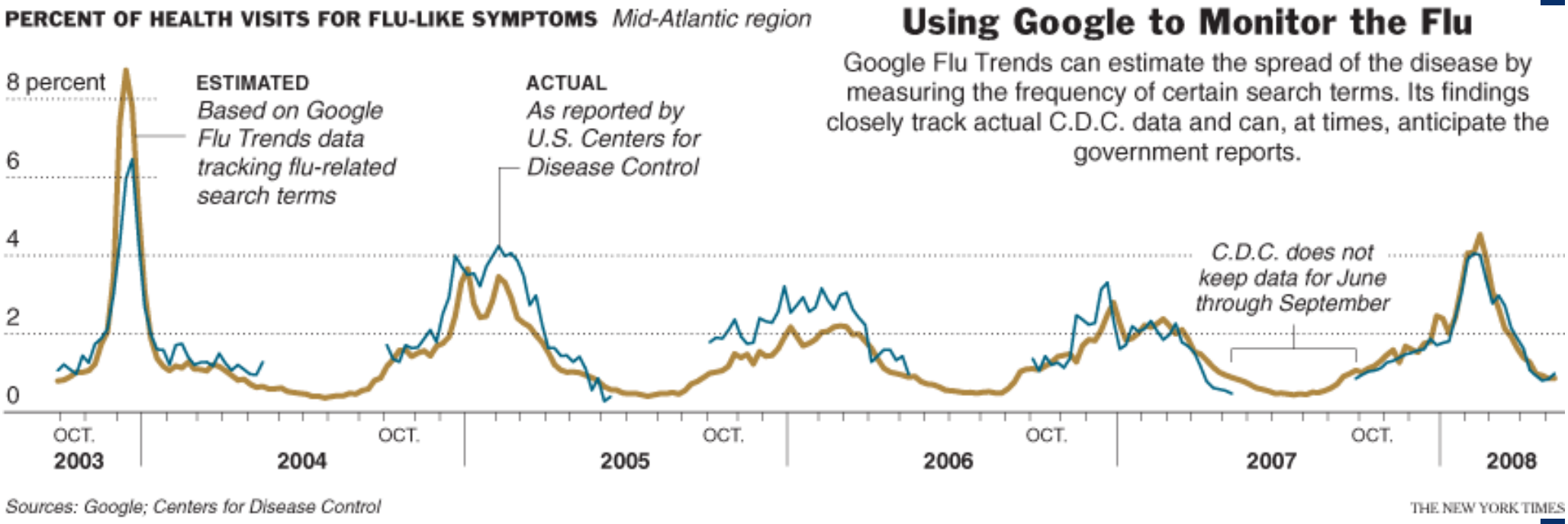
- **Cyber-Security**
  - Fraudulent credit-card and transaction activity
  - Predicting criminal activity
  - Detecting Malware
  - Critical Infrastructure Protection



Source: IBM X-Force® Research and Development

DATA SCIENCE - EXAMPLES

Why is Data Science exciting?



Using Google to Monitor the Flu

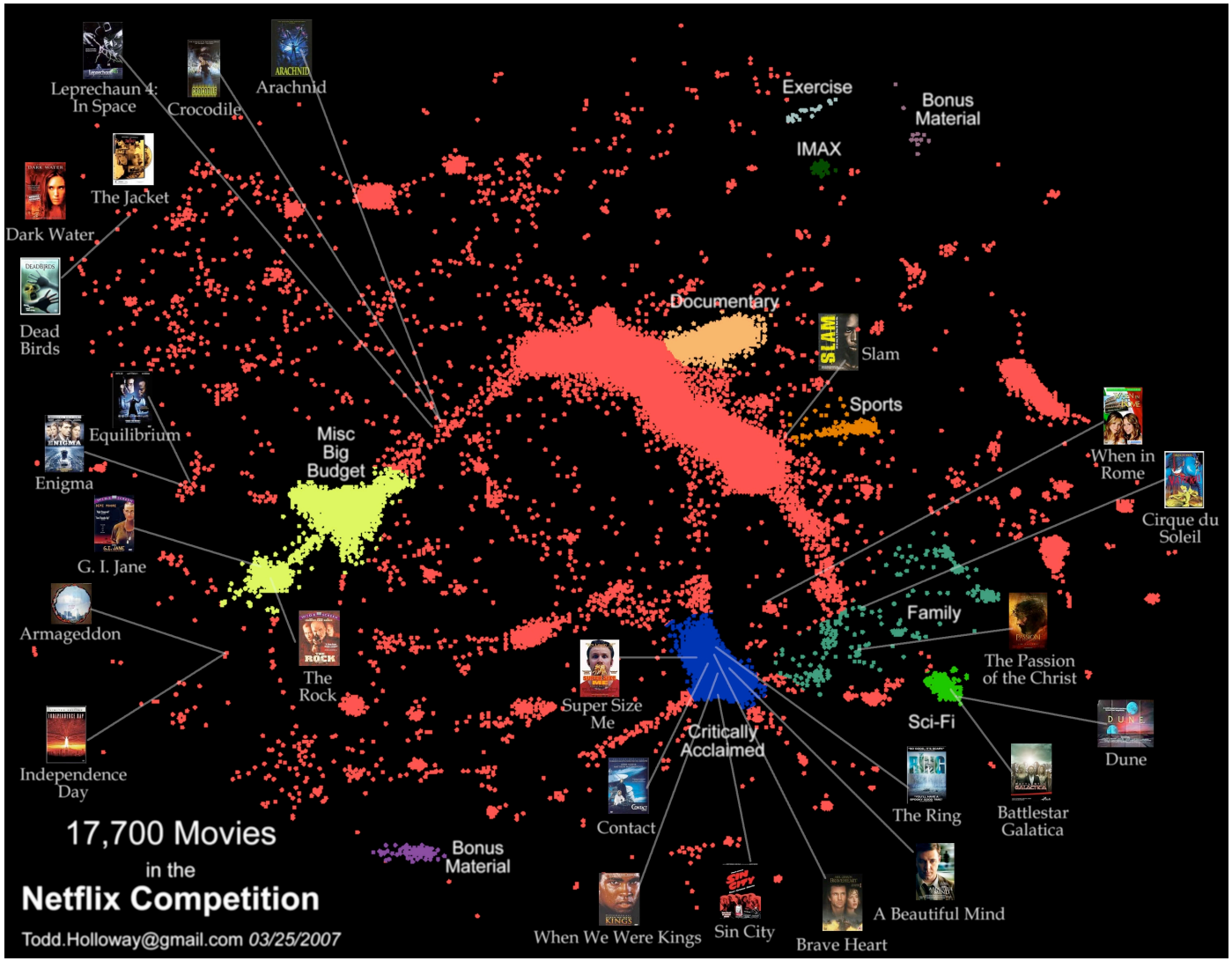
Google Flu Trends can estimate the spread of the disease by measuring the frequency of certain search terms. Its findings closely track actual C.D.C. data and can, at times, anticipate the government reports.

DATA SCIENCE - EXAMPLES

- **Netflix Challenge**
  - How much someone is going to enjoy a movie
  - Prior preferences of users
  - <user, movie, date, grade>
  - Training set 100 M
  - Qualifying set 2 M
  - Baseline *Cinematch*
  - $1 Million prize awarded

DATA SCIENCE - EXAMPLES

- **Netflix Challenge**



DATA SCIENCE - EXAMPLES

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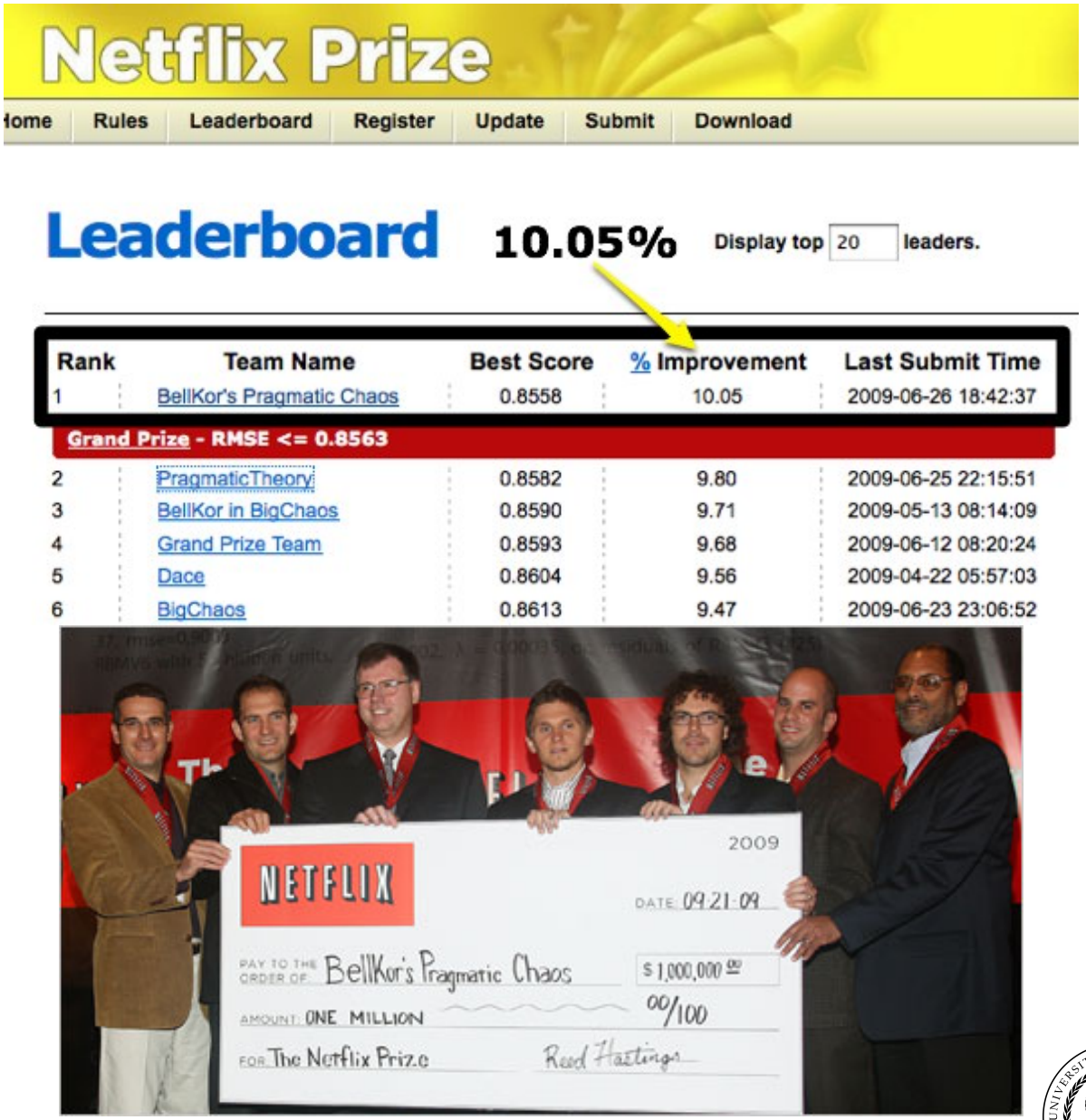

DATA SCIENCE - EXAMPLES

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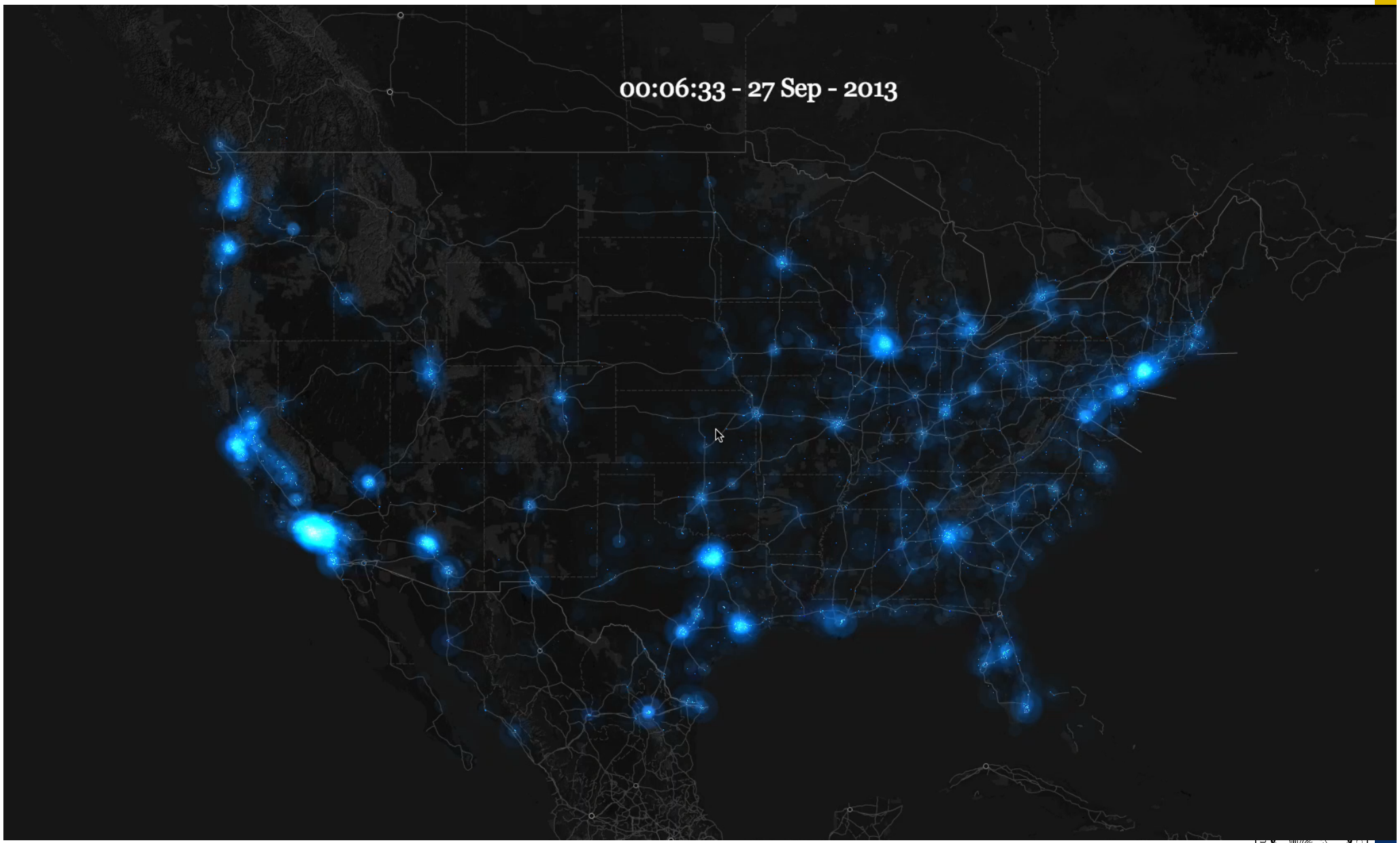
Twitter and Flicker

DATA SCIENCE - EXAMPLES



Twitter

DATA SCIENCE - EXAMPLES

DATA SCIENTIST

What is a Data Scientist job?

- **Data Scientist Job - "part analyst, part artist." – IBM**
- **Learn and utilize a large number of tools and methods**
- **Data Driven Products**
- **$118,709 (data-scientist) versus $64,537 (programmer)**
- **A shortage of 140,000 to 190,000 jobs by 2018**
- **The fastest growing job segment**
- **Why are they in demand?**
  - Need of expertise in data science is far more than available

DATA SCIENTIST

How to be a Data Scientist?

- **Learn a lot of tools, methods and techniques**
- **Let the data speak for itself**
  - Traditional approach
    - Have a question / hypothesis, use the data to prove it
  - New approach
    - Dive into the data and figure out what it says
    - Ask why at every step
- **Be creative with the data**
  - Data munging or wrangling – convert to different formats and analyze
  - Visualize to understand
  - Learn from the data
- **Keep learning**

DATA SCIENTIST

How does the course help?

- **New methods and techniques**
  - Access
  - Storage
  - Analysis
  - Machine Learning
  - Visualization
- **Change the old way of thinking**
- **Creative programming**

The course is not going to teach you everything ☺

But will get you started on the path……

CLASS PROJECT

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DATASETS

- **Academic Datasets**
  - UC Irvine Machine Learning Repository (http://archive.ics.uci.edu/ml/)
  - Stanford Large Network Dataset Collection (http://snap.stanford.edu/data/)
  - Inter-university Consortium for Political and Social Research (http://www.icpsr.umich.edu/)
  - Pittsburgh Science of Learning Center's DataShop (http://www.learnlab.org/technologies/datashop/)
  - Academic Torrents (http://academictorrents.com/)
- **Private Companies**
  - Data.World (https://data.world/)
  - Quandl (https://www.quandl.com/)
  - Amazon Web Services Public Data Sets (http://aws.amazon.com/datasets/)
  - Kaggle (http://www.kaggle.com/)
  - Nytimes (http://developer.nytimes.com/docs)

DATASETS

- **Gov. and NGO's**
  - Data.gov (https://www.data.gov/)
  - NYC Open Data (https://nycopendata.socrata.com/)
  - DC Open Data Catalog (http://data.dc.gov/)
  - OpenDataDC (http://www.opendatadc.org/)
  - DataLA (https://data.lacity.org/)
  - Project Open Data Dashboard (http://data.civicagency.org/))
  - data.gov.uk (http://data.gov.uk/)
  - US Census Bureau (http://www.census.gov/)
  - World Bank Open Data (http://data.worldbank.org/)
  - Humanitarian Data Exchange (http://docs.hdx.rwlabs.org/)
  - Sunlight Foundation (http://sunlightfoundation.com/api/)
  - ProPublica Data Store (https://projects.propublica.org/data-store/)

DATASETS

- **Other resources**
  - 20 Big Data Sources (http://www.smartdatacollective.com/bernardmarr/235366/big-data-20-free-big-data-sources-everyone-should-know)
  - Center for Data Innovation (http://www.datainnovation.org/category/publications/data-set-blog/)
  - Data Science Central (http://www.datasciencecentral.com/)
  - Python API's (http://www.pythonforbeginners.com/api/list-of-python-apis)
  - PyCoders Weekly (http://pycoders.com/)

PROJECT IDEAS

Twitter Human Mobility

- Mapping movement of Twitter users on temporal domain
- Utilize the geo-located tweets
- Twitter API (https://dev.twitter.com/overview/documentation)
- Google Maps (https://developers.google.com/maps/?hl=en)

Publication Topic modeling and Network Analysis

- Topic modeling of publications to visualize interest in areas
- Connectivity of topics across areas
- Topic Modeling (https://www.cs.princeton.edu/~blei/topicmodeling.html)
- Elsevier API (http://dev.elsevier.com/)
- MIT scholarly resources (http://libguides.mit.edu/apis)

PROJECT IDEAS

Wiki Topic modeling and Network analysis

- Wikipedia topic modeling and connectivity of topics
- Interests based on edits across temporal domain
- Wikipedia API (https://www.mediawiki.org/wiki/API:Main_page)
- DBpedia (http://wiki.dbpedia.org/)

IMDB data analysis

- Graph analysis of IMDB dataset
  - Actors, genres, producers, directors connectivity
- Analysis of important features for movie success
- Predicting movie rating
- IMDB API (http://www.omdbapi.com/)

PROJECT IDEAS

Sentiment models - Twitter, IMDB, Amazon reviews

- Categorizing Polarity of tweets, IMDB movie reviews, amazon reviews
- Plotting heat maps for twitter
- Clustering popular products in amazon
- Predicting movie success
- Twitter API (https://dev.twitter.com/overview/documentation)
- 35 million Amazon reviews (https://snap.stanford.edu/data/web-Amazon.html)

Million Song Dataset Analysis

- Popularity vs genre vs time
- Lyrics ngram analysis
- Clustering of songs
- API (http://labrosa.ee.columbia.edu/millionsong/)

PROJECT IDEAS

Facebook Network Analysis

- Clustering of Friends
- Influential Networks
- Post analysis
- Graph API (https://developers.facebook.com/docs/graph-api)

Campus Safety Dataset Analysis

Articles NY Times LDA over time

Twitter Flu Tracker

TEAMS

- **Teams Consist of 4-5 members**
- **Collaborative code repository**
  - Tracking via commit logs
- **Implementation via python**
- **Each team member must understand the methodology**
- **Visualizations for naïve user**
- **Effort vs Result**