Lecture 1: Introduction

UNIVERSITY OF
SAN FRANCISCO

James D. Wilson

ICSPR: Network Analysis I

Outline

- Course Overview
- What is Data Science?
  - Where is Data Science?
  - A brief history

A Little About Me

- Ph.D. Statistics and Operations Research (UNC Chapel Hill, ’15)
  - Research focused on statistical analysis of networks
  - Explore, model, and analyze network data (e.g., social networks)
- M.S. Mathematical Sciences (Clemson University, ’10)
- B.S. Mathematics and Chemistry (Campbell University ’08)

Making every problem a networks problem since 2013

A Little About Me

- Assistant Professor of Statistics at the University of San Francisco
- Born and raised in NC (near Raleigh)
- Live in Rockridge, Berkeley.
- A huge college basketball fan! (Go Heels!)
- Have loved college football since 2008 (Go Tigers!)
- Enjoy brewing and tasting new beers

A Little About Me

Classes I teach (at USF):

- BSDS 100 - Intro to Data Science with R
- MATH 106 - Business Statistics
- MATH 370 - Probability with Applications
- MATH 373 - Statistical Learning
- MSAN 601 - Linear Regression Analysis
- MSAN 630 - Advanced Computational Statistics
- MSAN 700 - Social Network Analysis

Course Description

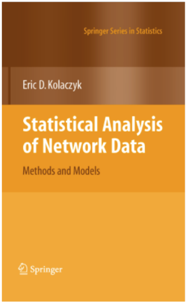
All lecture notes, the syllabus, assignments, and course description are available at this course website:

https://github.com/jdwilson4/Network-Analysis-I

Teacher's Assistant: Melanie Baybay, University of San Francisco

Office Hours: 3:30 - 4:30 on T, TH in 1106D Perry building

Useful Network Resources



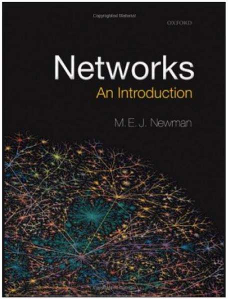
Springer Series in Statistics

Eric D. Kolaczyk

Statistical Analysis of Network Data

Methods and Models

Springer



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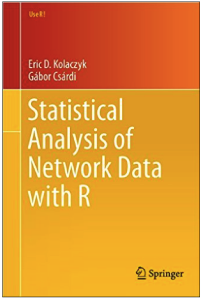
Networks

An Introduction

M. E. J. Newman



Use R!

Eric D. Kolaczyk
Gábor Csárdi

Statistical Analysis of Network Data with R

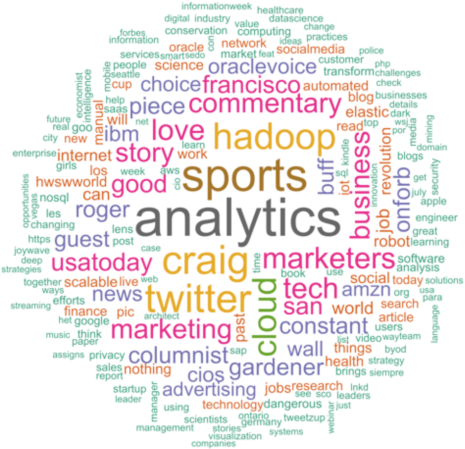
Springer

Useful Tools: GraphX, GraphLab, *igraph, gergm, statnet* packages (in R and some in Python), Gephi

What is Data Science?

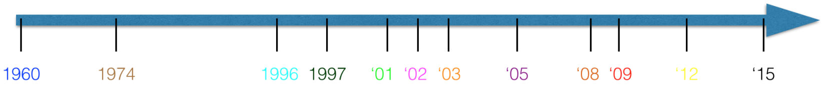
- **Wikipedia**: “the extraction of knowledge from data."
- A precise definition is a bit unclear and has faced much controversy... (we’ll see more on this in a moment)
- Practitioners tend to agree on the *components* of data science:
  - gathering and cleaning data
  - database management
  - exploratory analysis
  - predictive modeling
  - data summary and visualization

Where is Data Science?



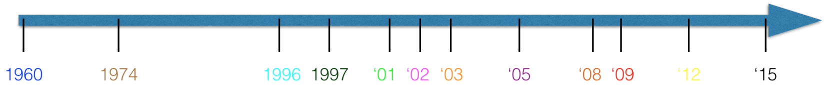
- Twitter feed, December 2014

The Evolution of Data Science



- 1960: Peter Naur (CS Ph.D.) published *Datalogy: the science of data and its place in education.*
- 1974: Peter Naur published *Concise Survey of Computer Methods*.
  - defines data science as “the science of dealing with data, once they have been established."
  - continues to say that “... the relation of the data to what they represent is delegated to other fields and sciences."

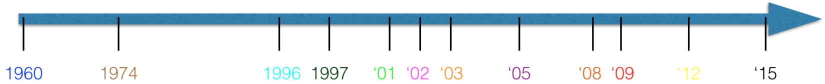
The Evolution of Data Science



- 1996: International Federation of Classification Societies meet in Tokyo and for the first time include “data science" in the conference title: “Data science, classification, and related methods."

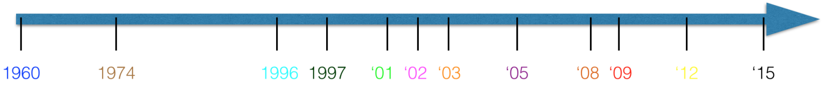
- 1997: C.F. Jeff Wu gave the inaugural lecture “Statistics = Data Science?" for appointment to the H. C. Carver Professorship at the University of Michigan.

The Evolution of Data Science



- 2001: William Cleveland (Bell Labs) published *Data Science: An Action Plan for Expanding the Technical Areas of the Field of Statistics*.
    - Sets forth 6 areas for a university department involving statistics.
- 2002: *Data Science Journal* is launched
    - Focus on data systems, publications on internet, and applications
- 2003: *Journal of Data Science* is launched
    - Focus on application of statistical and quantitative methods

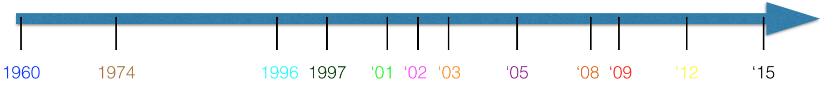
The Evolution of Data Science



1960 1974 1996 1997 ‘01 ‘02 ‘03 ‘05 ‘08 ‘09 ‘12 ‘15

- 2005: National Science board redefines data scientists:
  - “The information and computer scientists, data and software programmers, disciplinary experts, ... who are crucial to successful management of a digital data collection whose primary activity is to conduct creative inquiry and analysis"
- 2008: DJ Patil (LinkedIn) and Jeff Hammerbacher (Facebook) coined the term "data scientist" to define their jobs

The Evolution of Data Science



- January, 2009: Hal Varian (chief economist at Google) writes that "... the sexy job in the next 10 years will be statisticians."
- October, 2012: Harvard Business Review publishes "Data Scientist: The Sexiest Job of the 21st Century."
- February 5th, 2015: DJ Patil appointed as the first Chief Data Scientist in the White House.

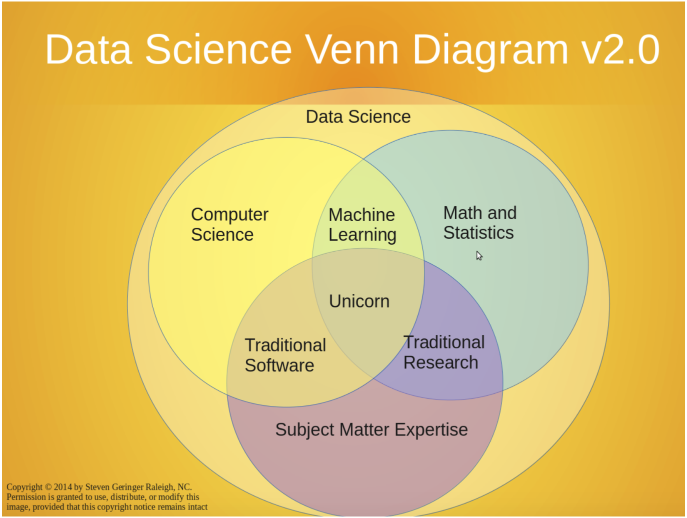
Applications

Marketing analytics, sports analytics, biotechnology, social experiments, e-commerce, government analysis, ...

Why Data Science?

- Size, complexity, and amount of data
  - Predicted ≈ 40 trillion gigabytes of data in 2020; up from 130 billion in 2005!
  - Big data requires innovative techniques for analysis
- *McKinsey*: "The U.S. faces a shortage of 140K - 190K people with analytical expertise and 1.5 million managers and analysts with the skills to understand and make decisions based on the analysis of big data." (May, 2011)
- *Harvard Business Review*: "Data Scientist: The Sexiest Job of the 21st Century." (October, 2012)

Data Scientists: The unicorn industries want?



Data Scientists: The unicorn industries want?

- The field is inherently interdisciplinary
  - mathematical statistics
  - computer science
  - domain expertise
- The magical Unicorn: having all three skills
  - In 2014, these jobs go unfilled for 6 months or longer on average
- Has lead to the development of data science *teams*
  - hope is to merge skills of analysts

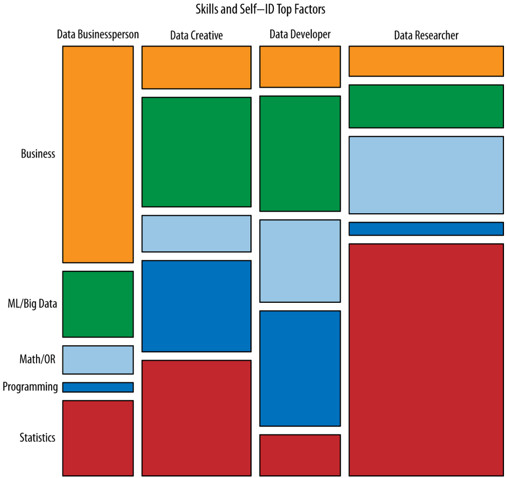
A Social Scientist's Role in Data Science

... it depends on the context of the problems you're trying to solve. If they're social science-y problems like friend recommendations or people you know or user segmentation, then by all means, bring on the social scientist! Social scientists also do tend to be good question askers and have other good investigative qualities, so a social scientist who also has the quantitative and programming chops makes a great data scientist.

But it's almost a historical artifact to limit your conception of a data scientist to someone who works only with online user behavior data. There's another emerging field out there called computational social sciences, which could be thought of as a subset of data science.

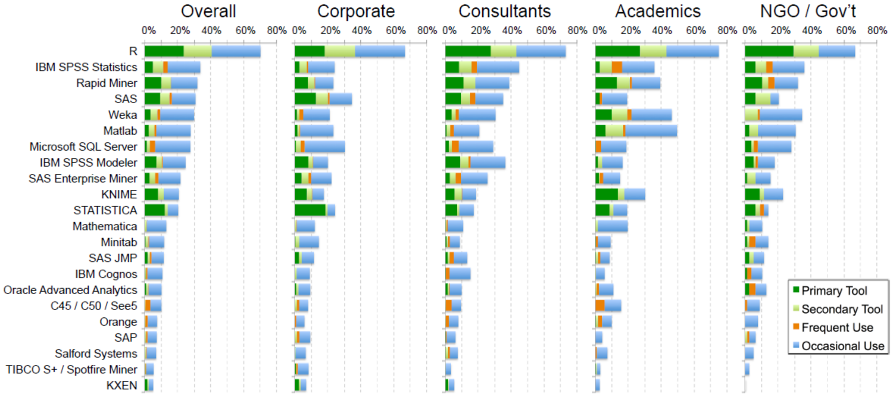
- From *Doing Data Science*

The Analysts of Data Science



"Analyzing the Analyzers (2013) by Harry, Murphy, and Vaisman."

Software: A Data Scientist’s first weapon



-www.datasciencecentral.com

A Data Scientist’s Toolkit

Harvard’s data science toolkit:

1. **Wrangle the data**: gather, clean, and sample data
2. **Manage the data**: access big data quickly and reliably
3. **Explore the data**: to make a hypothesis
4. **Make predictions**: statistical methods
5. **Communicate the results**: visualization, presentations, summaries

Get Involved! Great Resources

- Flowingdata.com
  - Contemporary visualization and data manipulation techniques
- Kaggle.com
  - Kaggle competitions: win money for solving problems!
- Coursera.org
  - Free online courses in data science and machine learning
  - 972 courses. Great resource for coding, data analysis, etc.
  - Recent notable course: "The Data Scientist's Toolbox."