Introduction to Data Science

Cody Carroll

BSDS 100 - Lecture 1

Outline

- Course Overview & Syllabus
- What is Data Science?

Course Overview & Syllabus

Course Description and Syllabus

The syllabus and course description can be found here:

https://github.com/codycarroll/Intro-DS-F23

All lecture notes and assignments will be posted here over the semester.

Nice to meet ya!

- Texas → Japan → CA
- Ph.D. in Statistics from UC Davis
  - Statistical research expertise: statistical analysis of curves
  - Other applied DS interests: CA wildlife, conservation, computer vision & deep learning

About the instructor

Before coming to USF:

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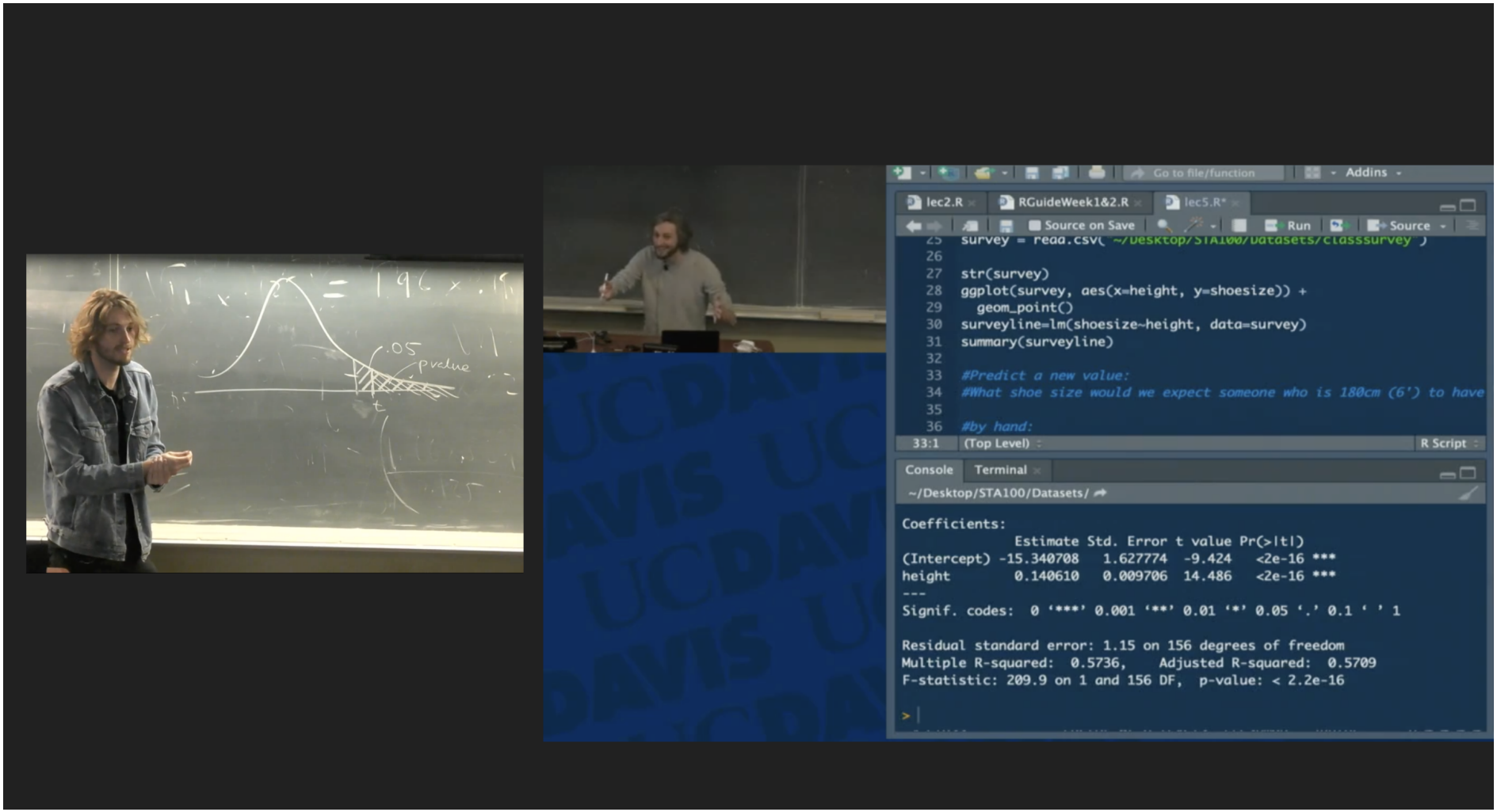
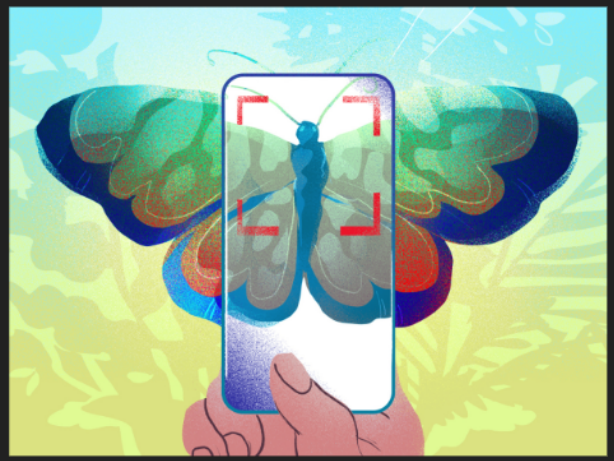
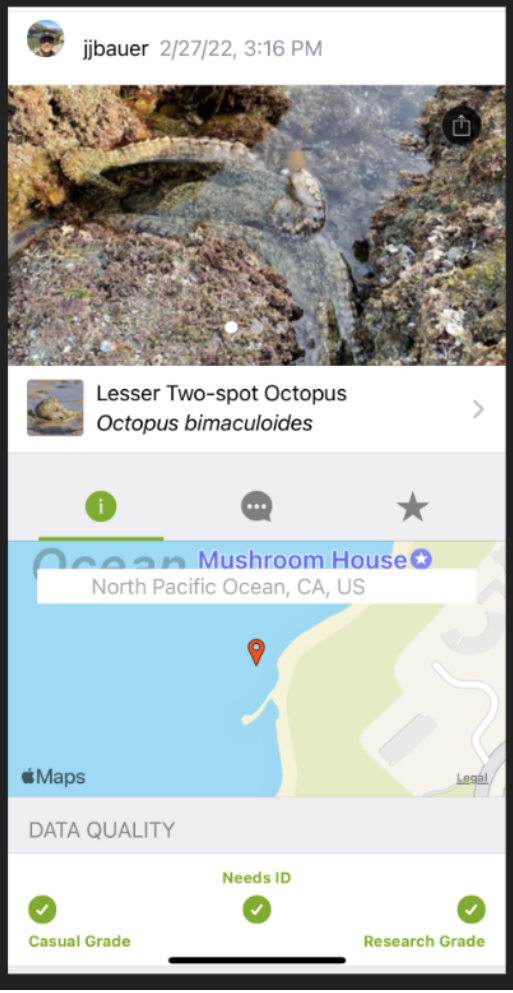
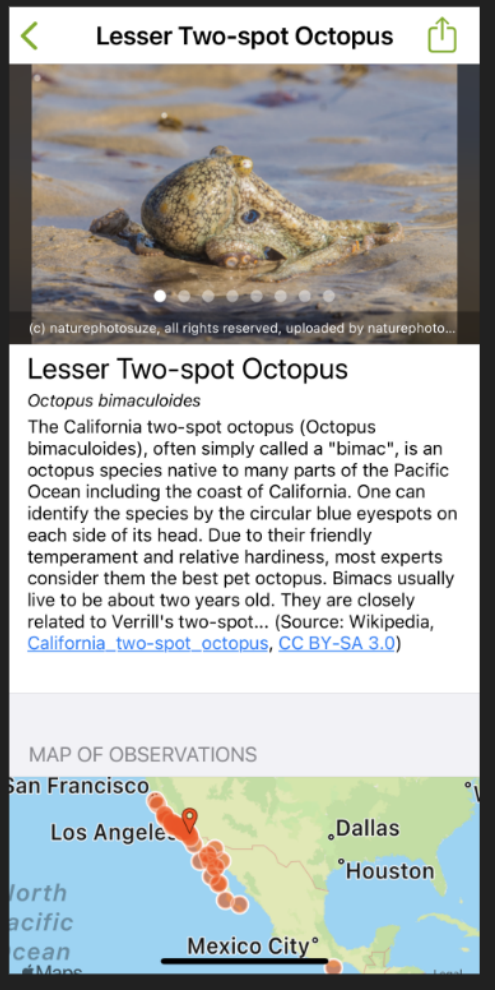


About the instructor

iNaturalist

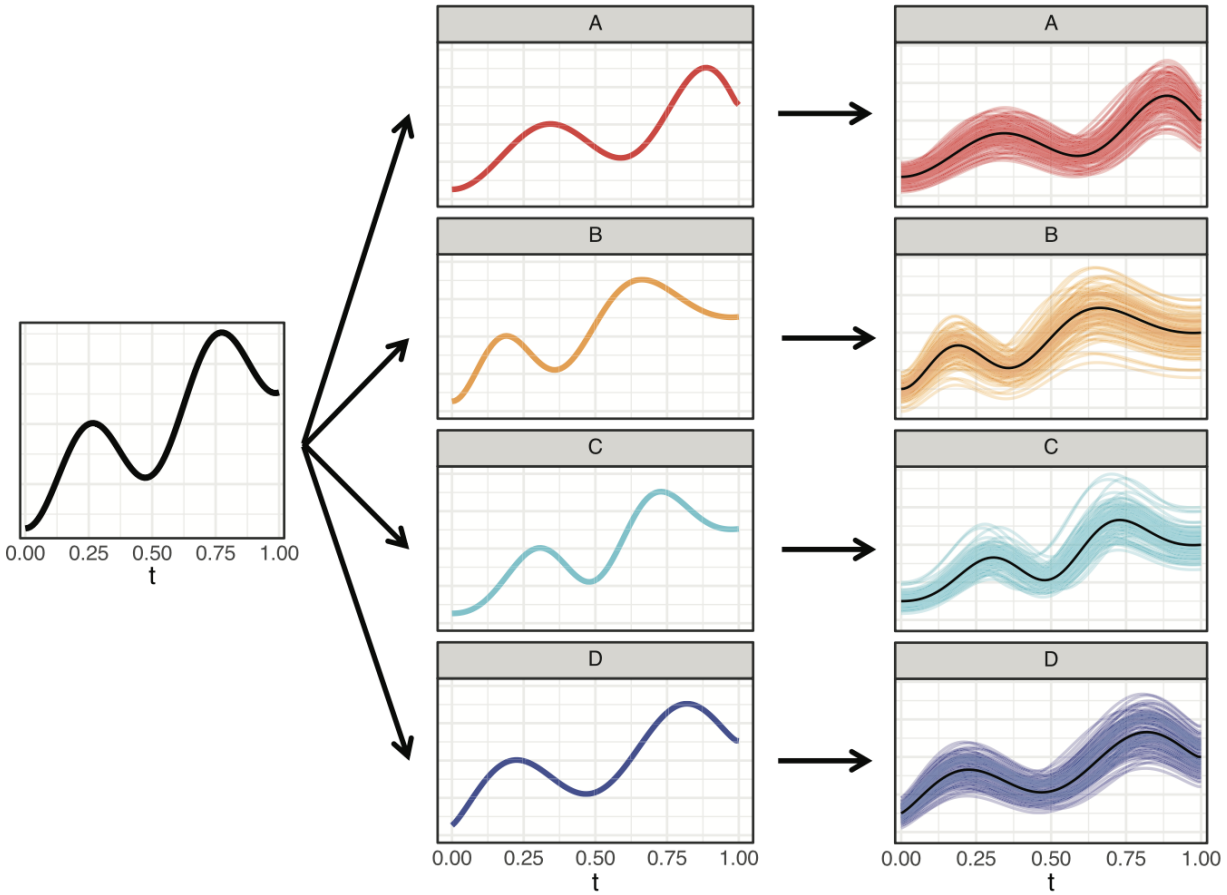






About the instructor

Functional data & time warping:



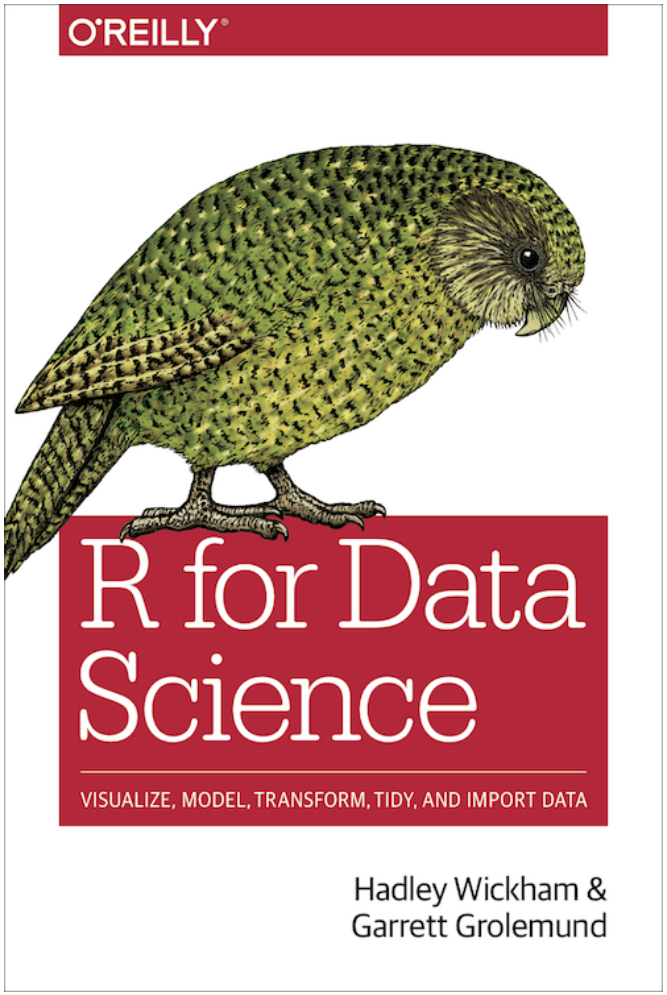
$$\lambda \xrightarrow[\circ\ \Psi]{} \gamma \xrightarrow[\circ\ H]{} X$$

About the Instructor

I teach jointly across Math and MSDS:

- BSDS 100 - Intro to Data Science with R
- MATH 372 - Linear Regression
- MATH 371 - Statistics with Applications
- MSDS 610 - Communication for Analytics
- MSDS 630 - Advanced Machine Learning
- MSDS 699 - Machine Learning Lab

Main Text



Available online here: http://r4ds.had.co.nz/index.html

Other Resources

The Best Place for Answers to R Questions?

The Best Place for Answers to R Questions?

Friends!

- Find someone to pair up with.
- Self-introduce and trade emails/contact info.
- Major? Year? Interests? Something memorable?
- What makes you curious about data science?
- How would you explain what “data science" is? (your perception, not an “official" definition)

Part II: What is Data Science?

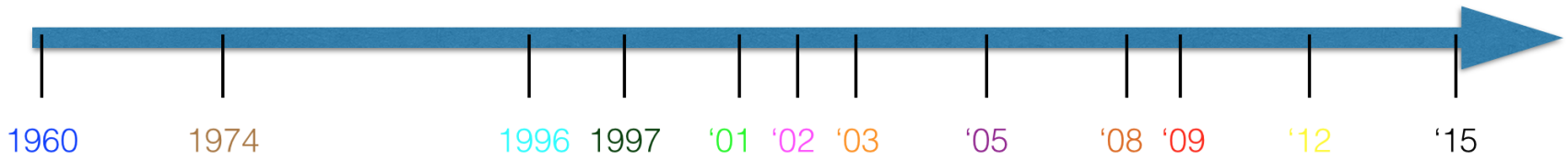
What is Data Science?

- **Wikipedia**: “the extraction of knowledge from data."
- A precise definition is a bit unclear and has faced much controversy...
- 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?

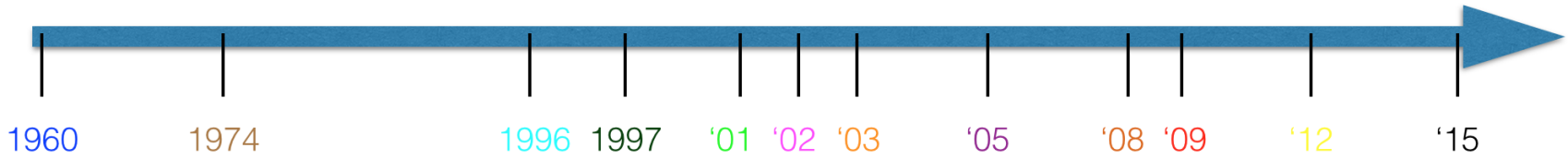
- Twitter

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."

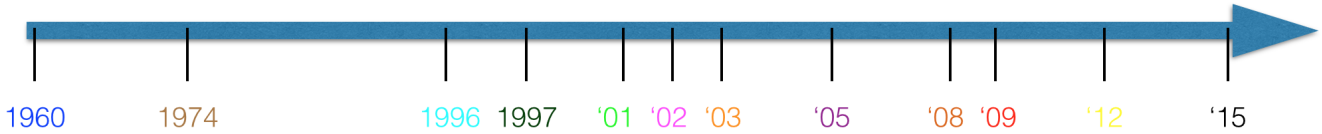
The Evolution of Data Science



- 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."

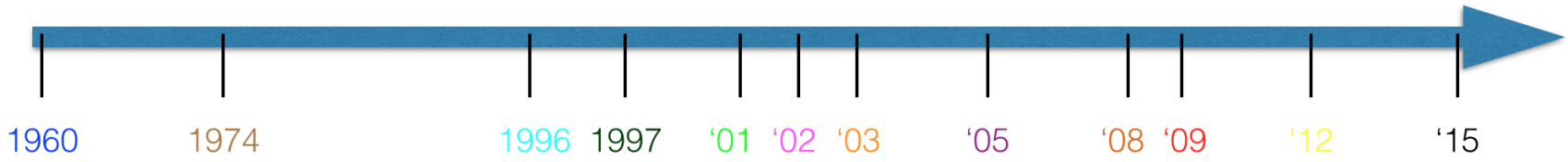
- 1997: C.F. Jeff Wu gave the inaugural lecture “Statistics = Data Science?" for appointment to the H. C. Carver Professorship at the University of Michigan.

The Evolution of Data Science



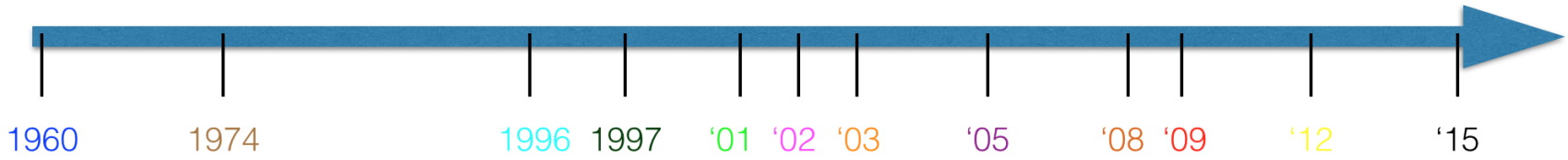
- 2001: William Cleveland (Bell Labs) published *Data Science: An Action Plan for Expanding the Technical Areas of the Field of Statistics*.
  - "Faculty members should devote their careers to advances in computing with data and who form partnerships with computer scientists."
- 2002: *Data Science Journal* is launched
  - Focus on data systems and applications
- 2003: *Journal of Data Science* is launched
  - Focus on application of statistical and quantitative methods

The Evolution of Data Science



- 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.

Recent trends

- 2021: DS jobs starting to shift toward Data Engineering tasks
- 2022: A big correction in tech industry - DS market tightens
- 2023+ : Recovery?

Applications

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

Why Data Science?

- Size, complexity, and amount of data
  - Over 80 trillion gb of data generated in 2022; up from 130 billion in 2005!
  - Big data requires innovative techniques for analysis

Why Data Science?

DATA SCIENCE US

SALARY AND DAY RATE BREAKDOWNS

PERMANMENT – AVERAGE ANNUAL SALARY

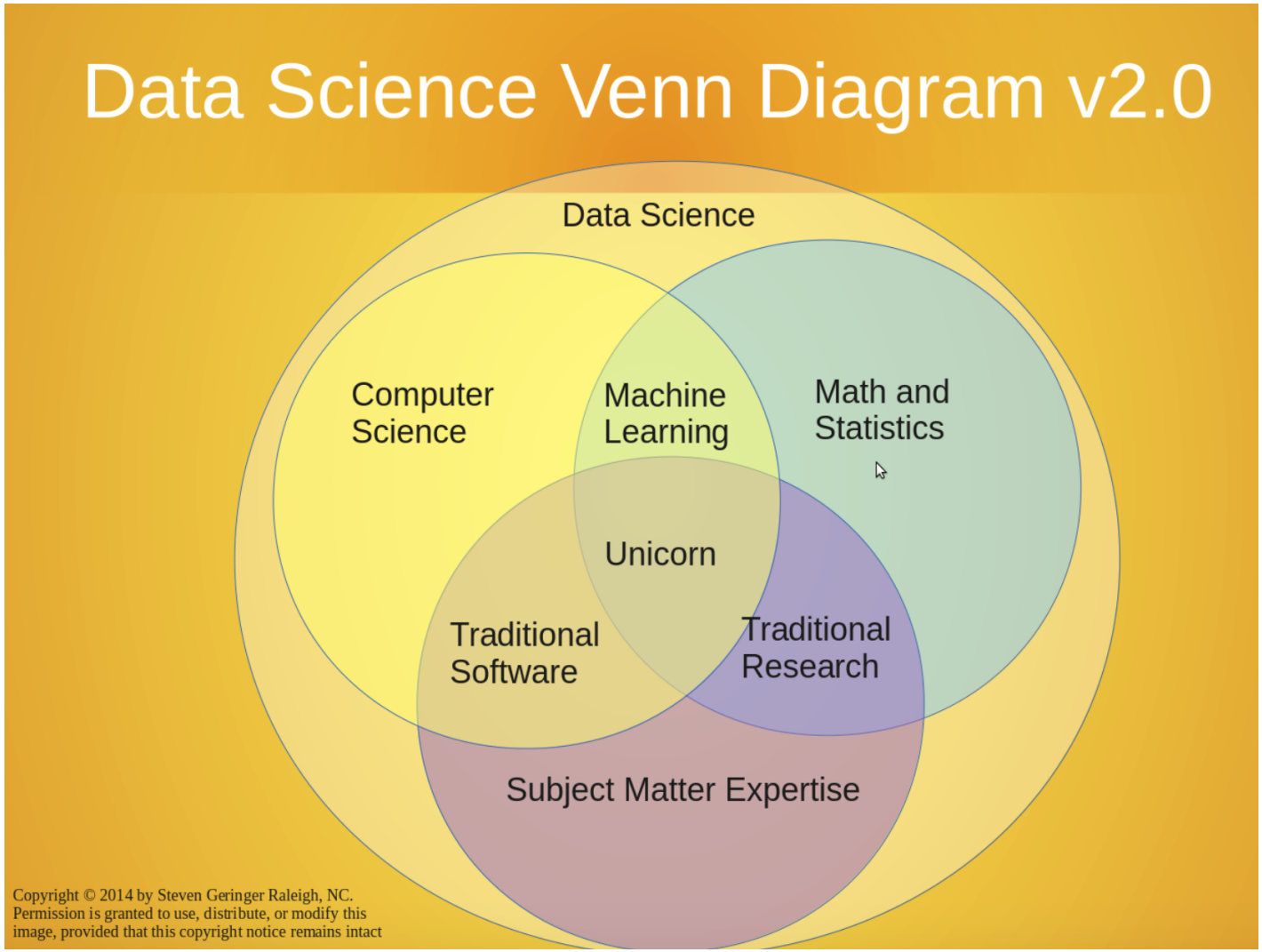
Role Type	Entry Level	Mid-Level	Principal/ Manager Level	Technical Lead/ Director	VP and above
Annual Base Salary - $USD | East • West • Mid					
Data Science – ML Modelling	$132k | $126k | $100k	$160k | $161k | $118k	$196k | $201k | $166k	$253k | $243k | $213k	$360k | $260k | $240k
Deep Learning & AI	$132k | $110k | n/a	$173k | $173k | $119k	$208k | $228k | $160k	$252k | $249k | $202k	$321k | $269k | $250k
ML Engineering – Deployment & Infrastructure	$138k | $117k | $120k	$180k | $156k | $140k	$228k | $201k | $198k	$287k | $252k | $244k	$340k | $283k | $283k
MLOps	$133k | $108k | $120k	$189k | $156k | $140k	$232k | $198k | $178k	n/a | $250k | $250k	n/a | $269k | n/a
Natural Language Processing	$138k | $115k | n/a	$176k | $155k | $155k	$215k | $195k | $195k	$250k | $225k | $225k	n/a | $262k | n/a

CONTRACT – AVERAGE DAY RATES

Role Type	Entry Level	Mid-Level	Principal/ Manager Level	Technical Lead/ Director	VP and above
Hourly Contract Rate - $USD | East • West					
Data Science – ML Modelling	$65 | $65	$80 | $75	$95 | $105	$120 | n/a	$150 | n/a
Deep Learning & AI	$65 | $55	$85 | $85	$100 | $115	$120 | n/a	$150 | n/a
ML Engineering – Deployment & Infrastructure	$70 | n/a	$90 | $80	$100 | $100	$130 | n/a	$150 | n/a
MLOps	$65 | n/a	$90 | $85	$100 | $100	n/a | n/a	n/a | n/a
Natural Language Processing	$70 | n/a	$85 | $75	$100 | $100	$120 | n/a	n/a | n/a

Harnham's US 2023 Data & AI Salary Guide

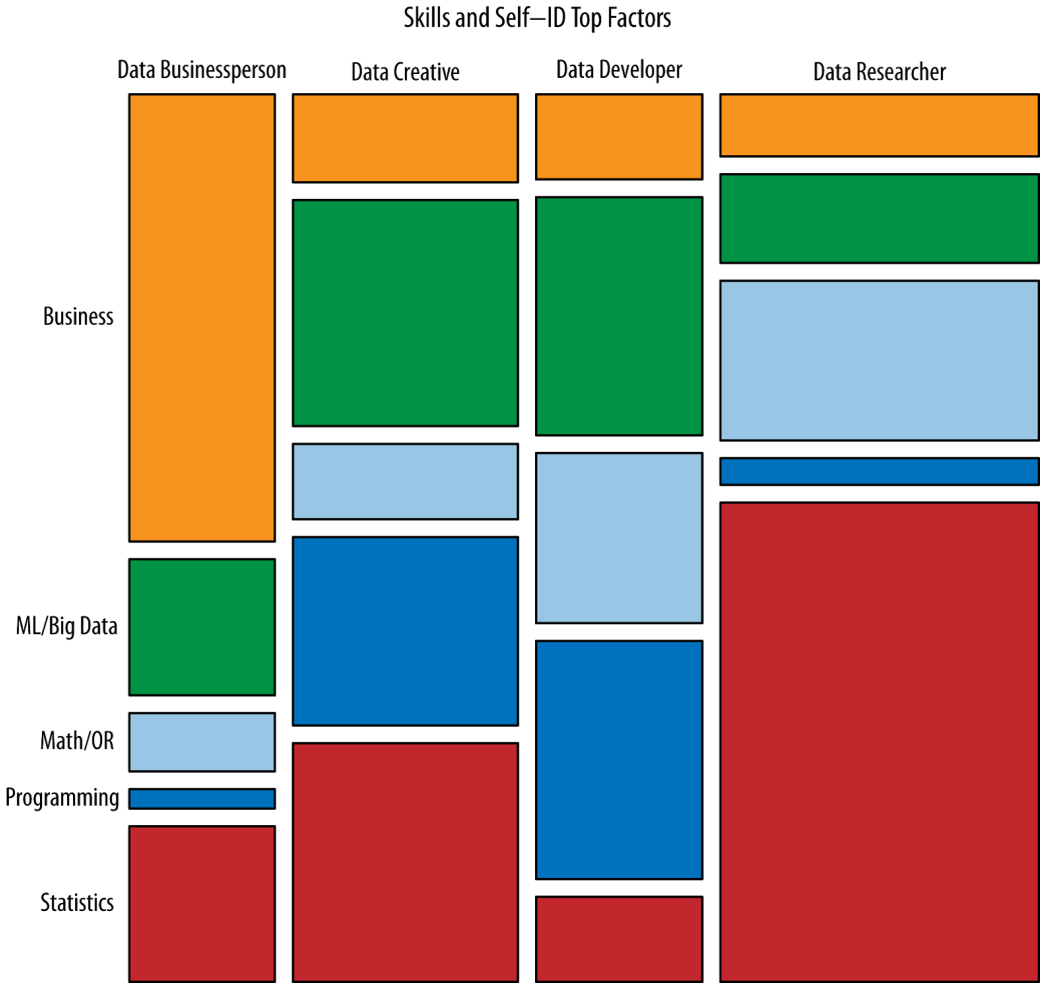
Data Scientists: The unicorn industries want?



Data Scientists: The unicorn industries want?

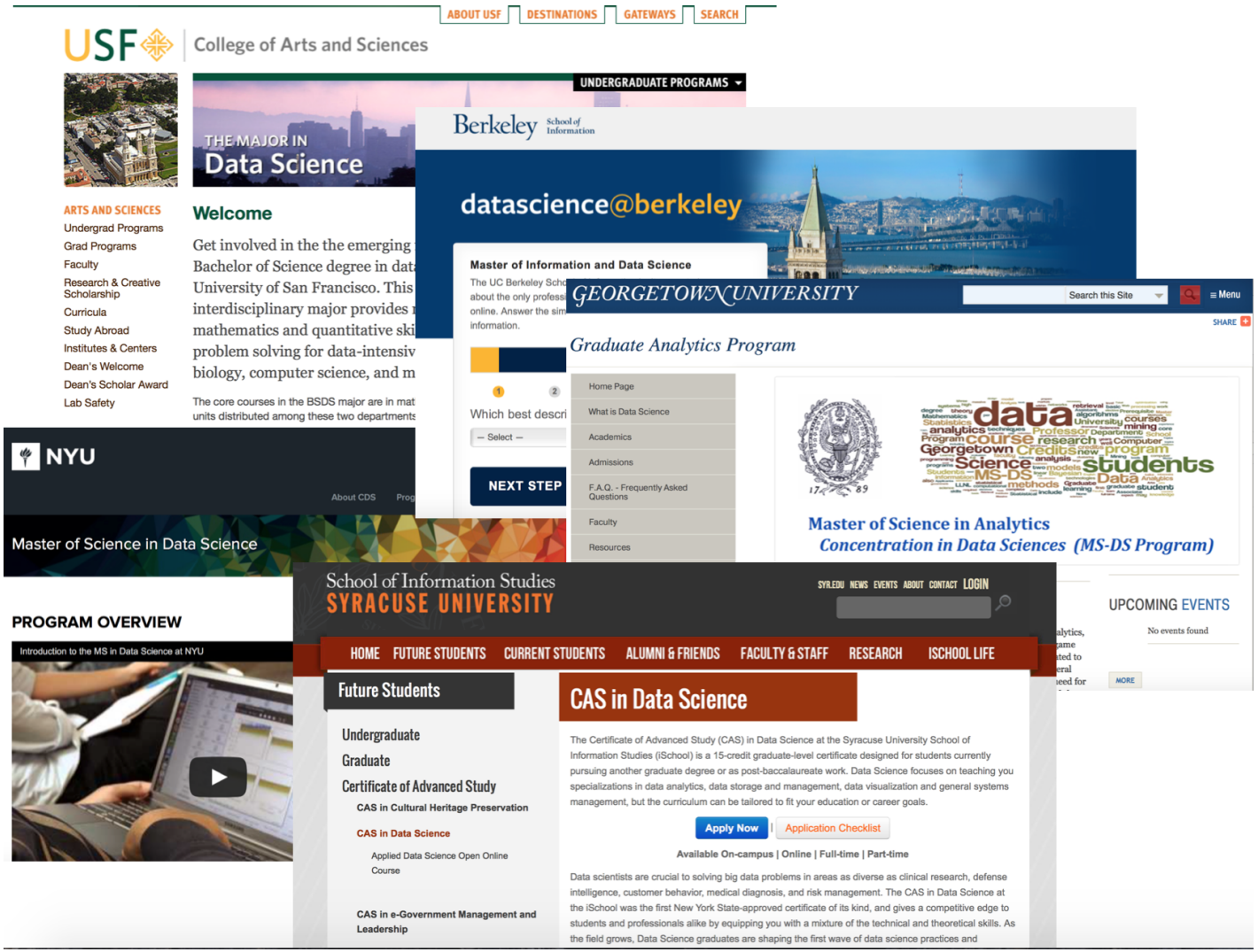
- The field is inherently interdisciplinary
  - mathematical statistics
  - computer science
  - domain expertise
- The elusive “unicorn": all three skills
  - In 2014, these jobs go unfilled for 6 months or longer on average
- Has lead to the development of data science *teams*
  - hope is to merge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

The Analysts of Data Science

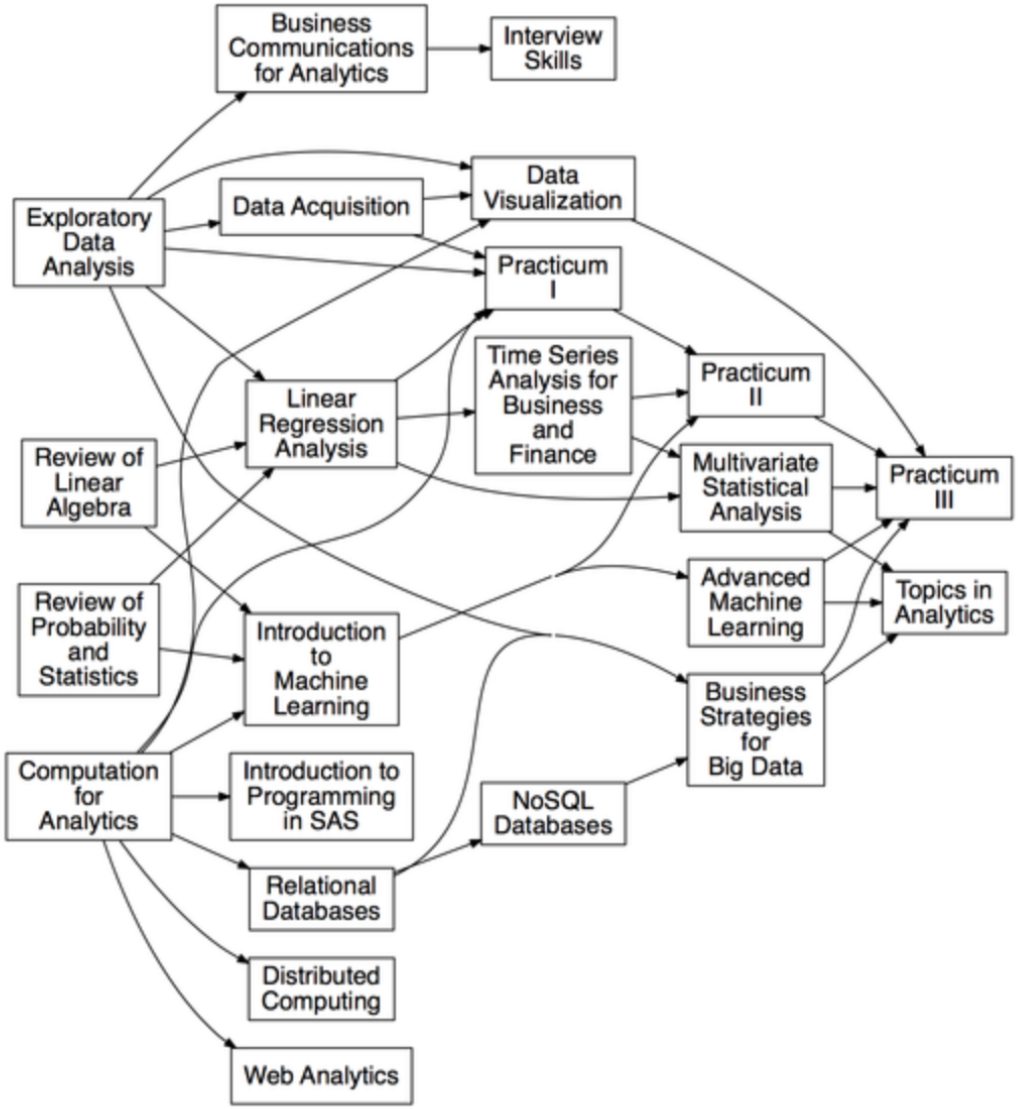


"Analyzing the Analyzers (2013) by Harry, Murphy, and Vaisman."

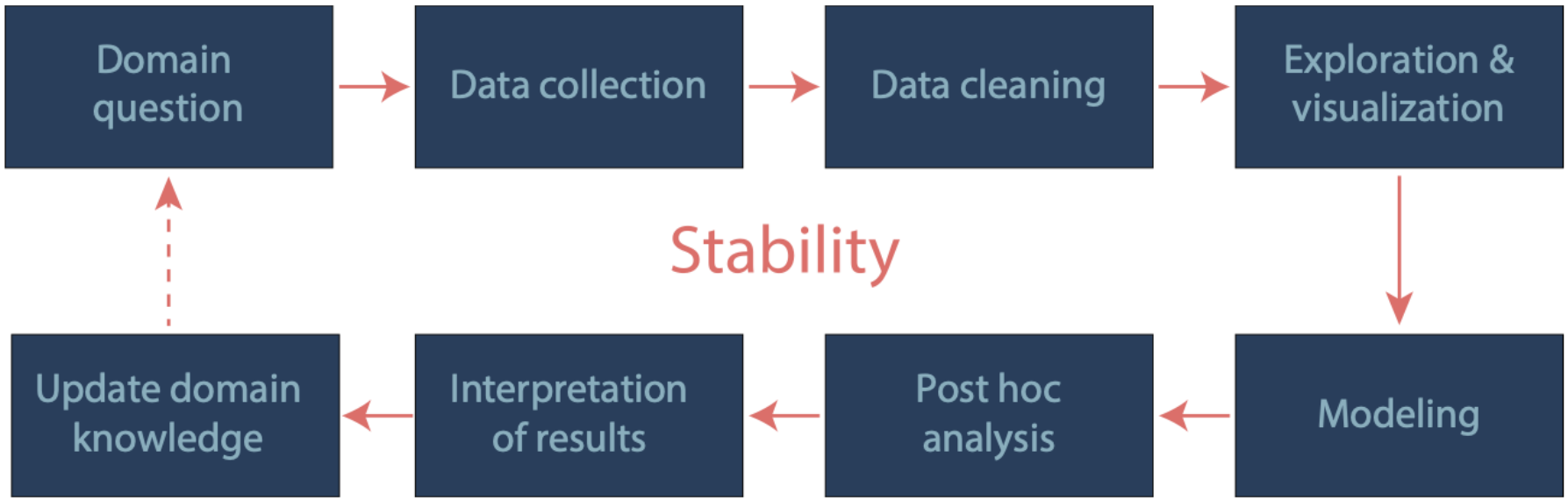
Data Science in Academia



Academic Programs



The Data Science Life Cycle



Yu and Kumbier 2020

A Data Scientist's Toolkit

1. **Data wrangling**: gather, clean, and sample data
2. **Database management**: access big data quickly and reliably
3. **Data exploration**: summarize, visualize, and contextualize data to make a hypothesis
4. **Make predictions**: statistical and machine learning methods
5. **Communicate the results**: more visualization, presentations, summaries

Resources for Exploring DS

- Flowingdata.com
  - Contemporary visualization and data manipulation techniques
- Kaggle.com
  - Kaggle competitions: can 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."