

# NEW EDUCATIONAL PARADIGM

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ENGINEERING COLLEGE COUNCIL

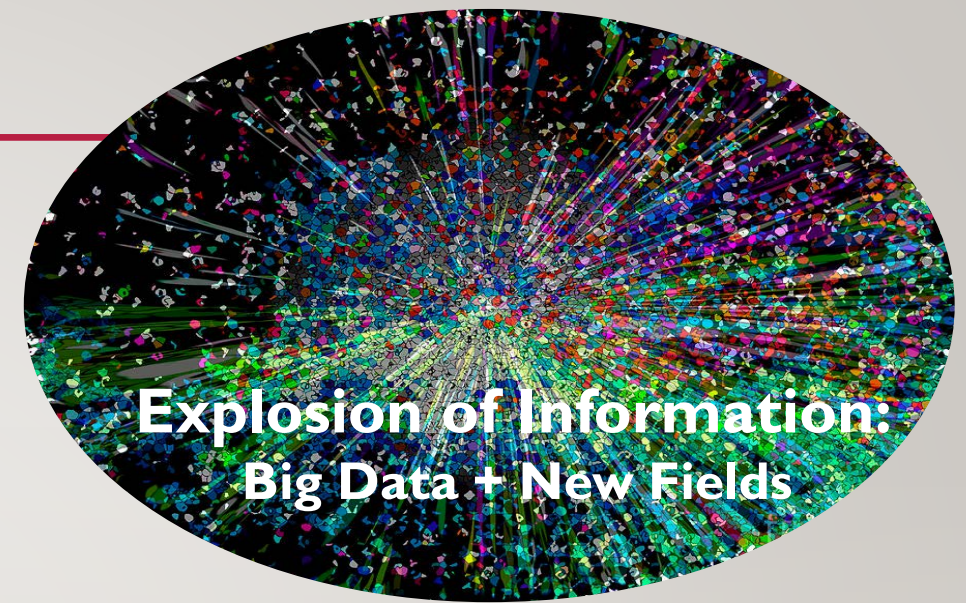
OCT. 27, 2017

# Engineering in the 21<sup>st</sup> Century

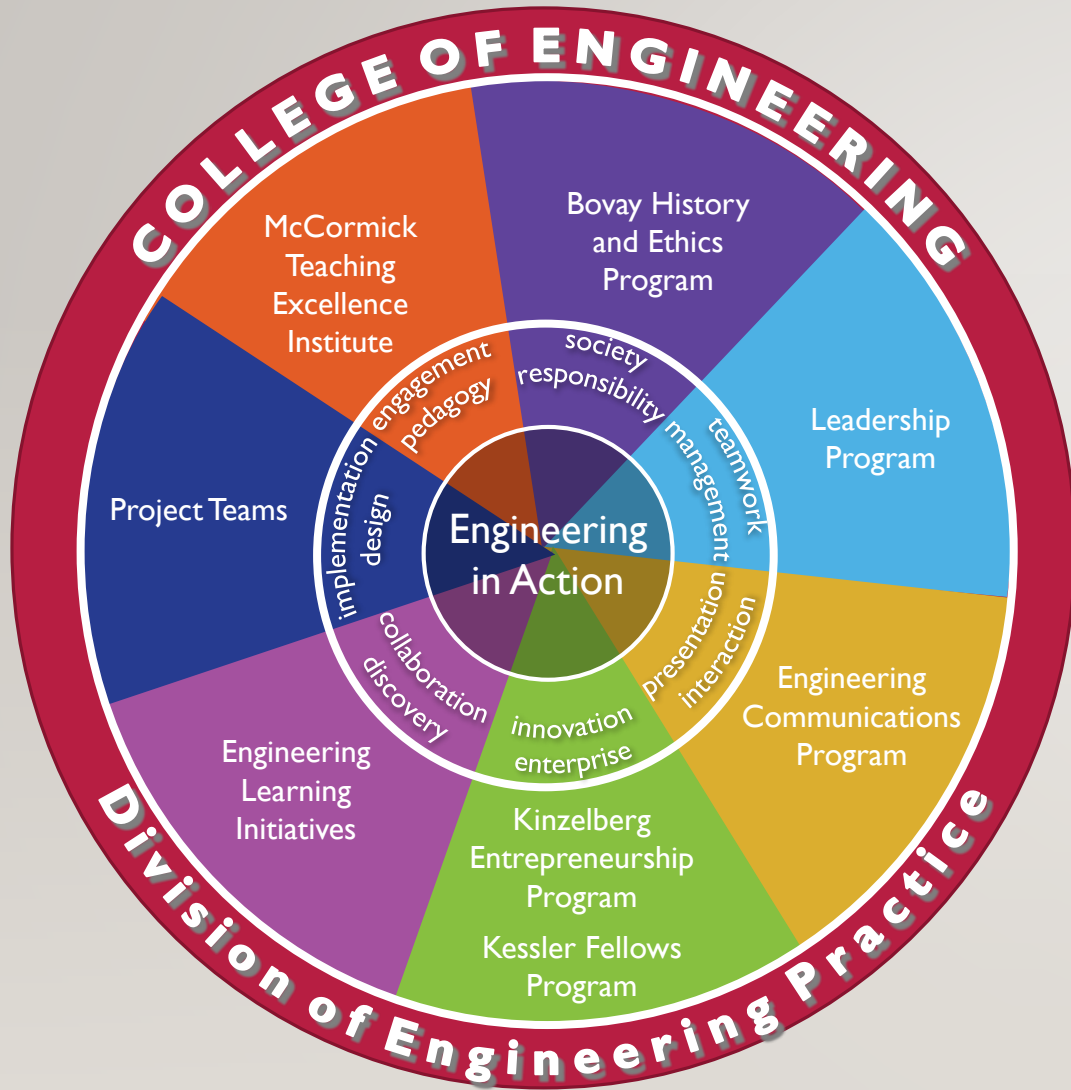


**Create, Lead, Disrupt, Invent**

# EVOLVING FACE OF EDUCATION



# DIVISION OF PROFESSIONAL PRACTICE AND DEVELOPMENT



- Communications
  - Broadest sense – written, oral, visual – technical, elevator, pitches, general public
- Ethics
  - Individual, engineering and societal responsibility
- Leadership
  - Vision, teams, communication, management, group dynamics
- Engineering Learning initiatives
  - Research involvement / Collaborative Learning
- McCormick Teaching Excellence
  - Pedagogy / assessment

# EXPERIENTIAL EDUCATION: LEARNING BY DOING

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- Coop program
- Engineering Leadership Program
- Entrepreneurship
  - Business Minor with the Dyson School
  - Engineering Entrepreneur Minor
  - eLab/PopShop and eHub
  - Innovation Competition
  - Kessler Programs
- **Cornell-Tech Internships!**
- Project Teams



**Kessler Fellows**

# PROJECT TEAMS



- 29 teams – over 1,100 students from all 14 Engineering majors and 7 colleges/schools
- Total expenditures over \$1M (endowment, college, gifts, corporate sponsorship)

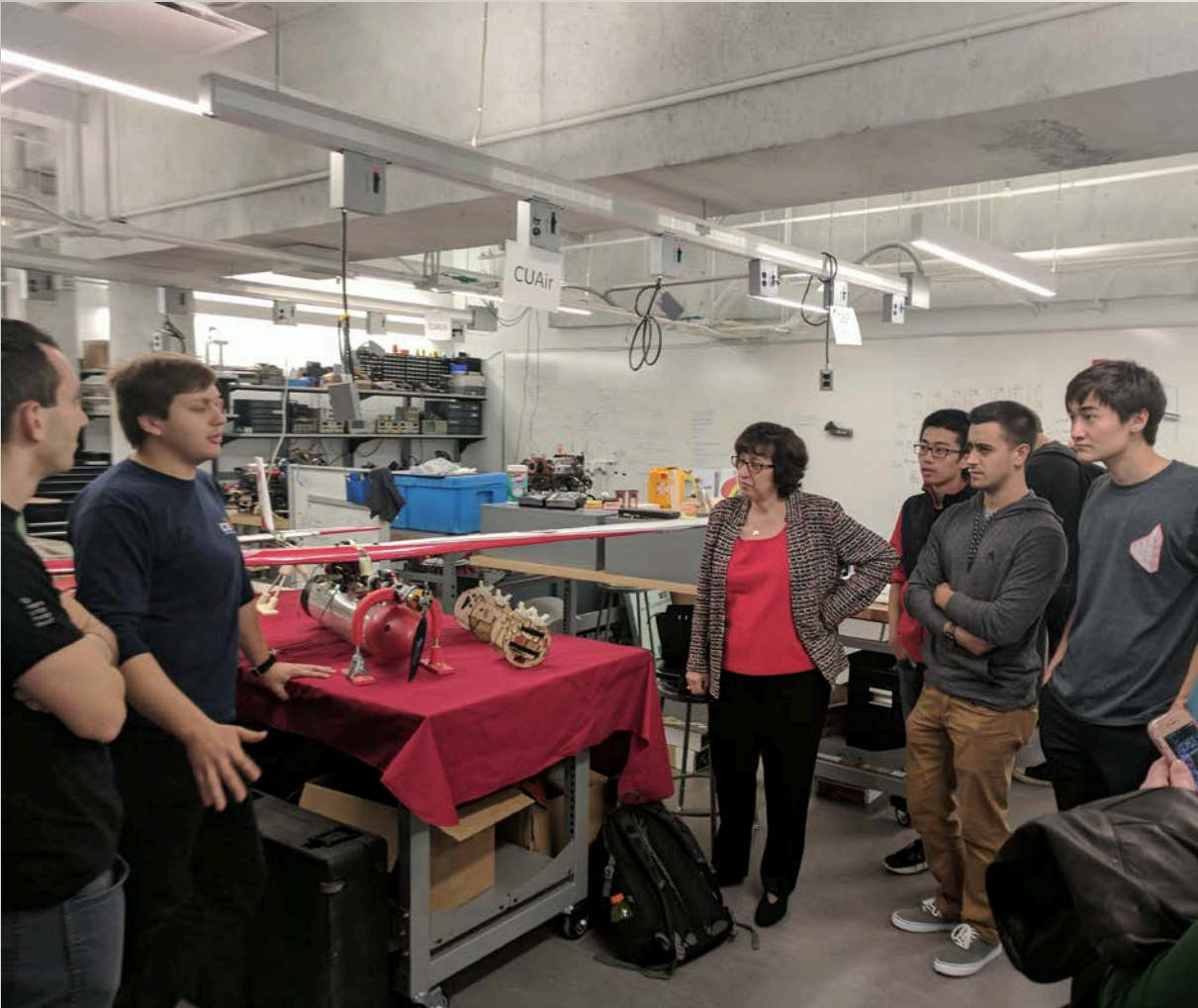
# PROJECT TEAMS

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# BUT EVEN PROJECT TEAMS APPRECIATE THE PRESIDENT AND BILL NYE!

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# NEW DIRECTIONS AND CHALLENGES

Developing  
Professional  
Skills

Core Technical  
Expertise

Career Paths  
Consulting,  
Business and  
Entrepreneur

Learning  
Styles and  
Expectations

Diverse  
and Global  
Work  
Environment

# EVOLVING CLASSROOMS



**Large Lectures**  
**Efficient Information Presentation**

**Poor Information Transfer**  
**Limited Student Engagement**

**Small Group Engagement**  
**Learning while Doing**  
**High Tech Classroom (technology)**  
**Resource Challenges**  
**Faculty (workforce) retraining**

# FROM “ACTIVE TEACHING” TO FULLY “FLIPPED CLASSES”



- New classrooms in Upson
- Active learning rooms enable small groups work within traditional lecture
  - Leverage best of each
- Design / teaching studio rooms for full course flip (group work focus)
- Faculty still learning to efficiently utilize spaces

# LEVERAGING TECHNOLOGY TO MEET STUDENTS “HALFWAY”

The screenshot shows a Panopto video player displaying an Ellingham Diagram. The diagram plots  $\Delta G^\circ = RT \ln K$  (J/mol) on the y-axis against Temperature (°C) on the x-axis. The x-axis ranges from 0 to 1600°C, and the y-axis ranges from -1200 to 0 J/mol. Several lines represent different chemical reactions, such as  $\text{CO} + \frac{1}{2} \text{O}_2 = \text{CO}_2$ ,  $2\text{CO} + \text{O}_2 = 2\text{CO}_2$ , and  $\text{C} + \text{O}_2 = \text{CO}_2$ . The lines are labeled with their respective partial pressure ratios ( $P_{\text{CO}}/P_{\text{CO}_2}$ ). The video player interface includes a search bar, notes, and a progress bar.

- Increased on-line content for self-paced learning
- Rooms enabled to immediately record and post lectures for review
  - Has not, so far, resulted in significantly reduced attendance
- On-line tools to develop “near professional” presentations as supplements to class lectures
  - Part of the true flip
  - Content outside of class time
  - Class devoted to development of more complex skills

# DISTANCE LEARNING FACILITIES

- Smile! ... You're on camera.
- Key to enable course sharing between
  - Ithaca campus
  - Cornell-Tech campus
  - Weill Medical Campus
  - Room expansion with college
- Similar challenges for faculty to make effective use of the technology



# KEY PARTNER: MCCORMICK TEACHING INSTITUTE

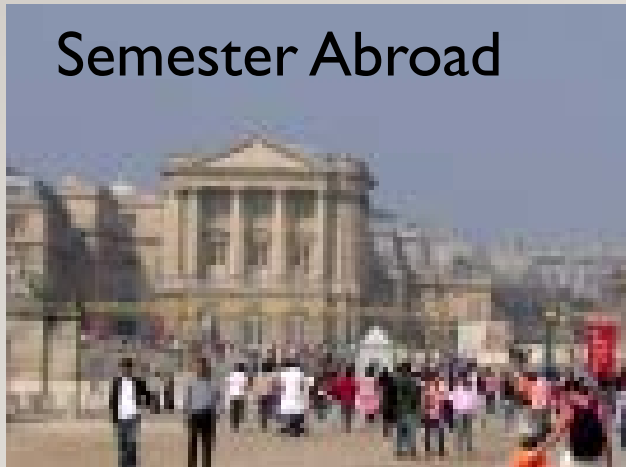
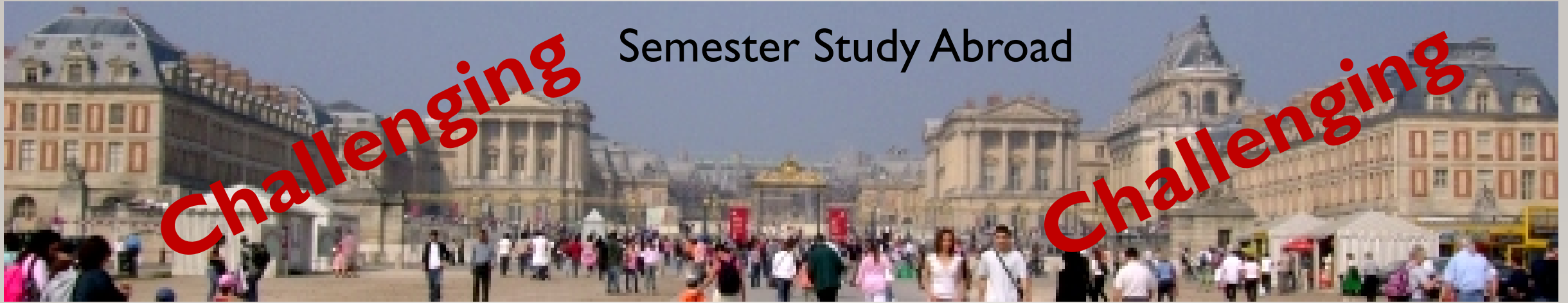
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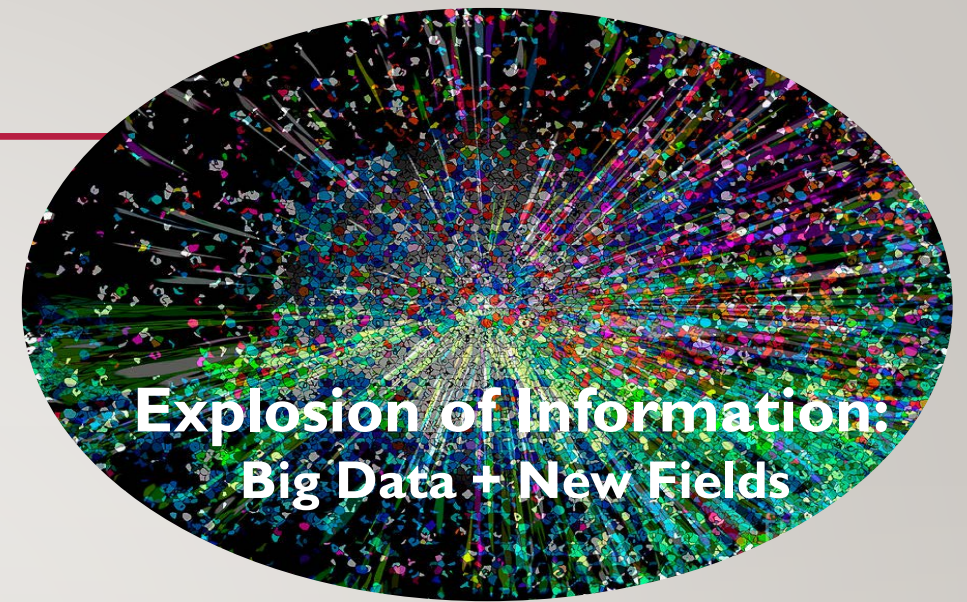
**Kathy Dimiduk**  
Director

- Encouragement for new teaching styles
  - Movement to flipped course models
  - Second round of funding for course redesign
    - Engaged learning
    - Flipped courses
- Assessment and Course improvement
  - Support of existing curriculum
  - Critical for continuous improvement
- Critical to implement changes in this new paradigm

# DEVELOPING GLOBAL INNOVATORS



# EVOLVING FACE OF EDUCATION





# MANAGING THE EXPLOSION AND ENGAGEMENT: ONE EXAMPLE

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Madeleine Udell - ORIE

**Skill:  
Driven  
ions  
nded  
alum)**

**valuation of  
n insights**

**Developing an engineering like  
approach to understanding  
complexity and data within the  
larger university environment**

**Global leaders across all of Cornell**

# THE NEW EDUCATIONAL PARADIGM

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DATA SCIENCE FOR ALL

# DATA DRIVEN DECISION MAKING

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Data driven decision making is a critical skill for the modern world

- For engineers:
  - how to draw conclusions from data
- For everyone:
  - how to evaluate data-based reasoning

# NATIONAL CHALLENGE

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In the United States, it is reported that in 2018 there will be more than 490,000 data science positions available, but only 200,000 qualified people to fill the roles. The **average size of a graduate class of data science students is 23 students**. With approximately only 110 universities offering data science studies, the growing market will continue to pressure the supply in the US.

January 22, 2016

**Data Scientists: The Myth and the Reality**

Seamus Breslin

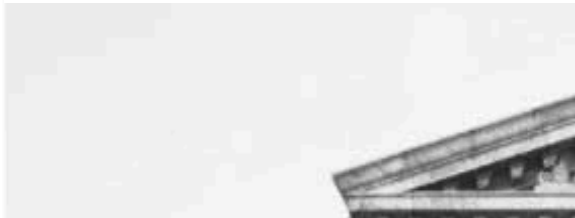
<https://www.datanami.com/>



*Seamus Breslin is the founder and managing director of Solas Consulting, an Irish company that specializes in placing big data, BI, SQL, Oracle, Java and .Net professionals with a variety of clients ranging from multinationals to SMEs and start-ups.*

OCT. 17, 2017 AT 6:00 AM

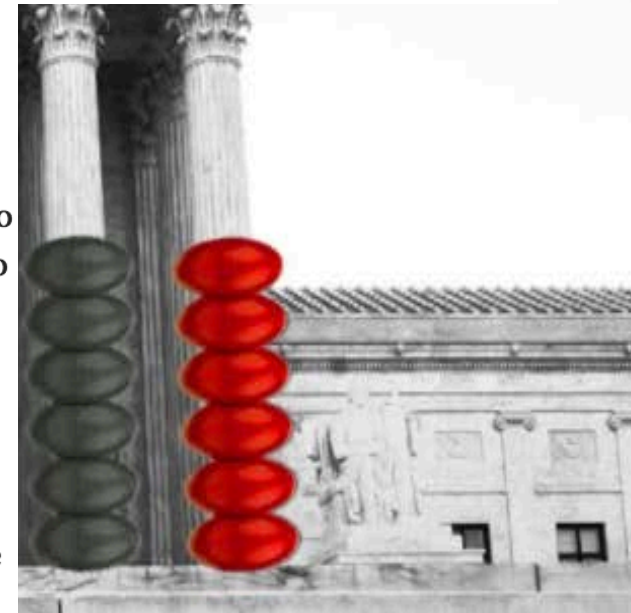
# The Supreme Court Is Allergic To Math



The Supreme Court does not countenance quantitative evidence. It would rather not. The justices, however, have a reluctance — even an aversion — to engage with it seriously.

For decades, the court has struggled with quantitative evidence of all kinds in a wide variety of cases. Sometimes justices ignore this evidence. Sometimes they misinterpret it. And sometimes they cast it aside in order to hold on to more traditional legal arguments. (And, yes, sometimes they also listen to the numbers.) Yet the world itself is becoming more computationally driven, and some of those computations will need to be adjudicated before long. Some major artificial intelligence case will likely come across the court's desk in the next decade, for example. By voicing an unwillingness to engage with data-driven empiricism, justices — and thus the court — are at risk of making decisions without fully grappling with the evidence.

quantify partisan gerrymandering: “It may be simply my educational background, but I can only describe it as sociological gobbledygook.” This was



Standing is good for you, but wait, N=50!!! Why would Psychological Science or The Economist publish a study with such sample size?



Standing is good for your mind as well as your body

It seems to promote cognitive performance

ECONOMIST.COM

NEW YORK TIMES BESTSELLER



# WEAPONS OF MATH DESTRUCTION



HOW BIG DATA INCREASES INEQUALITY  
AND THREATENS DEMOCRACY

CATHY O'NEIL

A NEW YORK TIMES NOTABLE BOOK

# INSPIRATION:

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## Foundations of Data Science @ UCB

<https://data-8.appspot.com/sp16/course>

**Instructor: John DeNero**

Co-instructors: Ani Adhikari, Michael I. Jordan, Tapan Parikh,  
and David Wagner

**Book:** [Computational and Inferential Thinking: The Foundations of Data Science](#)

by [Ani Adhikari](#) and [John DeNero](#)



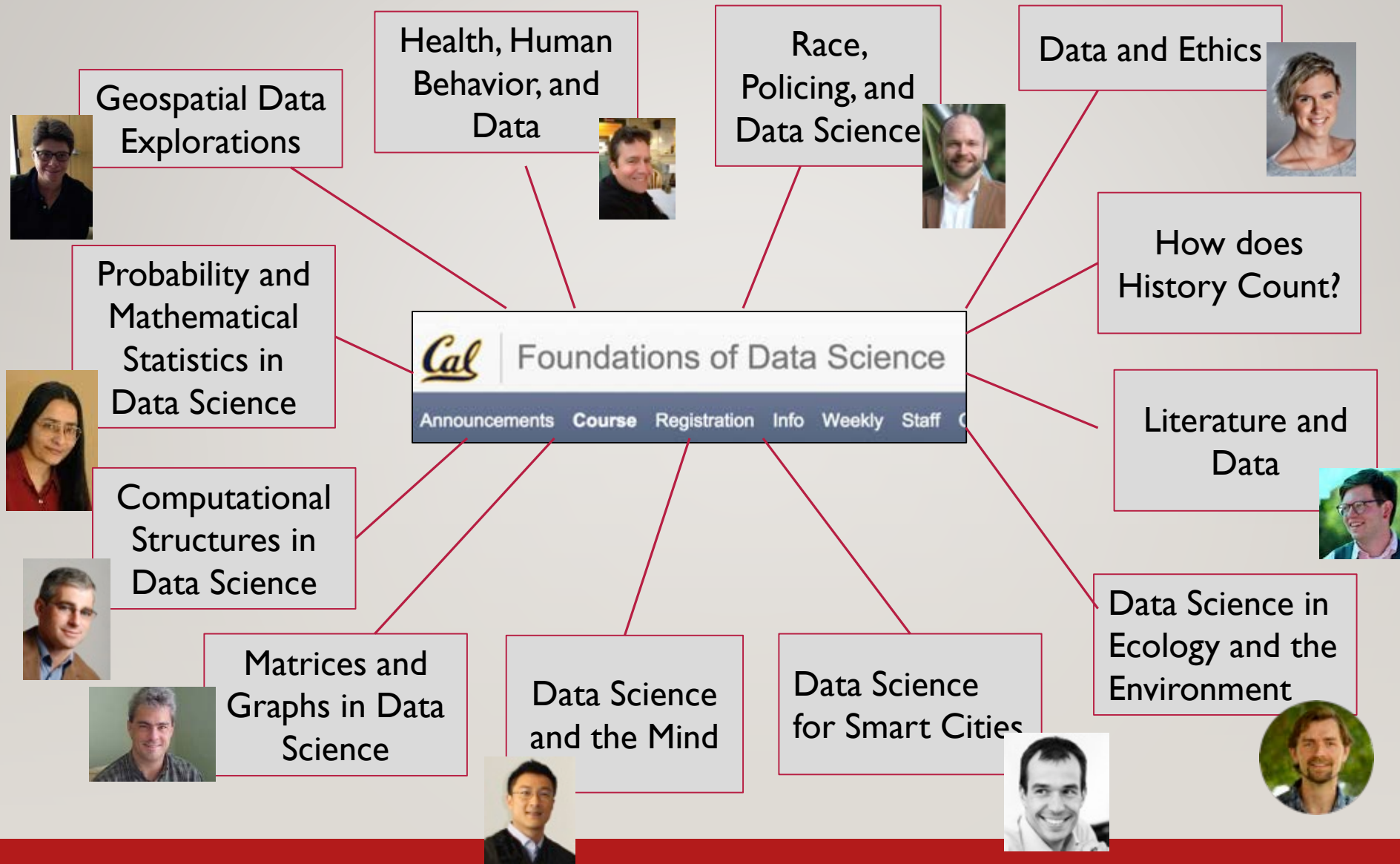
# OPPORTUNITY

## Foundations of Data Science @ UCB

414 students  
42% women  
46% freshmen



# DATA SCIENCE CONNECTIONS AT BERKELEY



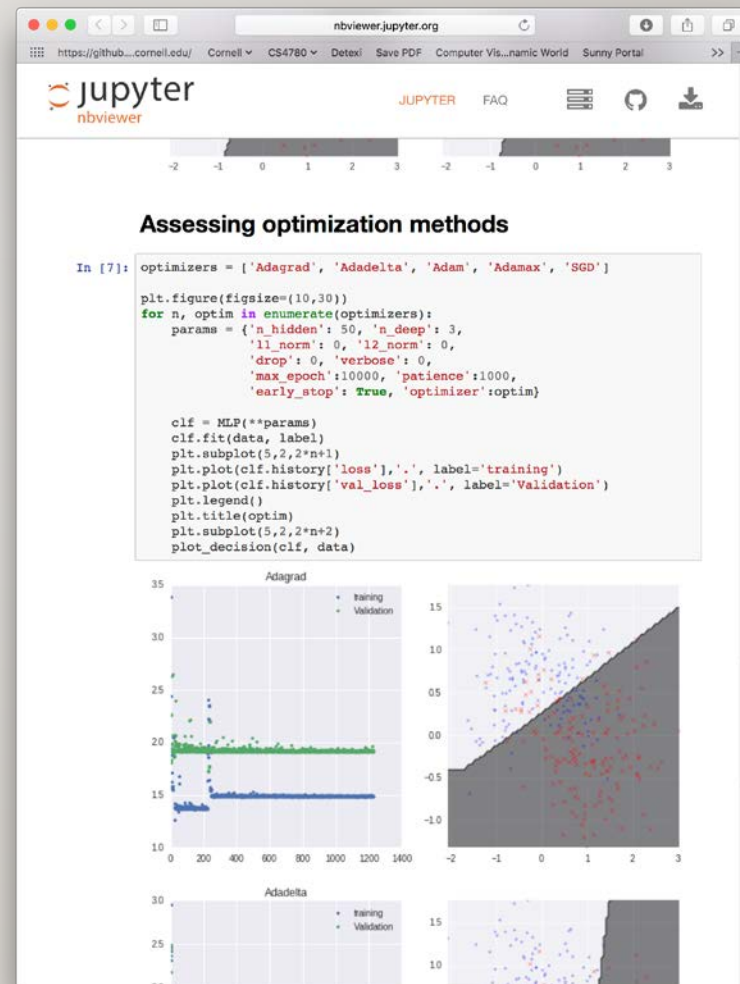
BEARS DS @ UCB

# CS/ORIE I380: DATA SCIENCE FOR ALL

- **No prerequisites**
- priority for **freshman and sophomores** outside of engineering (CALS, A&S, ILR)
- Combines **theory** and **practice**
- Uses **Jupyter / IPython** notebooks: simple, great for sharing and visualization, and open source

C.f. existing Cornell courses which either

- do not touch data
- or have many prerequisites



See also [Berkeley survey](#)

# SYLLABUS (I)

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- Data Science: Causality, Randomization, Experiments
  - Why Data Science?
  - Cause and Effect
- Programming: Data Types, Tables, Functions
  - Expressions
  - Sequences
  - Data Sets
  - Tables
  - Functions
  - Categories
- Visualization: Interpreting and exploring data
  - Charts
  - Histograms

# SYLLABUS (II)

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## Randomness and Sampling: Understanding random selection

- Sampling
- Iteration
- Estimation and Means
- Variability

## Prediction: Making predictions from data

- Correlation
- Explorations: Privacy
- Regression
- Prediction
- Explorations: Design and Critique
- Errors
- Multiple Regression
- Classification
- Explorations: Machine Learning
- Feature Selection

# SYLLABUS (III)

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## Inference: Reasoning about populations

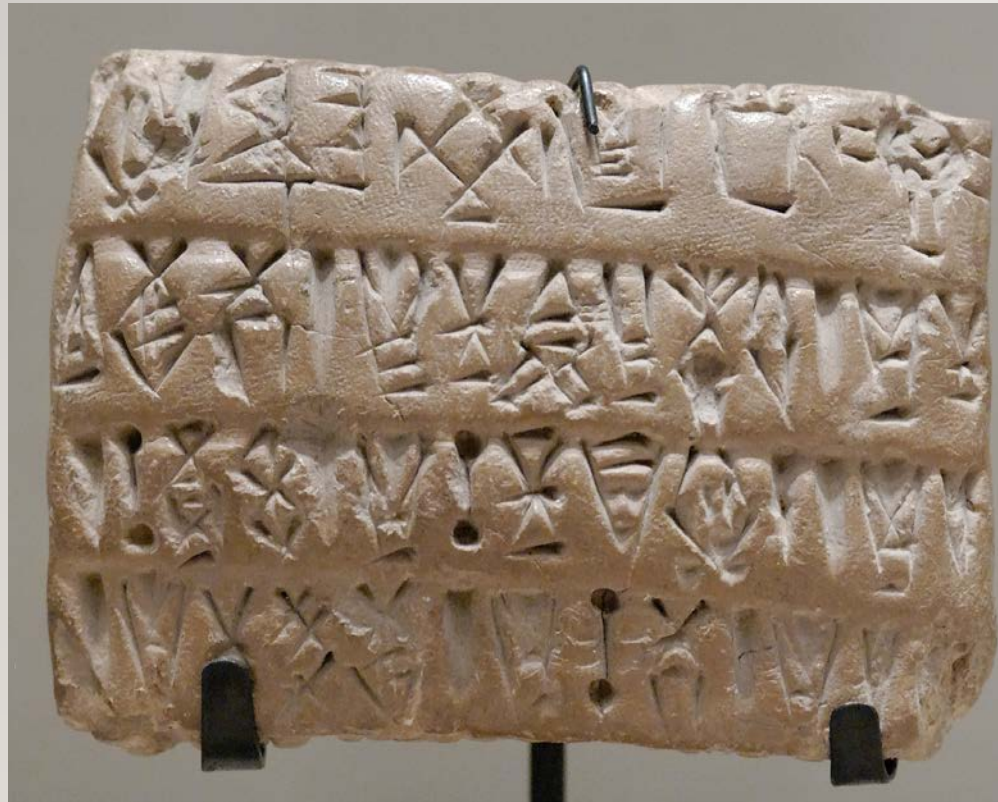
- Confidence Intervals
- Percentiles
- Distance Between Distributions
- Hypothesis Testing
- Hypothesis Testing II
- Permutation Tests
- A/B Testing
- Regression Inference
- Slope Inference
- Regression Diagnostics

# QUESTIONS FOR THE ECC

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# DATA SCIENCE VS ARTIFICIAL INTELLIGENCE?

- Data science: augmenting humans' abilities
- Artificial intelligence: replacing humans



## MATH & STATISTICS

- ☆ Machine learning
- ☆ Statistical modeling
- ☆ Experiment design
- ☆ Bayesian inference
- ☆ Supervised learning: decision trees, random forests, logistic regression
- ☆ Unsupervised learning: clustering, dimensionality reduction
- ☆ Optimization: gradient descent and variants

## DOMAIN KNOWLEDGE & SOFT SKILLS

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



## PROGRAMMING & DATABASE

- ☆ Computer science fundamentals
- ☆ Scripting language e.g. Python
- ☆ Statistical computing packages, e.g., R
- ☆ Databases: SQL and NoSQL
- ☆ Relational algebra
- ☆ Parallel databases and parallel query processing
- ☆ MapReduce concepts
- ☆ Hadoop and Hive/Pig
- ☆ Custom reducers
- ☆ Experience with xaaS like AWS

## 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



# ACTIVE LEARNING

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- Engaging lectures
  - “I can pay attention the entire time”
- Small group discussions
- Demos
- Projects
- Labs
- ?