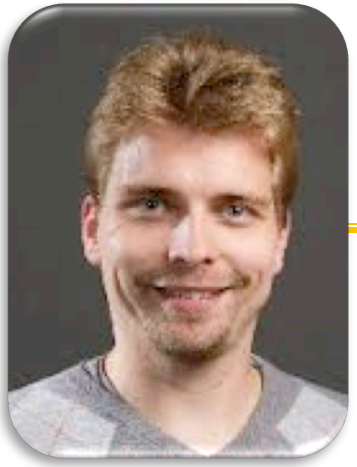

Computational Structures in Data Science

Lecture #1: Welcome to CS88!

UC Berkeley EECS
Adj. Ass. Prof.
Dr. Gerald Friedland

January 28, 2019

http://inst.eecs.berkeley.edu/~cs88

CS88 Team

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Andrew Cullen

Kevin Gu Photo

Kevin Gu

Minos Park

CS88 Team - me

- **Dr. Gerald Friedland (fractor@berkeley.edu)**
  - **424 Saturdai Daj Hall (CITRIS)**
  - **http://www.gerald-friedland.org**
  - **Office hours: Mo 1:30-2:30 @ 424 SDH**
  - **Before/after class**

Berkeley
UNIVERSITY OF CALIFORNIA

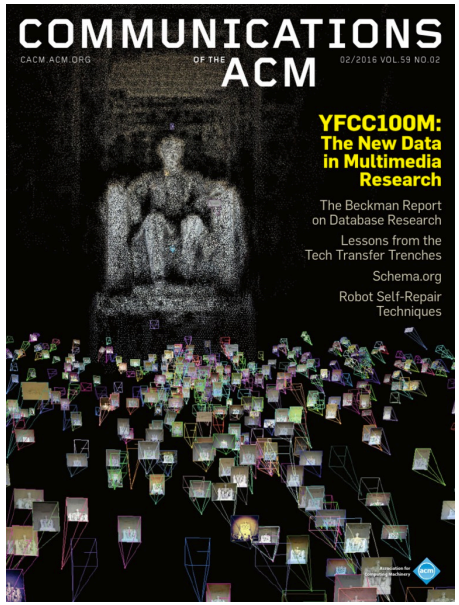
- **Adjunct Assistant Professor, EECS UC Berkeley**
- **Principal Data Scientist, Lawrence Livermore National Laboratories**

CS88 Team - me

Projects you might want to check out:

- **http://mmcommons.org**

- Work with 100M images, 1M videos in your own Amazon instance.



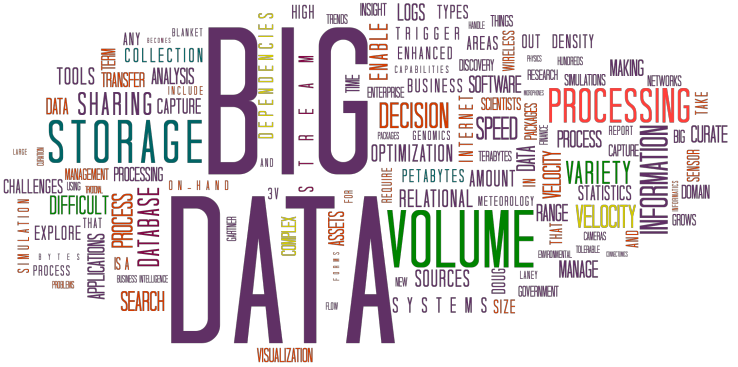
- **http://www.teachingprivacy.org**

- Creating teaching materials informing about data over sharing.

<Teaching Privacy>

Goals today

- Introduce you to
  - the field
  - the course
  - the team

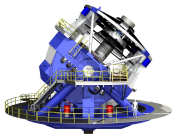


- Answer your questions

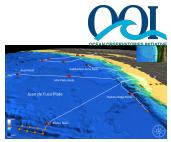
- Big Ideas:
  - Abstraction
  - Data Type

Data Science

Nearly every field of discovery is transitioning from "data poor" to "data rich"


Astronomy: LSST


Physics: LHC

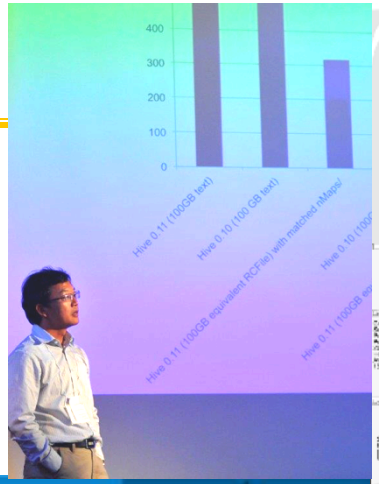

Oceanography: OOI

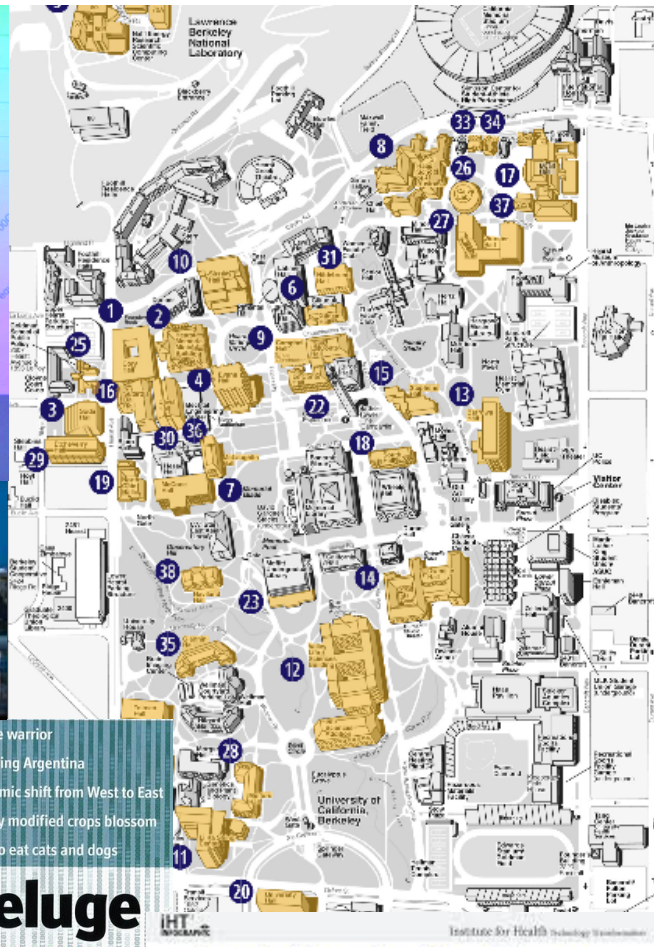

Sociology: The Web


Biology: Sequencing


Economics: POS terminals


Neuro





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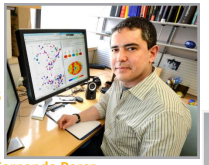
Data Science growing organically everywhere

WIRED Spark: Open Source Superstar Rewrites Future of Big Data
BY CADE METZ 06.19.13 6:30 AM


AMP Lab
Ion Stoica, CS
Michael Franklin, CS


Fernando Perez,
Brain Imaging Center
iPython tools and community


Reconstructing the movies in your mind
Bin Yu, Statistics
Jack Gallant, Neuroscience

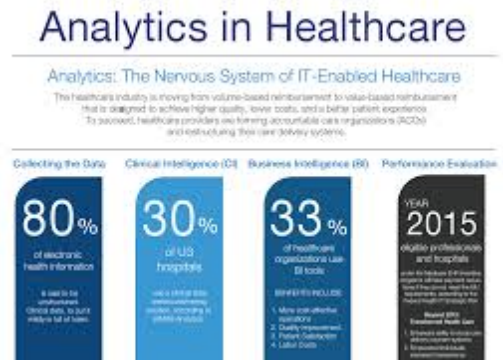

Richard Allen
Earth& Plan. Science
Geospatial Lab

The New York Times
Incomes Flat in Recovery but Not for the 1%
Feb 15, 2013
Emmanuel Saez, Economics

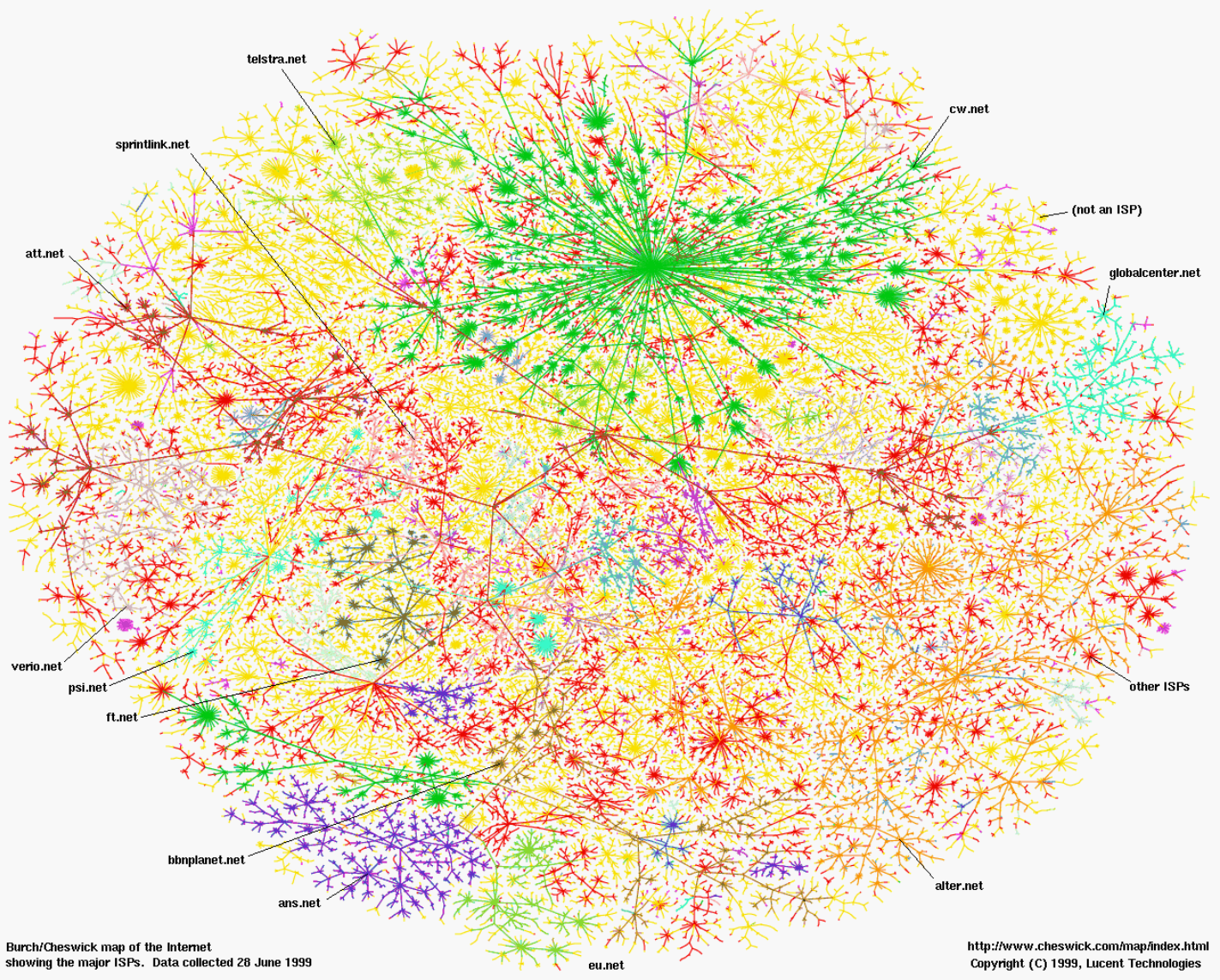
KBase
PREDICTIVE BIOLOGY
DOE Systems Biology Knowledgebase

Adam Arkin,
Bioengineering


Charles Marshall
Rosie Gillespie
Integrative Biology
Digitized Museum



Greatest Artifact of Human Civilization …



A Connecte

3.0 B 11/15

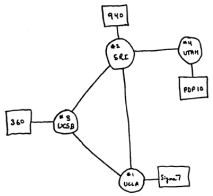
3,293,151,639

Internet Users in the world

Internet

ARPANet

RFC 675 TCP/IP



1969 1974

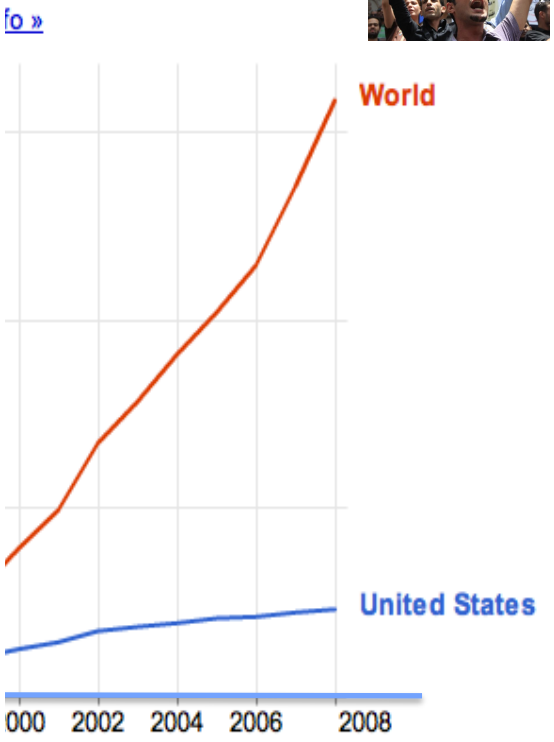
2,652,887,737

Google searches today

5,835,884,253

Videos viewed today on YouTube

2.0 B 1/26/11

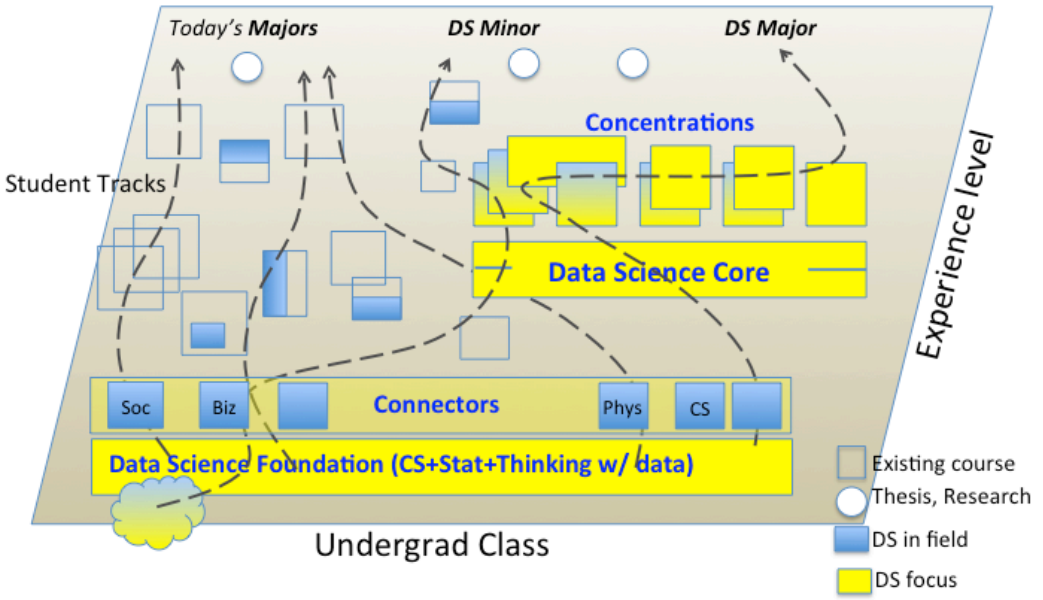


ent Indicators - Last updated December 21, 2010

2010

Data 8 – Foundations of Data Science

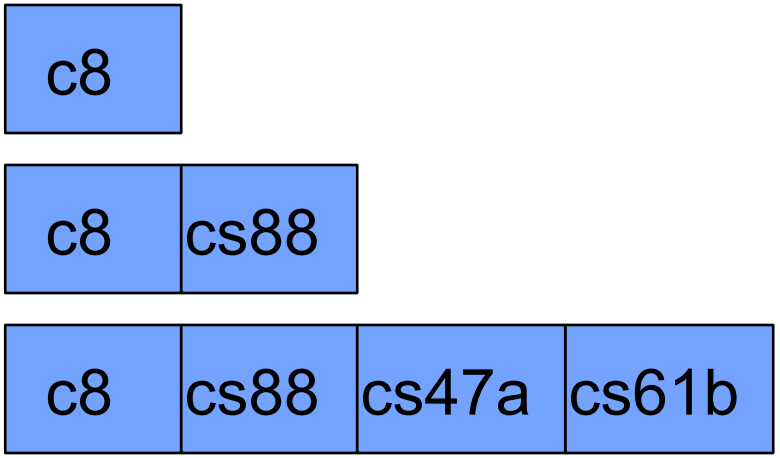
- **Computational Thinking + Inferential Thinking in the context of working with real world data**
- **Introduce you to several computational concepts in a simple data-centered setting**
  - **Authoring computational documents**
  - **Tables**
  - **Within Python3 and "SciPy"**



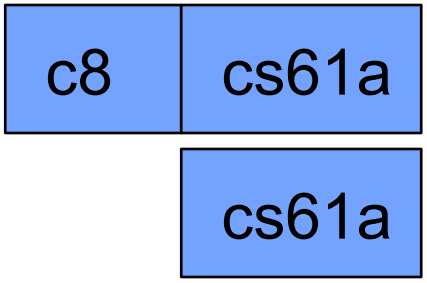
CS88 – Computational Structures in Data Science

- **Deeper understanding of the computing concepts introduced in c8**
  - **Hands-on experience => Foundational Concept**
  - **How would you create what you use in c8 ?**
- **Extend your understanding of the structure of computation**
  - **What is involved in interpreting the code you write ?**
  - **Deeper CS Concepts: Recursion, Objects, Classes, Higher-order Functions, Declarative programming, …**
  - **Managing complexity in creating larger software systems through composition**
- **Create complete (and fun) applications**
- **In a data-centric approach**

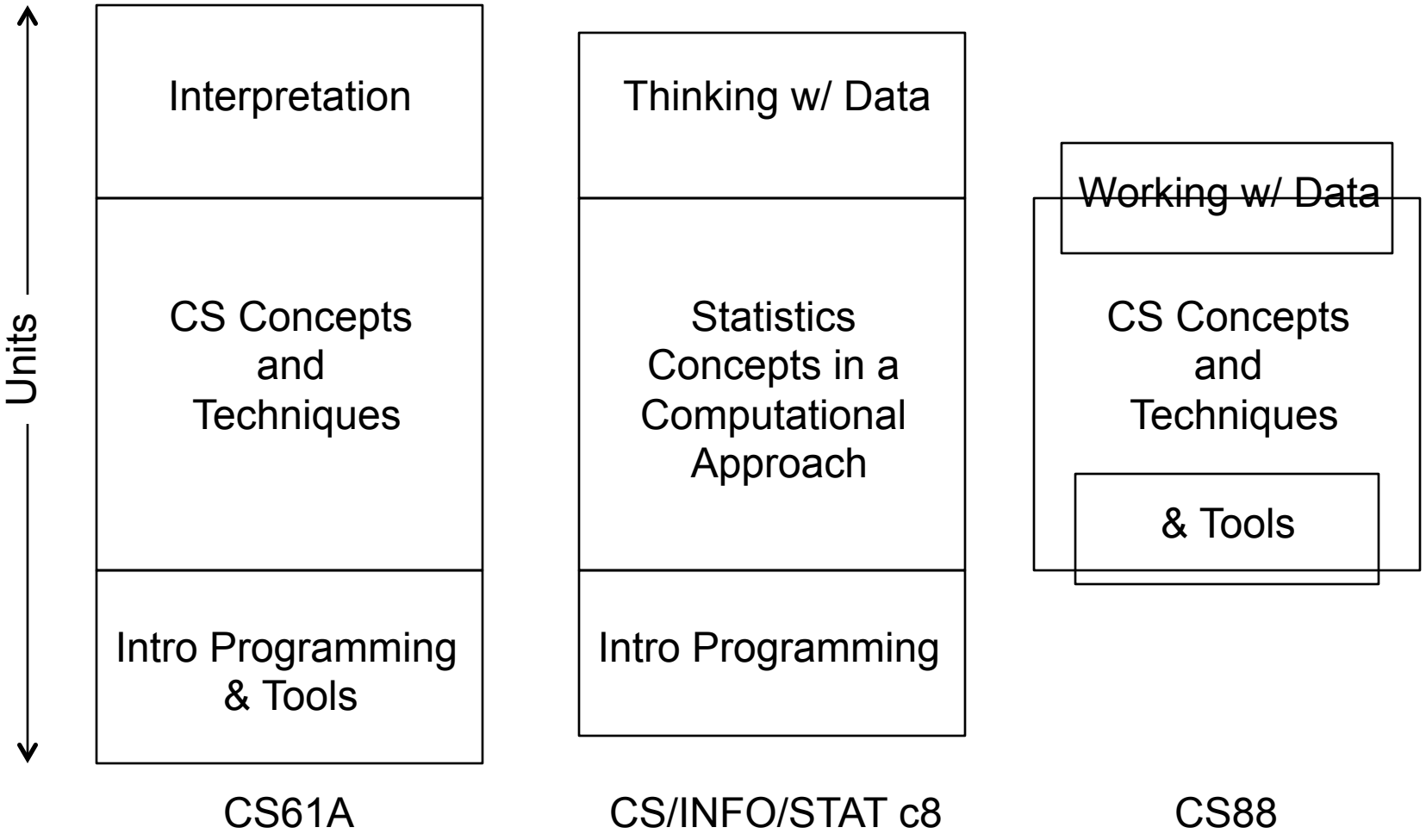
Pathways



*** CS major

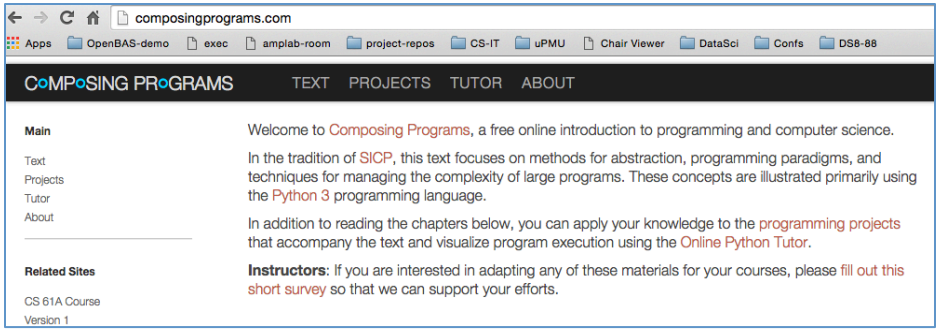


How does CS88 relate to CS61A ?



Course Structure

- 1 Lecture + 1 Lab/Discussion on Wednesday (!!!)
- Lecture introduces concepts (quickly!), answers why questions.
- Lab provides concrete detail hands-on
- Homework (10) cements your understanding
  - Out Monday, Due Sunday
- Projects (3) put your understanding to work in building complete applications
  - Maps
  - Hangman
  - Open Projects!

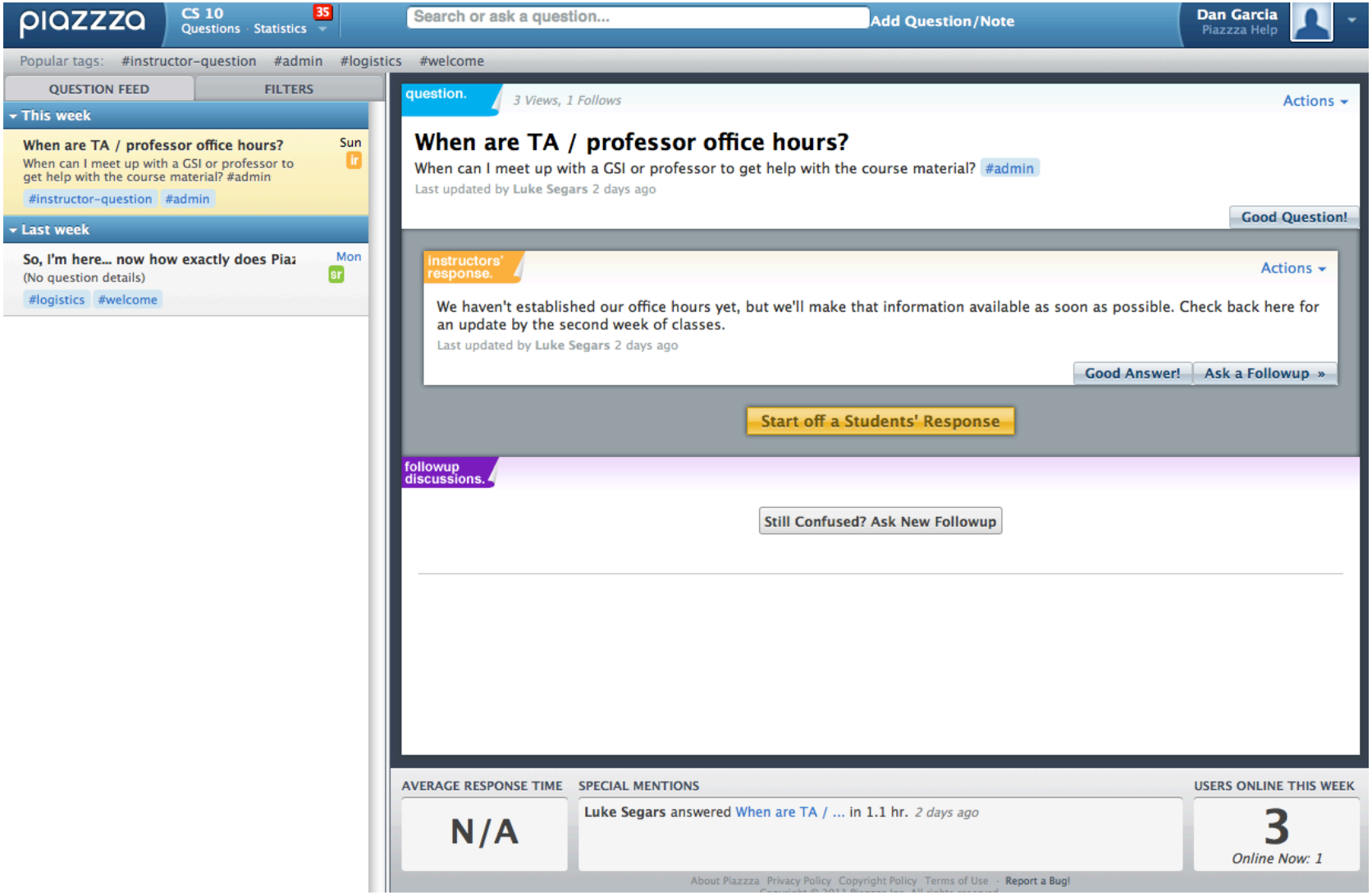


- Readings: http://composingprograms.com
  - Same as cs61a

Course Culture

- Learning
- Community
- Respect
- Collaboration
- Peer Instruction

Piazza for {ask,answer}ing questions



Where will we work?

- Datahub.berkeley.edu
- Your laptop
- Inst.eecs.Berkeley.edu

Pro-student Grading Policies

- EPA
  - Rewards good behavior
  - Effort
    - » E.g., Office hours, doing every single lab, hw, reading Piazza pages
  - Participation
    - » E.g., Raising hand in lec or discussion, asking questions on Piazza
  - Altruism
    - » E.g., helping other students in lab, answering questions on Piazza
- You have 2 "Slip Days"
  - You use them to extend due date, 1 slip day for 1 day extension
  - You can use them one at a time or all at once or in any combination
  - They follow you around when you pair up (you are counted individually)
    - » E.g., A has 2, B has 0. Project is late by 1 day. A uses 1, B is 1 day late

Abstraction

- **Detail removal**

  "The act of leaving out of consideration one or more properties of a complex object so as to attend to others."

- **Generalization**

  "The process of formulating general concepts by abstracting common properties of instances"

- **Technical terms: Compression, Quantization, Clustering, Unsupervized Learning**

Henri Matisse *"Naked Blue IV"*

Experiment


Standard Time Zones of the World
WHERE ARE YOU FROM?
CANADA
U.S.
UNITED STATES
MEXICO
BRAZIL
ARGENTINA
CHILE
PERU
BOLIVIA
PARAGUAY
URUGUAY
COLOMBIA
VENEZUELA
ECUADOR
RUSSIA
CHINA
INDIA
MONGOLIA
KAZAKHSTAN
AUSTRALIA
INDONESIA
PHILIPPINES
JAPAN
ALGERIA
LIBYA
EGYPT
SUDAN
ETHIOPIA
NIGERIA
ZAIRE
SOUTH AFRICA
North Atlantic Ocean
South Atlantic Ocean
North Pacific Ocean
South Pacific Ocean
Indian Ocean
Coordinated Universal Time (U.T.C.) formerly Greenwich Mean Time
C.A.R. -Central African Republic
F.Y.R.O.M. -The Former Yugoslav Republic of Macedonia

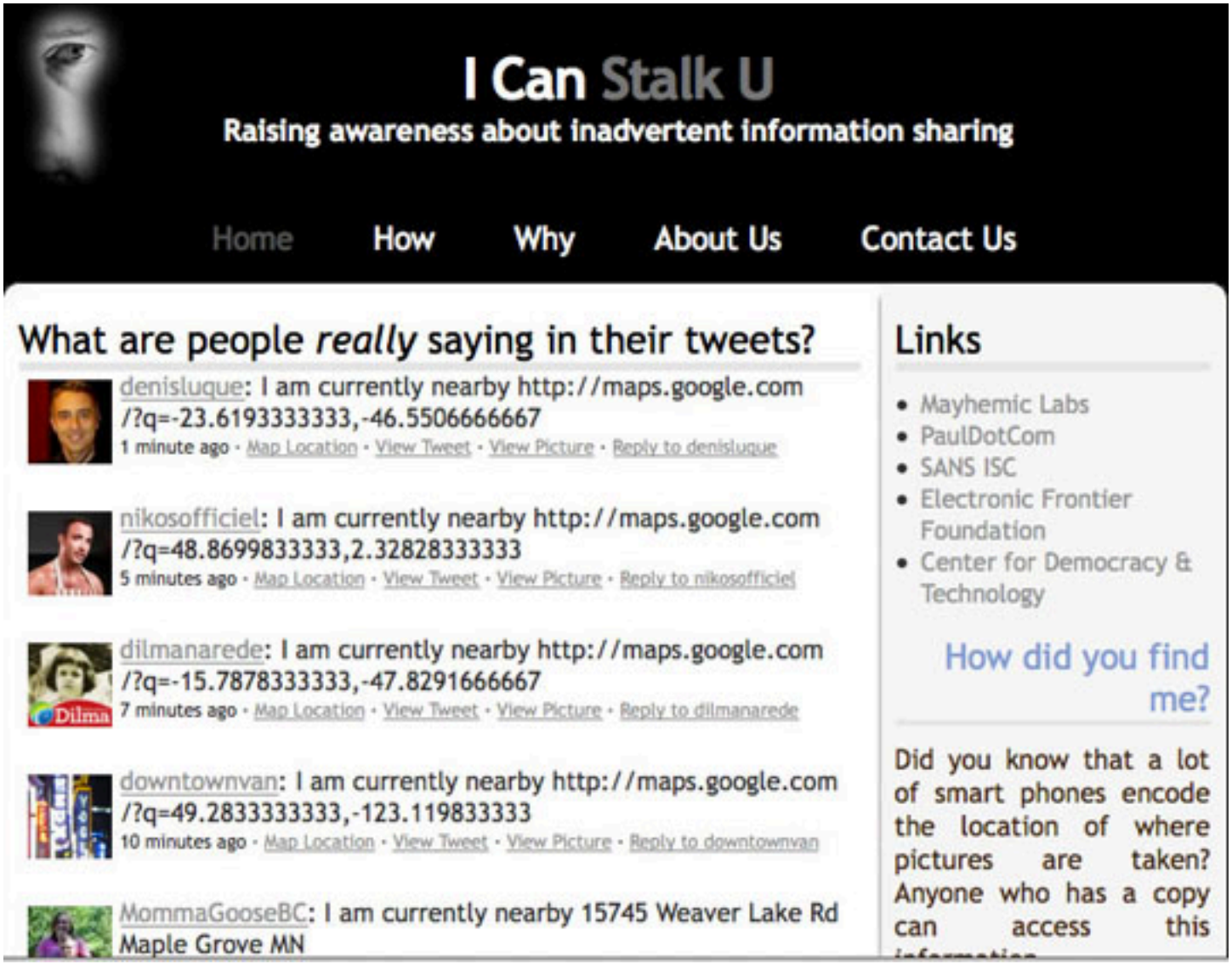
Where are you from?

Possible Answers:

- **China**
- **California**
- **The Bay Area**
- **San Mateo**
- **1947 Center Street, Berkeley, CA**
- **37.8693° N, 122.2696° W**

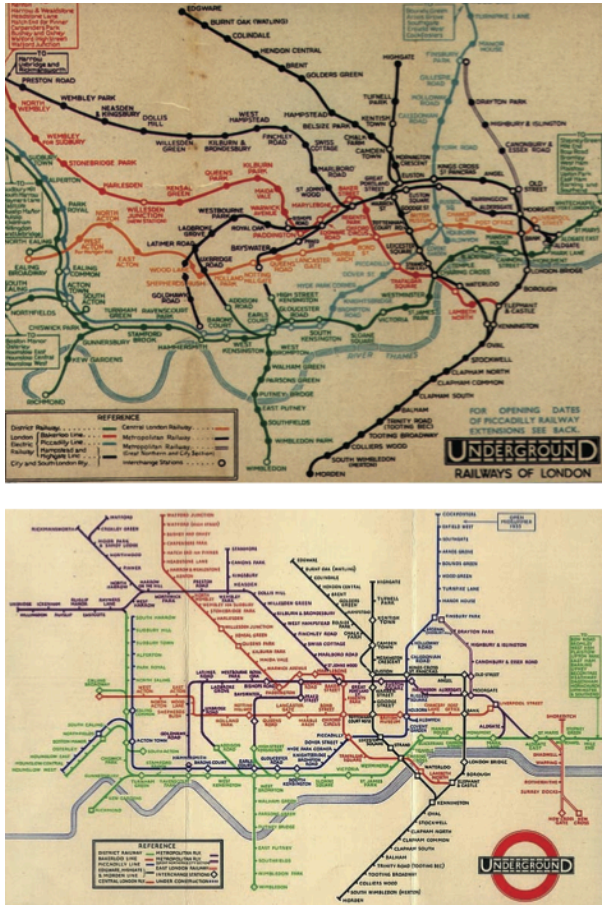
All correct but different levels of abstraction!

Abstraction gone wrong!



Detail Removal (in Data Science)

- You'll want to look at only the interesting data, leave out the details, zoom in/ out…
- Abstraction is the idea that you focus on the essence, the cleanest way to map the messy real world to one you can build
- Experts are often brought in to know what to remove and what to keep!



The London Underground 1928 Map & the 1933 map by Harry Beck.

The Power of Abstraction, Everywhere!

- **Examples:**
  - **Functions (e.g., sin x)**
  - **Hiring contractors**
  - **Application Programming Interfaces (APIs)**
  - **Technology (e.g., cars)**

- **Amazing things are built when these layer**
  - **And the abstraction layers are getting deeper by the day!**

We only need to worry about the interface, or specification, or contract NOT how (or by whom) it's built

Above the abstraction line

Abstraction Barrier (Interface)
(the interface, or specification, or contract)

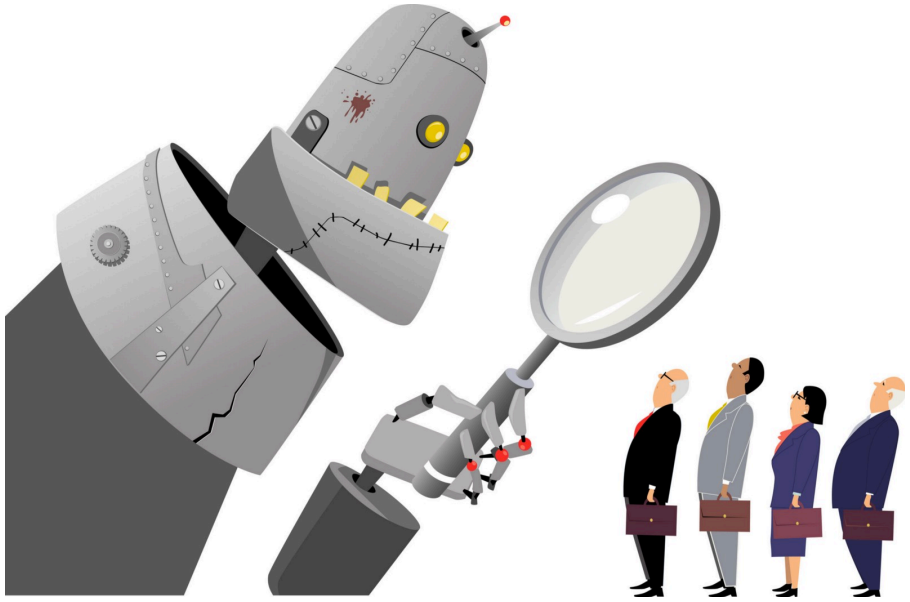
Below the abstraction line

This is where / how / when / by whom it is actually built, which is done according to the interface, specification, or contract.

Abstraction: Pitfalls

- Abstraction is not universal without loss of information (mathematically provable). This means, in the end, the complexity can only be “moved around”

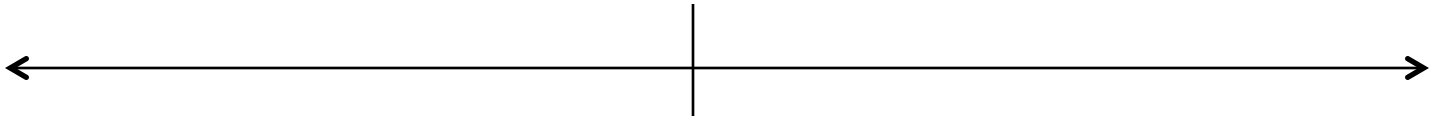
- Abstraction makes us forget how things actually work and can therefore hide bias. Example: AI and hiring decisions.



- Abstraction makes things special and that creates dependencies. Dependencies grow longer and longer over time and can become unmanageable.

Abstraction in CS: Data Type

- **What's this?**



Real (or ideal) world

42

Computer representation

Data Types and Operations

- Set of elements
  - with some internal representation
  - E.g. Integers, Floats, Booleans, Strings, …
- Set of operations on elements of the type
  - e.g. +, *, -, /, %, //, **
  - ==, <, >, <=, >=
- Properties
  - Commutative, Associative, … , Closure (???)
- Expressions are valid well-defined sets of operations on elements that produce a value of a type

Lab and HW this week

- **Lab will get you to where you have a *program development environment***
  - **Even on your computer**
- **HW will give practice and explain subtleties of types, operators, and expressions**
  - **In a program development environment**
- **What's the difference between '==' and '=' ?**

Thoughts for the Wandering Mind

A binary digit (bit) is a symbol from {0,1}.

- **How many strings can you represent with N bits?**

- **Could you build a program that compresses all strings of N bits to strings of M bits (with M<N) such that you can go back to all original strings of length N? How or Why?**