Introduction to Data Programming

CSE 160
University of Washington
Spring 2015
Ruth Anderson

Slides based on previous versions by Michael Ernst and earlier versions by Bill Howe

Welcome to CSE 160!

CSE 160 teaches core programming concepts with an emphasis on real data manipulation tasks from science, engineering, and business

Goal by the end of the quarter: Given a data source and a problem description, you can independently write a complete, useful program to solve the problem

Course staff

- Lecturer:
  - Ruth Anderson
- TAs:
  - Lee Organick
  - Trevor Perrier
  - Nicholas Shahan

Ask us for help!

Learning Objectives

- Computational problem-solving
  - Writing a program will become your “go-to” solution for data analysis tasks
- Basic Python proficiency
  - Including experience with relevant libraries for data manipulation, scientific computing, and visualization.
- Experience working with real datasets
  - astronomy, biology, linguistics, oceanography, open government, social networks, and more.
  - You will see that these are easy to process with a program, and that doing so yields insight.

What this course is <u>not</u>

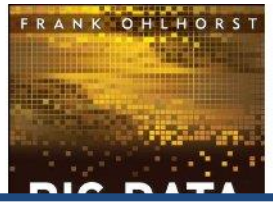
- A “skills course” in Python
  - …though you will become proficient in the basics of the Python programming language
  - …and you will gain experience with some important Python libraries
- A data analysis / “data science” / data visualization course
  - There will be very little statistics knowledge assumed or taught
- A “project” course
  - the assignments are “real,” but are intended to teach specific programming concepts
- A “big data” course
  - Datasets will all fit comfortably in memory
  - No parallel programming

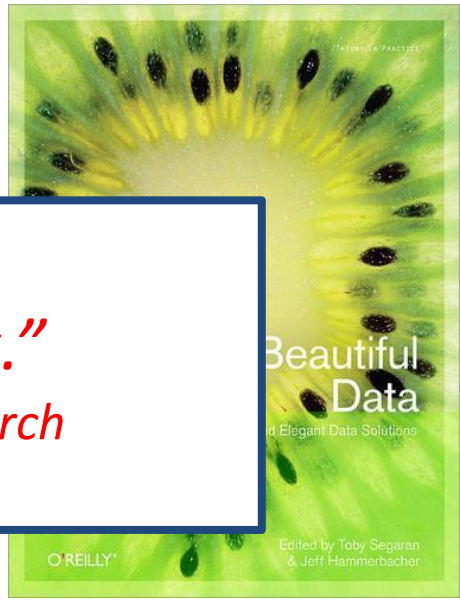
"It's a great time to be a data geek."

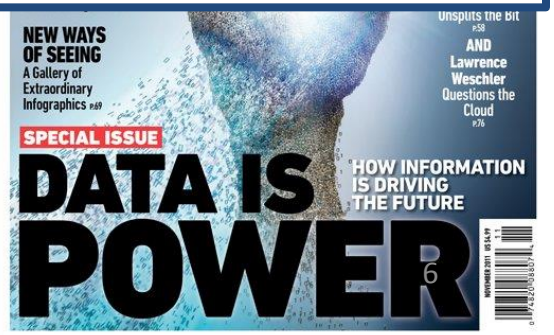
-- Roger Barga, Microsoft Research

"The greatest minds of my generation are trying to figure out how to make people click on ads"

-- Jeff Hammerbacher, co-founder, Cloudera





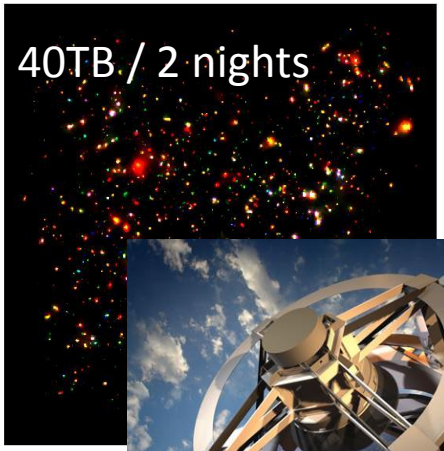


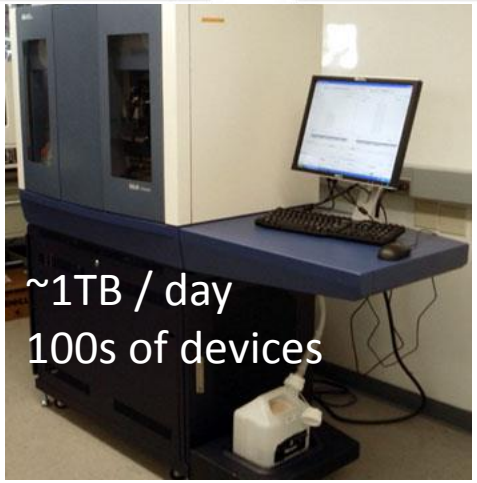
All of science is reducing to computational data manipulation

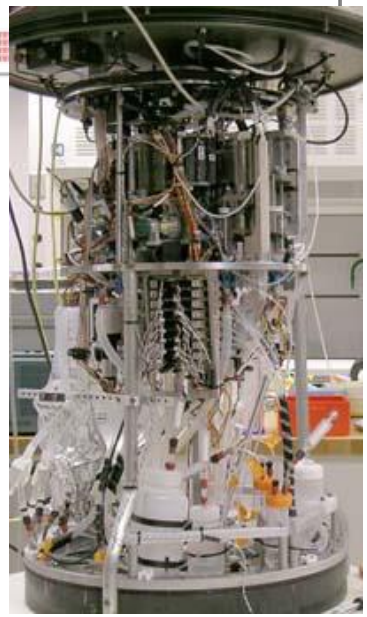
Old model: "Query the world" (Data acquisition coupled to a specific hypothesis)

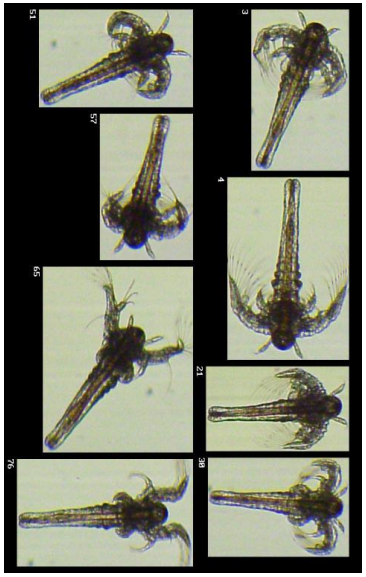
New model: "Download the world" (Data acquisition supports many hypotheses)

- **Astronomy: High-resolution, high-frequency sky surveys (SDSS, LSST, PanSTARRS)**
- **Biology: lab automation, high-throughput sequencing,**
- **Oceanography: high-resolution models, cheap sensors, satellites**









Slide from Bill Howe, eScience Institute

Example: Assessing treatment efficacy

	A	B	C	D	E	F	G	H	I	J
1	fu_2wk	fu_4wk	fu_8wk	fu_12wk	fu_16wk	fu_20wk	fu_24wk	total4type_fu	clinic_zip	pt_zip
2	1	3	4	7	9	9	9	12	98405	98405
3	2	4	6	7	8	8	8	8	98405	98403
4	0	0	[illegible]	[illegible]	[illegible]	0	0	[illegible]	98405	98445
5	3	4	[illegible]	[illegible]	[illegible]	5	5	[illegible]	98405	98332
6	0	0	[illegible]	[illegible]	[illegible]	0	0	[illegible]	98405	98405
7	2	2	[illegible]	[illegible]	[illegible]	2	2	[illegible]	[illegible]	98402
8	1	2	5	6	8	10	10	14	98405	98418
9	1	1	2	2	2	2	2	2	98499	98406
10	0	0	1	2	2	2	2	6	98405	98404
11	0	0	0	0	0	0	0	0	98405	98402
12	1	1	2	2	4	4	4	4	98405	98405
13	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98404	98404
14	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98499	98498
15	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98499	98445
16	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98499	98405
17	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98499	98498
18	1	3	3	3	3	3	3	3	98499	98499
19	1	1	4	5	7	7	7	7	98499	98371

number of follow ups within 16 weeks after treatment enrollment.

Zip code of clinic

Zip code of patient

Question: Does the distance between the patient's home and clinic influence the number of follow ups, and therefore treatment efficacy?

Python program to assess treatment efficacy

```
# This program reads an Excel spreadsheet whose penultimate
# and antepenultimate columns are zip codes.
# It adds a new last column for the distance between those zip
# codes, and outputs in CSV (comma-separated values) format.
# Call the program with two numeric values:  the first and last
# row to include.
# The output contains the column headers and those rows.

# Libraries to use
import random
import sys
import xlrd        # library for working with Excel spreadsheets
import time
from gdapi import GoogleDirections

# No key needed if few queries
gd = GoogleDirections('dummy-Google-key')

wb = xlrd.open_workbook('mhip_zip_eScience_121611a.xls')
sheet = wb.sheet_by_index(0)

# User input:  first row to process, first row not to process
first_row = max(int(sys.argv[1]), 2)
row_limit = min(int(sys.argv[2]+1), sheet.nrows)

def comma_separated(lst):
 return ",".join([str(s) for s in lst])

headers = sheet.row_values(0) + ["distance"]
print comma_separated(headers)

for rownum in range(first_row,row_limit):
   row = sheet.row_values(rownum)
   (zip1, zip2) = row[-3:-1]
   if zip1 and zip2:
      # Clean the data
      zip1 = str(int(zip1))
      zip2 = str(int(zip2))
      row[-3:-1] = [zip1, zip2]
      # Compute the distance via Google Maps
      try:
         distance = gd.query(zip1,zip2).distance
      except:
         print >> sys.stderr, "Error computing distance:", zip1, zip2
         distance = ""
     # Print the row with the distance
     print comma_separated(row + [distance])
     # Avoid too many Google queries in rapid succession
     time.sleep(random.random()+0.5)
```

23 lines of executable code!

Course logistics

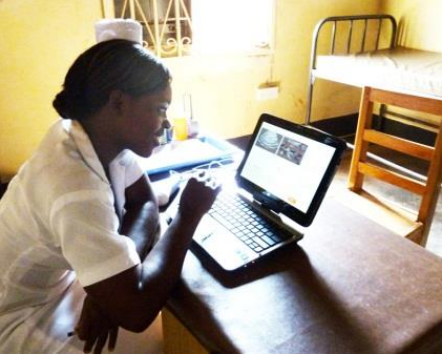
- Website: **`http://www.cs.washington.edu/cse160`**
- See the website for all administrative details
- Read the handouts and required texts, *before* the lecture
  - There is a brief reading quiz due *before* each lecture
- Take notes!
- Homework 1 part 1 is due Wednesday
  - As is a survey (and a reading quiz before lecture)
- You get 5 late days throughout the quarter
  - No assignment may be submitted more than 3 days late. (contact the instructor if you are hospitalized)
- If you want to join the class, sign sheet at front of class, email rea@cs.washington.edu, from your @u address

Academic Integrity

- Honest work is required of a scientist or engineer
- Collaboration policy on the course web. **Read it!**
  - Discussion is permitted
  - **Carrying materials from discussion is not permitted**
  - Everything you turn in must be your own work
    - Cite your sources, explain any unconventional action
  - **You may not view others' work**
  - If you have a question, ask
- I trust you completely
- I have no sympathy for trust violations – nor should you

How to succeed

- No prerequisites
- Non-predictors for success:
  - Past programming experience
  - Enthusiasm for games or computers
- Programming and data analysis are challenging
- Every one of you can succeed
  - There is no such thing as a “born programmer”
  - Work hard
  - Follow directions
  - Be methodical
  - *Think* before you act
  - Try on your own, then ask for help
  - Start early



Me (Ruth Anderson)

- Grad Student at UW: in Programming Languages, Compilers, Parallel Computing
- Taught Computer Science at the University of Virginia for 5 years
- PhD at UW: in Educational Technology, Pen Computing
- Current Research: Computing and the Developing World, Computer Science Education

Introductions

- Name
- Email address
- Major
- Year (1,2,3,4,5)
- Hometown
- Interesting Fact or what I did over break.