Introduction to Data Programming

CSE 160
University of Washington
Winter 2017
Ruth Anderson

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

• What is this course?
• Course logistics
• Python!
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:
  – Emily Furst
  – Cynthia(Lingyue) Zhang
  – Emilia Gan
  – Lauren Wolfe
  – Eric Green

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 not

• 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

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>fu_2wk</td>
<td>fu_4wk</td>
<td>fu_8wk</td>
<td>fu_12wk</td>
<td>fu_16wk</td>
<td>fu_20wk</td>
<td>fu_24wk</td>
<td>total4type_fu</td>
<td>clinic_zip</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>98405</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>98405</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>98405</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>98405</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>98405</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>98402</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>14</td>
<td>98405</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>98405</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>98405</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>98405</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>98405</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>98404</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>98499</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>98499</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>98499</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>98499</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>98499</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>98499</td>
</tr>
</tbody>
</table>

Question: Does the distance between the patient’s home and clinic influence the number of follow ups, and therefore 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)
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 Friday
  – 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 about the policy, just ask us
• 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.