CSE 160 Wrap-Up

UW CSE 160

Spring 2018

Presentations on Tuesday

- 2:30-4:20pm, Tuesday June 5
- No more than 5 slides (including title slide)
- Time limit to be announced
- Both partners should speak
- Slides are due BY NOON (12pm) on Tues June 5 to Canvas

- If you are submitting a video: slides and video are also due BY 12pm on Tues June 5 to Canvas

Progress in 10 weeks

10 weeks ago: you knew no programming

Goals:

- **Computational problem-solving**
- **Python** programming language
- Experience with **real datasets**
- **Fun** of extracting understanding and insight from data, and of mastery over the computer
- Ability to go on to more advanced **computing** classes

Today: you can write a useful program to solve a real problem

- You can even pose the problem yourself

Thanks!

Why do you care about processing data?

- The world is awash in data
- Processing and analyzing it is the difference between success and failure
  - for a team or for an individual
- Manipulating and understanding data is essential to:
  - Astronomers
  - Biologists
  - Chemists
  - Economists
  - Engineers
  - Entrepreneurs
  - Linguists
  - Political scientists
  - Zoologists
  - … and many more!

Programming Concepts

- Variables
- Assignments
- Types
- Programs & algorithms
- Control flow: loops (for), conditionals (if)
- Functions
- File I/O
- Python execution model
  - How Python evaluates expressions, statements, and programs

Data structures: managing data

- List
- Set
- Dictionary
- Tuple
- Graph

- List slicing (sublist)
- List comprehension: shorthand for a loop

$f(x) = x^2$

Functions

- **Procedural abstraction**
  - avoid duplicated code
  - the implementation does not matter to the client
- Using functions
- Defining functions

Data abstraction

- Dual to procedural abstraction (functions)
- A module is: operations
- An object is: data + operations
  - Operations: create, query, modify
  - Clients use the operations, never directly access data
  - The representation of the data does not matter to the client
  - Programmer defines a class.
    Each instance of a class is an object.

Testing and debugging

- Use small data sets to test your program
- Write enough tests:
  - Cover every branch of each boolean expression
    - especially when used in a conditional expression (if statement)
  - Cover special cases:
    - numbers: zero, positive, negative, int vs. float
    - data structures: empty, size 1, larger
- Assertions are useful beyond tests
- Debugging: after you observe a failure
  - Divide and conquer
    - In time, in data, in program text, in development history
    - this is also a key program design concept
  - The scientific method
    - state a hypothesis; design an experiment; understand results
- Think first ("lost in the woods" analogy)
  - Be systematic: record everything; have a reason for each action

Data analysis

- Statistics
  - Run many simulations
  - How uncommon is what you actually saw?
- Graphing/plotting results

Program design

How to write a **function**:

1. Choose name, arguments, and documentation string
2. Write tests
3. Write body/implementation

How to write a **program**:

1. Decompose into parts (functions, modules)
   - Each part should be a logical unit, not too large or small
2. Write each part
   - Define the problem
   - Choose an algorithm
   - In English first; test it via manual simulation
   - Translate into code

When necessary, use *wishful thinking*

- – Assume a function exists, then write it later
- – Can test even before you write it, via a stub

Recursion

- Base case: does all the work for a small problem
- Inductive case:
  - Divide the problem, creating one or more smaller problems
  - Ask someone else to solve the smaller problems
    - Recursive call to do most of the work
  - (Maybe) Do a small amount of postprocessing on the result(s) of the recursive call(s)

Speed of algorithms

- Affected primarily by the number of times you iterate over data
- Nested looping matters a lot

Data!

- DNA
- Images
- Social Networks
- Election Results/Polls
- Detecting Fraudulent Data
- Your Choice!

Your Projects!

- Traffic Stops
- Building Design
- El Nino and La Nina
- Bitcoin and Stock Markets
- Developmental Brain Changes
- Safety in Seattle Neighborhoods
- Seatbelts vs. Helmets
- Repeated Buyers Predictions
- Seattle Rainfall
- Board Game Popularity
- Rainfall vs. Hydro Power
- CO2 Trends
- Bike Sharing in Mexico City
- Meteorites
- Gene Expression in Zebrafish RNA
- Land Trust Property Analysis
- Global Markets & the Cost of Food
- School Shootings & Future Prevention
- Cancer Rates in Children
- What Influences Salary
- Colony Collapse of Honey Bees
- Plant Diversity in WA
- Competitive Pokemon
- Wages and Jobs
- Earthquakes
- NO2 Levels in King County
- Bank Statements & Projections
- Washington State Loans
- Correlations with Happiness
- Opioid-related drug deaths
- Climate Change on Columbia River
- Health Insurance in the U.S.
- Educational Attainment in the U.S.
- Gender Inequalities and GDP
- Car Collisions in WA
- CRISPR cut sites in Drosophila
- Home Advantage in Soccer
- Galactic Environments
- Soccer Player Evaluation
- Film Preferences
- Children's' School Readiness
- Popular words in Tweets
- Greenhouse Effect
- Flight Delay Trends
- Valuing NBA Players
- Coral Reef Bleaching
- Crime Ratios: East Coast vs. West Coast
- Avalanche Forecasting
- Drug Spending
- Seattle Bicycle Theft
- Energy use in the Northwest
- Climate Change in Seattle
- Success of Kickstarter Projects
- Weather in Austin, TX
- Ranking Premier League Teams
- Trend Analysis in Video Games
- How to Win at Settlers of Catan
- Formula 1 Race Analysis
- Obesity, Nutrition & Physical Activity in the U.S.

There is more to learn!

- Data analysis, data science, and data visualization
- Scaling up:
  - Larger and more complex programs
  - Algorithm selection
  - “Big data”: out-of-memory data, parallel programming, …
- Ensuring correctness
  - Principled, systematic design, testing, and programming
  - Coding style
- Managing complexity
  - Programming tools: testing, version control, debugging, deployment
  - Graphical User Interfaces (GUIs), user interaction
  - Data structures and algorithms
  - Working in a team

What you have learned in CSE 160

Compare your skills today to 10 weeks ago

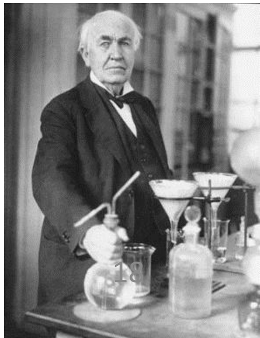
Bottom line: The assignments would be easy for you today

This is a measure of how much you have learned

There is no such thing as a “born” programmer!

Your next project can be more ambitious

> Genius is 1% inspiration and 99% perspiration.
> Thomas A. Edison



Why the Python language?

	Python	Excel	MATLAB	R	C/C++	Java
Readable syntax	☺	☹	☹	☹	☹	☺
Easy to get started	☺	☺	😐	☹	☹	☹
Powerful libraries	☺	😐	☺	☺	😐	☺

Comparison of Python with Java

- Python is better for learning programming
- Python is better for small programs
- Java is better for large programs

Main difference: dynamic vs. static typing

- Dynamic typing (Python): put anything in any variable
- Static typing (Java):
  - Source code states the type of the variable
  - Cannot run code if any assignment might violate the type

What comes next?

Classes

- Java: CSE 142 (you might skip), CSE 143, CSE 143X
- HDCE 310: Python for interactive systems
- MATLAB, other programming languages
- Self-study: books & websites

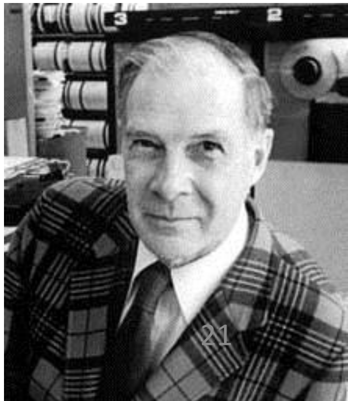
Data analysis: classes, research, jobs

- In programming and software engineering
- In any topic that involves software

Having an impact on the world

- Jobs (and job interviews)
- Larger programming projects

> The purpose of computing is insight, not numbers.
>
> Richard W. Hamming
>
> *Numerical Methods for Scientists and Engineers*



More Computer Science Courses!!

You could take any of these now!

- CSE 142, 143, 143x Programming in Java (143x only in fall)
- CSE 154 Web Programming (Fall 2018 & Spring 2019)
- CSE 163 Intermediate Data Programming (coming Spring 2019!)
- CSE 416 Intro to Machine Learning (requires Stat 311/390) (Spring 2019)
- INFO/STAT/CSE 180 Intro to Data Science (some Math pre-req) (all year)

Require CSE 143:

- CSE 373 Data Structures & Algorithms (all year)
- CSE 414 Databases (Fall 2018 & Spring 2019)
- CSE 374 Intermediate Programming Concepts & Tools (Spring 2019)

Require CSE 373:

- CSE 410 Computer Systems (Operating Systems & Architecture)
- CSE 413 Programming Languages and their Implementation
- CSE 415 Artificial Intelligence
- CSE 417 Algorithms and Complexity

Note: These classes are all open to NON-majors.
You may also be interested in applying for the CSE major!

Go forth and conquer

System building and scientific discovery are fun!

- It's even more fun when your system works

Pay attention to what matters

- Use the techniques and tools of CSE 160 effectively