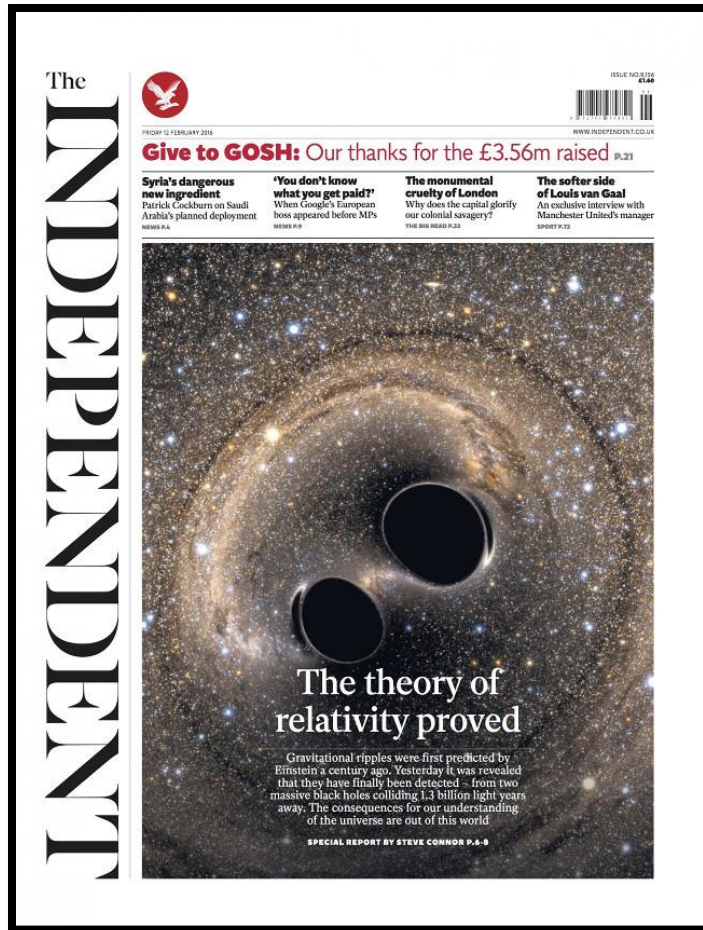# CS 1112
Introduction to Computing Using MATLAB

DR. CURRAN MUHLBERGER

WWW.CS.CORNELL.EDU/COURSES/CS1112

Who is Dr. Muhlberger?

And why should scientists learn to code?

About you… in CS 1112

- Undergraduates, graduates, researchers, and professionals who want (need) to learn computing

- No prior programming experience needed, but some "mathematical maturity" assumed

- You will…
  ◦ Learn programming concepts and good programming habits
  ◦ Practice problem analysis and decomposition
  ◦ Become a code detective—find out "whodunit"

- Develop a "spirit of experimentation"
  ◦ Not thoughtless trial-&-error but purposeful try-then-analyze

- Why should you learn computing?

Today's lecture

- An example problem

- Computational problem solving

- Tour of MATLAB

- CS 1112 vs. CS 1110

- Course logistics

Lab/discussion sections start tomorrow; exercise due Sunday!

Problem: how to compute square roots?

- Suppose $A > 0$

- Observation: If A is the area of a square …

    then I can just measure the side length—that is $\sqrt{A}$

- Solution idea: Make a square with area A

- Real task: Make a sequence of increasingly square rectangles, each with area A
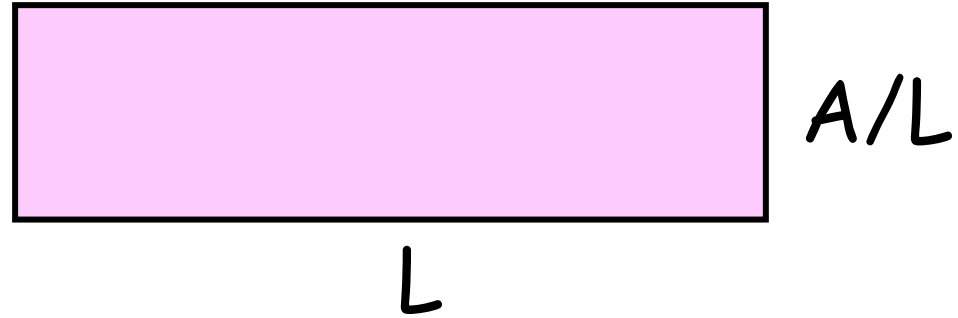
How to make a rectangle "more square"?

- If a square and a rectangle both have area A …
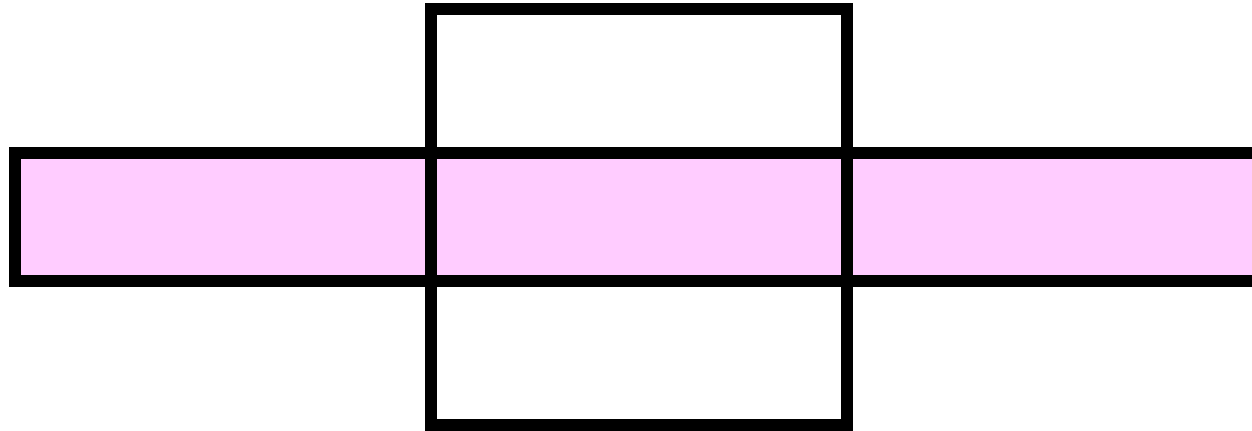
- then $\sqrt{A}$ is between the length and width of the rectangle
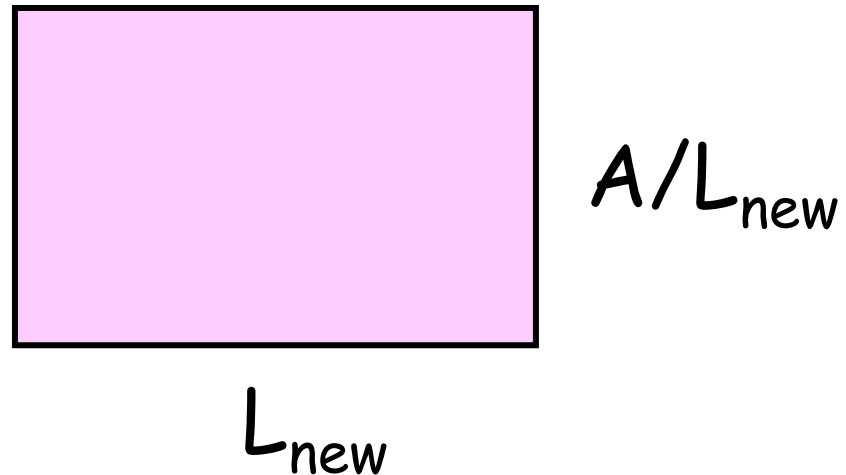
An improvement strategy

Current:

A/L

L

Recipe: $L_{new} = (L + A/L) / 2$ ← The average of the length and width.

Next:

A/L_{new}

L_{new}

A MATLAB program to make "increasingly square" rectangles

```matlab
% The first rectangle...
L1 = A;
W1 = 1;
% The second rectangle...
L2 = (L1+W1)/2;
W2 = A/L2;
% The third rectangle...
L3 = (L2+W2)/2;
W3 = A/L3;
% and so on...
```
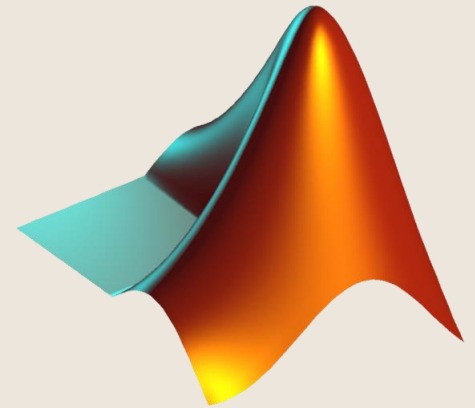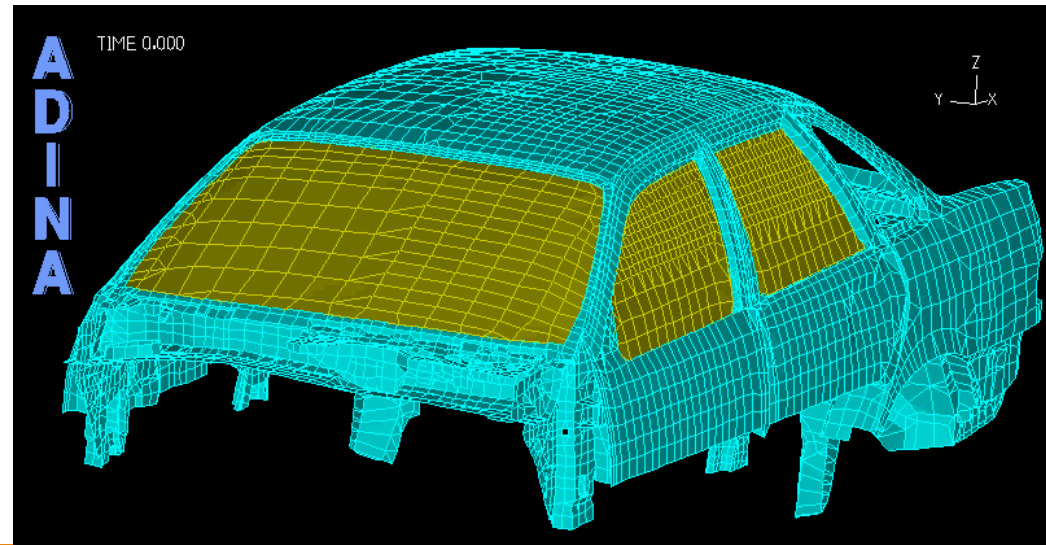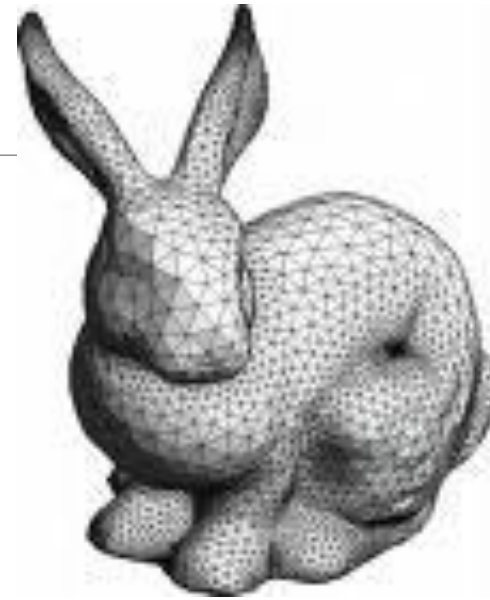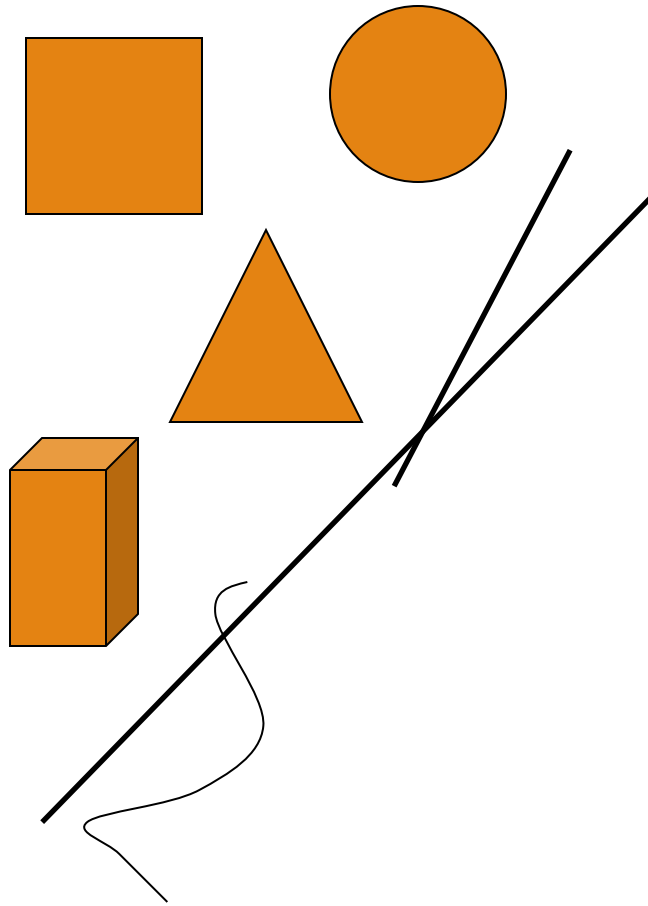
Some takeaways

- It paid to have a geometric sense

- A complicated computation was reduced to a sequence of elementary calculations

- A program is like a formula (or sequence of formulas)

Course Goals

- Develop your "computational senses," senses that you need in computer problem-solving

- Develop a facility with the Matlab programming environment

A sense of geometry

A sense of complexity

Major US Cities

What is the best itinerary to visit Boston, Miami, LA, Dallas?

3! = 6 possibilities

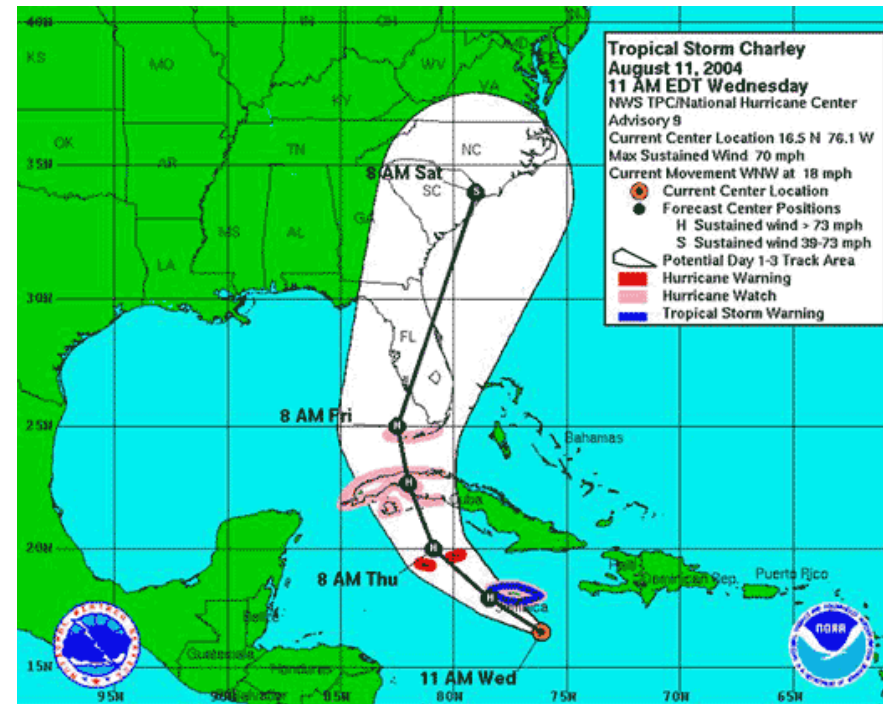Add Seattle, NYC Austin, Denver

7! = 5040

If a computer can process 1 billion itineraries a second, how long does it take to solve a 20-city problem?

Nearly a century…

A sense of approximation & error

π

1/3 = .33333…
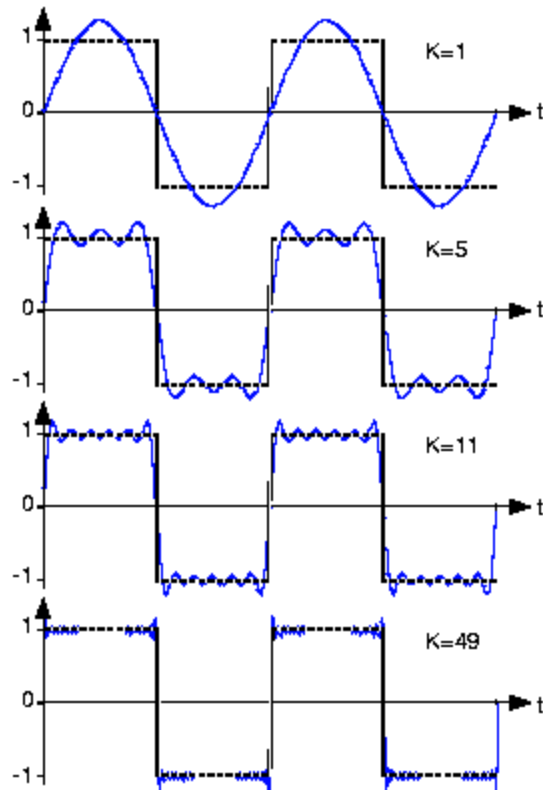
A sense of randomness and probability
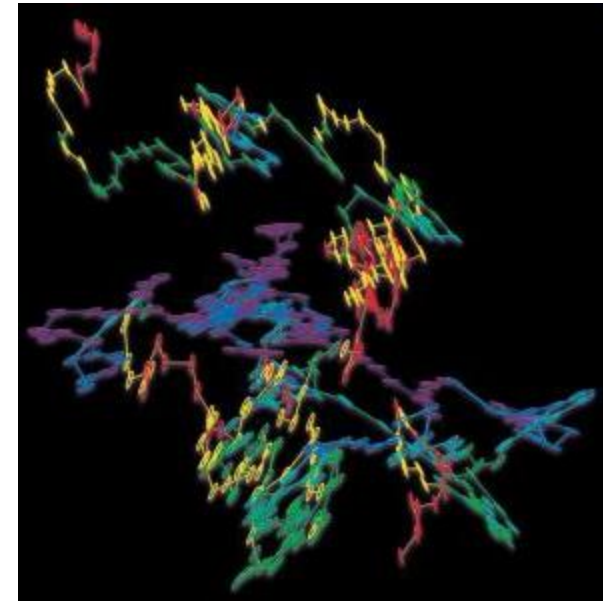
Random walk
Brownian motion in water

Course Goals

- Develop your "computational senses," senses that you need in computer problem-solving

- Develop a facility with the Matlab programming environment

Computer problem-solving

Key: Algorithmic thinking

Algorithm:

A step-by-step procedure that takes you from a prescribed set of inputs to a prescribed set of outputs

Program:

The algorithm expressed in a specific language, e.g., Matlab

Computer problem-solving — Programming

- Developing instructions for the computer to execute (in order to solve some problem)

- The steps must be logical

- Use a particular language *and follow the rules of the language* (grammar/syntax)

Example: *Adding songs from the internet to your music library*

- Find a website with MP3 or other audio files

- Register with the music site, if required for music downloading. (Don't steal music.)

- Click on the music file to download it onto your computer

- Drag the file to your library

Reference: iTunes

Example: *Adding songs from the internet to your music library*

- Drag the file to your library

- Click on a music file to download it onto your computer

- Find a website with MP3 or other audio files

- Register with the music site, if required for music downloading. (Don't steal music.)

These steps are out of order! Illogical!

Example: *Adding songs from the internet to your music library*

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Example: *Adding songs from the internet to your music library*

- Find a website with MP3 or other audio files

- Register with the music site, if required for music downloading. (Don't steal music.)

- **To download the computer onto your music file click it on**

- **file Drag your librAry to**

Bad grammar (syntax)!

Computer programming is…

- a tool used by computer scientists, engineers, and other professionals

- not all of computer science

- Think about astronomy: Telescope is a tool used by astronomers; astronomy is not about telescopes…

Course Goals

- Develop your "computational senses," senses that you need in computer problem-solving

- Develop a facility with the Matlab programming environment

Matlab is the vehicle we use

With the Matlab environment, you can <u>easily</u>

- Develop programs

- Display results & ideas graphically

- Interact with large data sets (process text, image, and other files)

Matlab has extensive libraries of mathematical, statistical, simulation, and other tools. It is heavily used in engineering & sciences, both in industry and academia.

Demo!
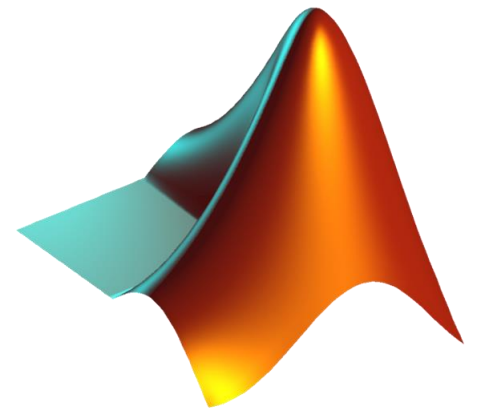
Choices for introductory programming

- CS 1112 – this course, Matlab

- CS 1110 – Python

Each course satisfies the Engineering Computing Requirement. In 1112 you *will* learn procedural programming in depth and be introduced to object-oriented programming.

Each course can serve as the prerequisite for CS/ENGRD 2110 Object-Oriented Programming & Data Structure

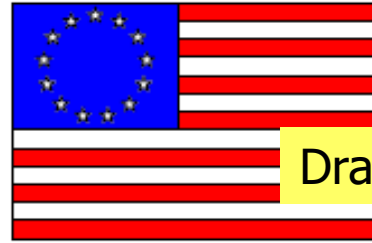# CS 1112 focuses on *computational science & engineering*

Approximation, randomness,
model building, sensitivity of models

- Lecture examples and homework illustrate above themes
  - Edge detection
  - Ranking web pages
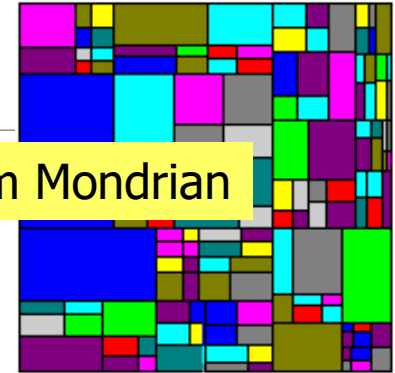 - Congressional apportionment
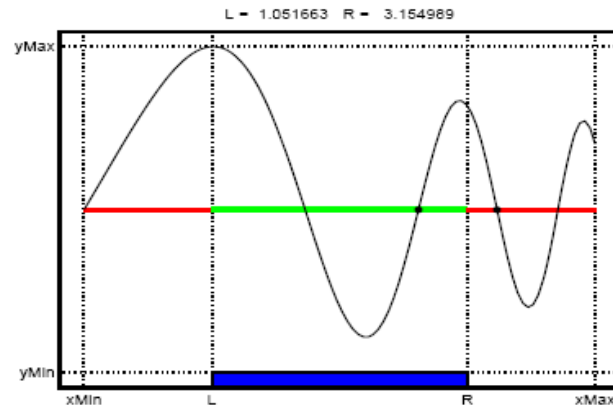
Some past programming assignments

- Find the US population center from census data

- Organize protein data using structure arrays

- Mozart's musical dice game

Draw the random Mondrian

Draw the "Betsy Ross Flag"

Pyramid of Khufu, Egypt Scale is 5.54 feet per unit length on axes
Select a path using multiple mouse clicks. Click outside the map to stop.
Total distance: 8379.3 feet
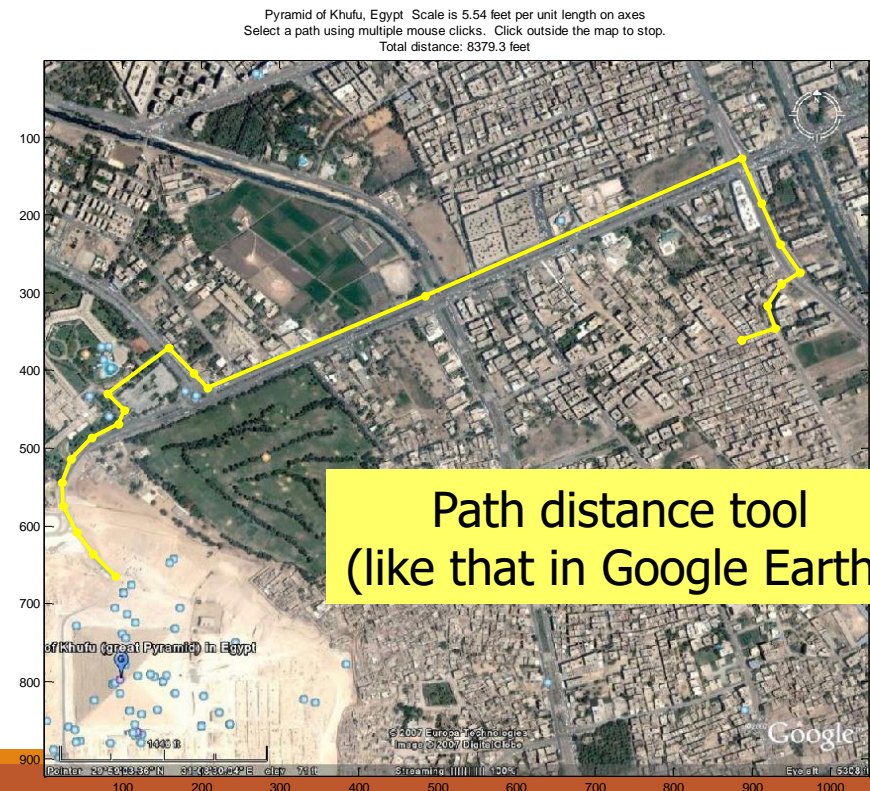
Path distance tool
(like that in Google Earth)

L = 1.051663 R = 3.154989

Root finding tool

Course comparison

CS 1112

- No prior programming experience
- One semester of Calculus
- *Focus on computational science & engineering*
- Matlab

CS 1110

- No prior programming experience
- No Calculus
- *Focus on software development*
- Python

Online organization

CS 1112 requirements

4 credits → 4x3=12hrs/week
In class: 2hr lec + 1 hr dis = 3 hrs/week
Outside class: 9 hrs/week

- Attend lecture and be engaged
  ◦ Synchronous modality
  ◦ Laptops **not** required – take handwritten notes!

- Attend lab/discussion—get individual attention/help on weekly exercises!

- Monitor course announcements on website

- Do homework: 6 programming projects

- Take 2 prelims and a final exam at their scheduled times

- Adhere to the Code of Academic Integrity

Learning and integrity

- Learning is something *you* do; we can only facilitate

- Computers facilitate duplication; duplication does not facilitate learning
  - No value in being a delivery vehicle for the write answer
  - In real engineering, there is no "right answer" to copy

- Respect yourself and others
  - Craft your own programs; build confidence in your own answers

Staying healthy

- Uphold the behavioral compact

- You may always attend an online lecture or discussion instead of your assigned in-person one
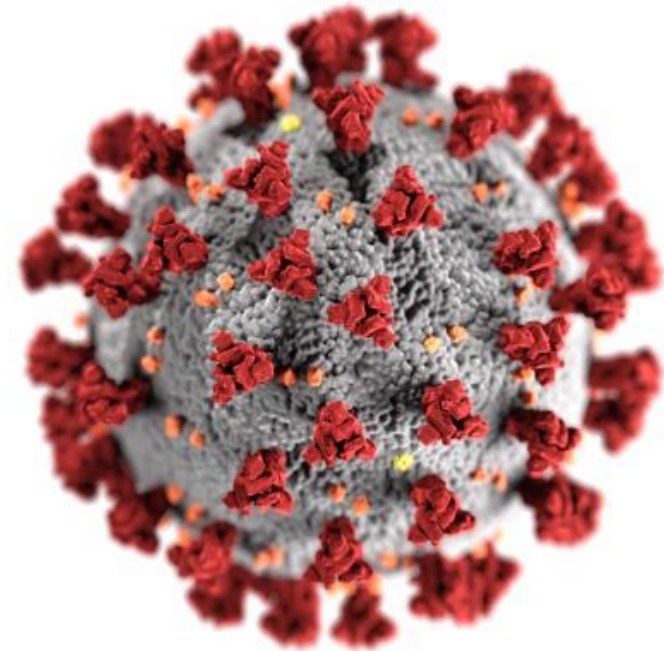
Assessing your learning

- Best five* of six projects (40%)
  ◦ Your lowest-scored project is eligible to be dropped only if you scored at least 50% on it

- Discussion exercises (5%)

- Prelim 1 (15%)

- Prelim 2 (15%)

- Final exam (24%)

- Other (1%)
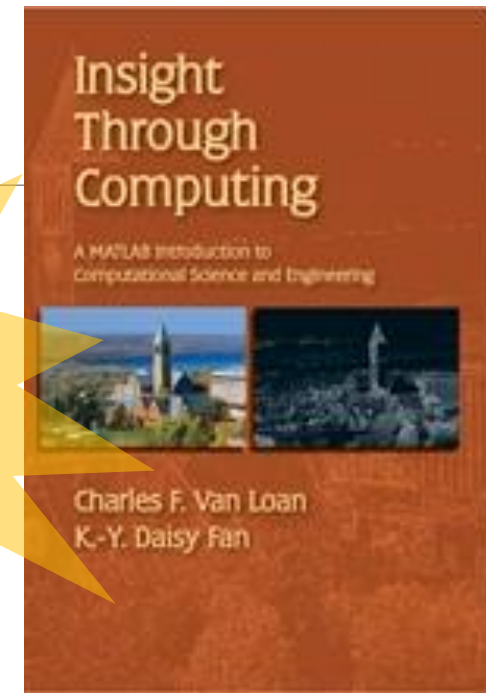 ◦ Surveys, etc.

Not a competition!

Grades are based on absolute performance, not rankings

Course Materials

- *Insight Through Computing*

  A Matlab introduction to Computational Science and Engineering

FREE PDF from library!

- MATLAB Student Version
  Download your own copy, or use *MATLAB Online* (web browser based)

FREE for students!

What to do now?

- Pick a course

  Take CS 1112 or CS 1110

  (add/drop: lecture and discussion and optional AEW)

- Check course website

- Start reading (see listing on course website)

- Attend discussion tomorrow