Introduction to Computing Using Matlab

CS 1112

Dr. K.-Y. Daisy Fan

http://www.cs.cornell.edu/courses/cs1112/

Discussion starts next week!
In Upson 225 lab, not classroom listed in Student Center

Today's lecture

- An illuminating problem

- CS1112 philosophies & syllabus

- What is computer programming?

- Choosing between CS1112 & CS1110

- Course logistics/policies (highlights)

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In Upson 225 lab, not classroom listed in Student Center

An illuminating problem: computing 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
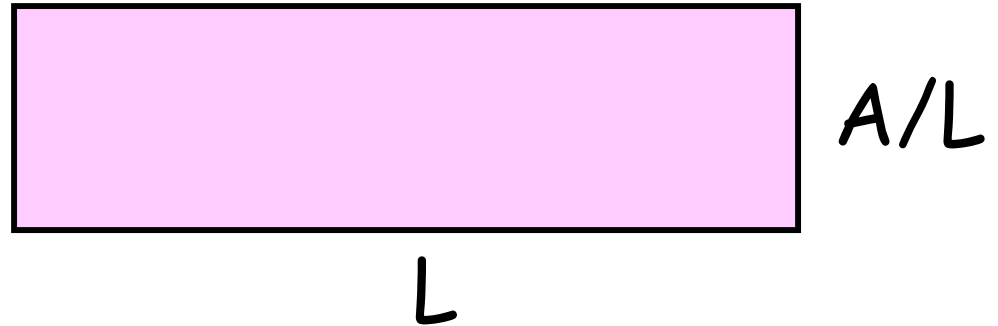
How to make a rectangle "more square"?

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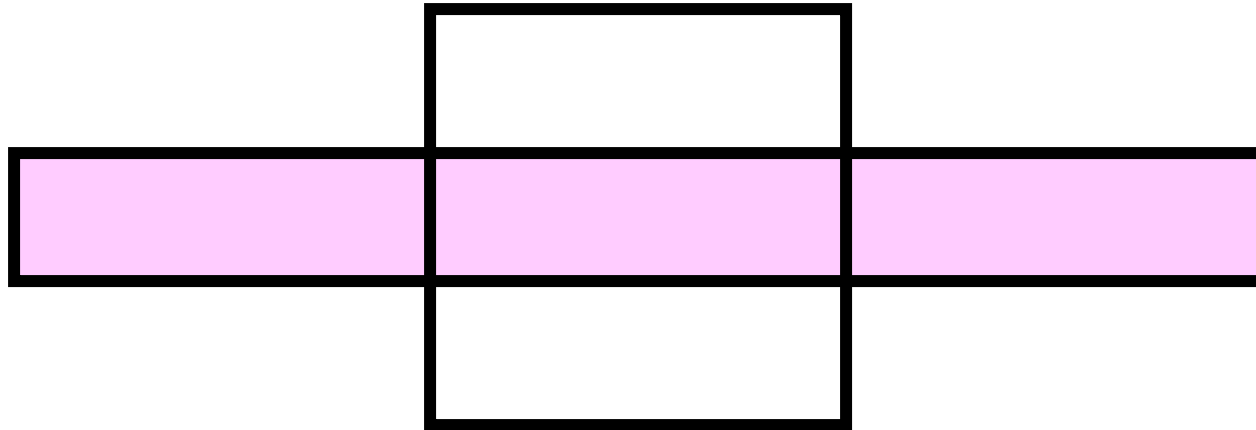
- then $\sqrt{A}$ is between the length and width of the rectangle
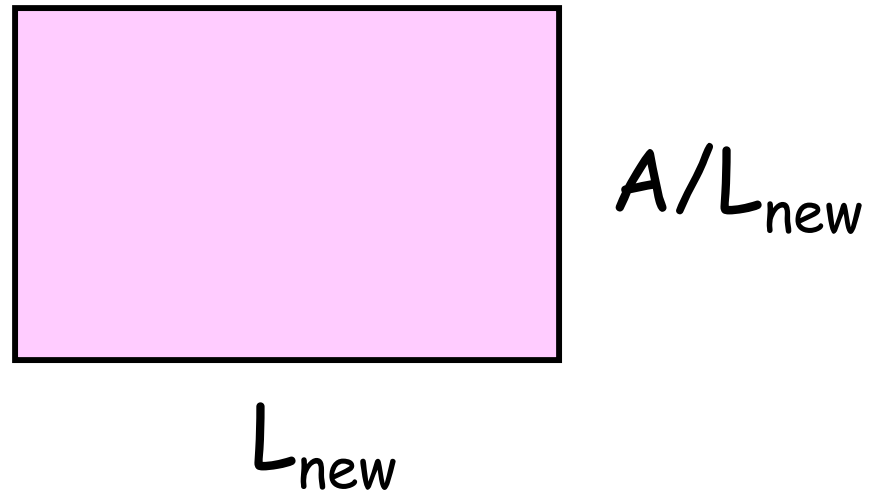
An improvement strategy

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 conclusions from square root finding problem

- 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
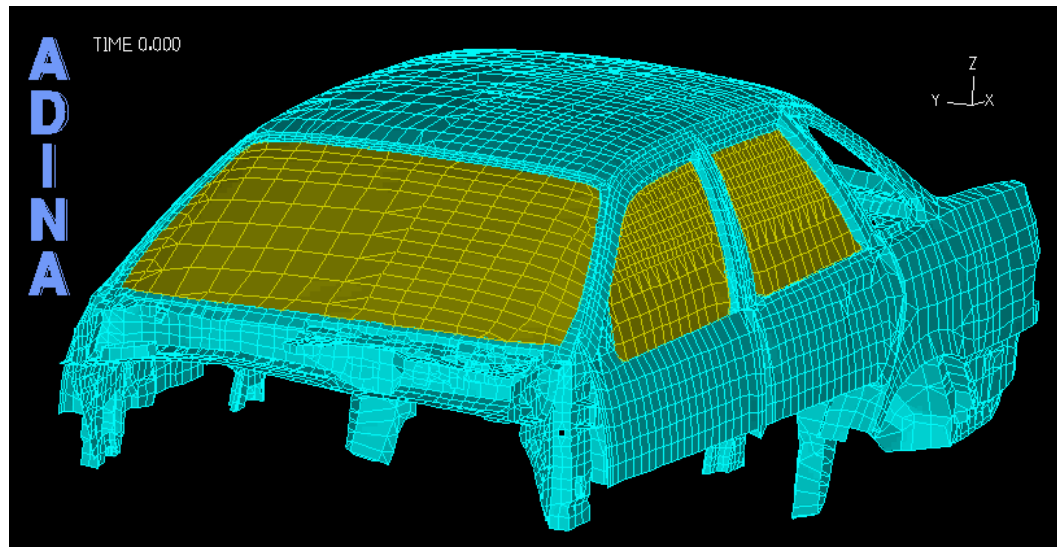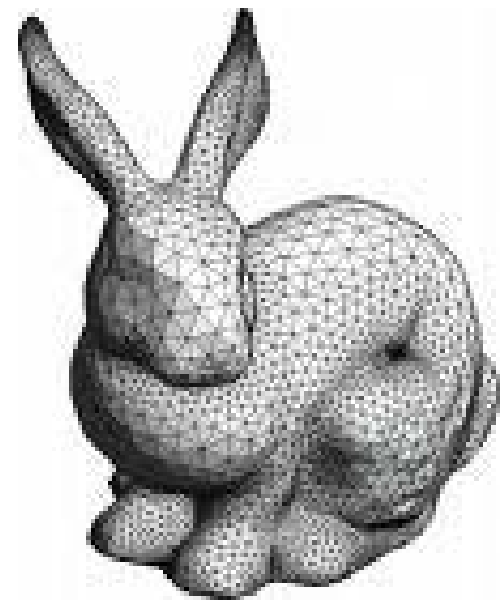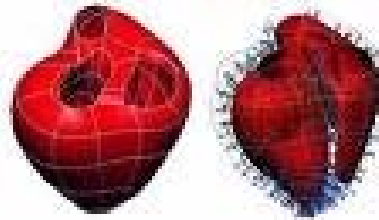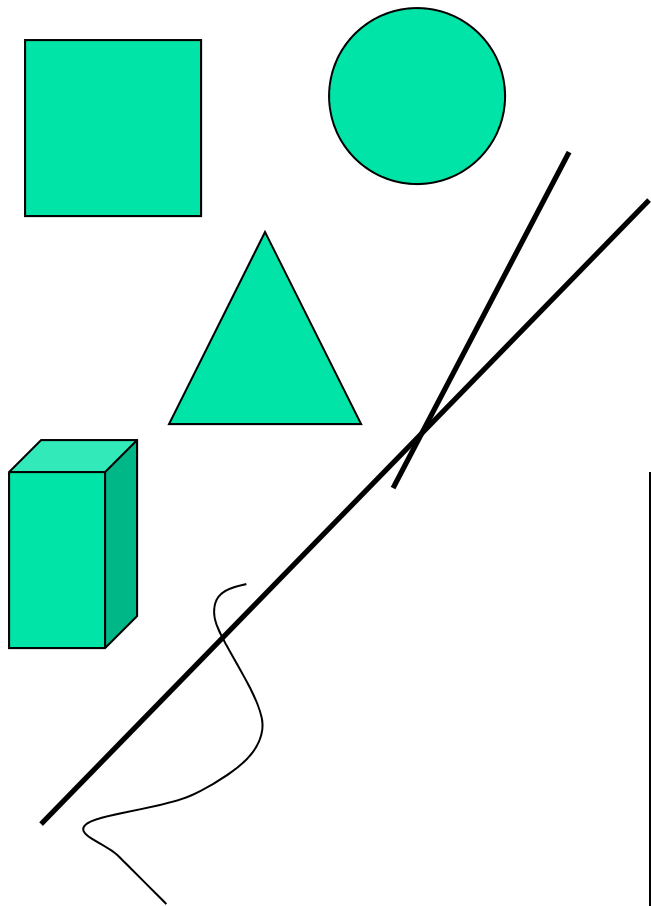
A sense of complexity

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 100-city problem?

A sense of complexity

Major US Cities

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

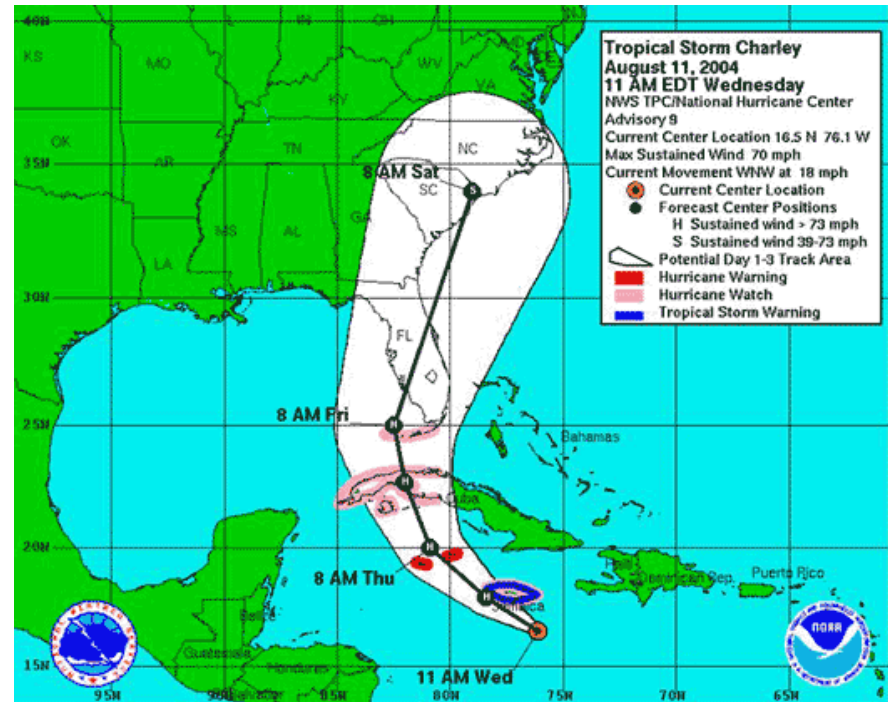3! = 6 possibilities

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 100-city problem?

About a century…

A sense of approximation & error

π

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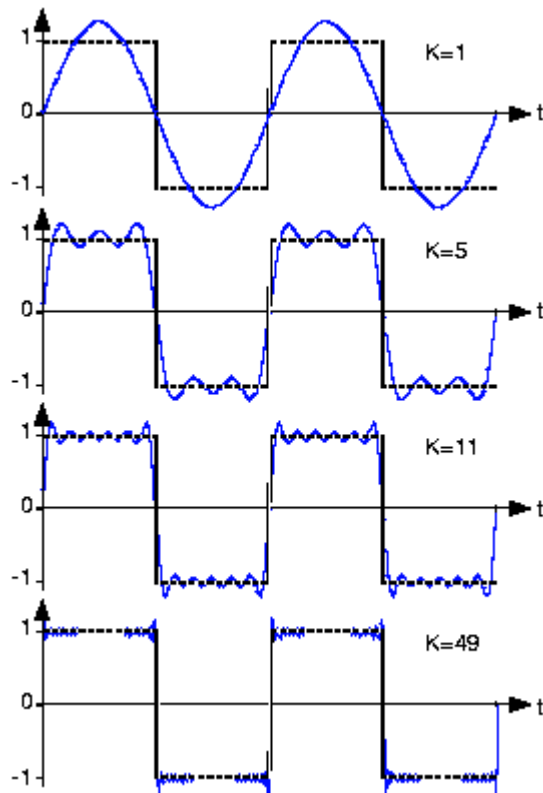
A sense of randomness and probability
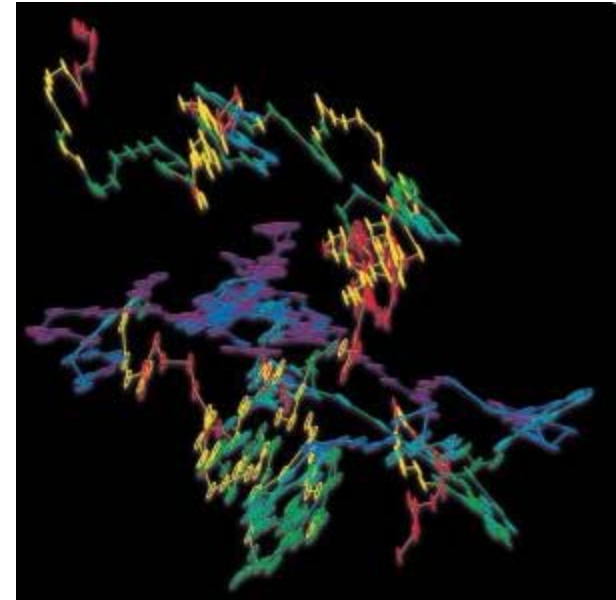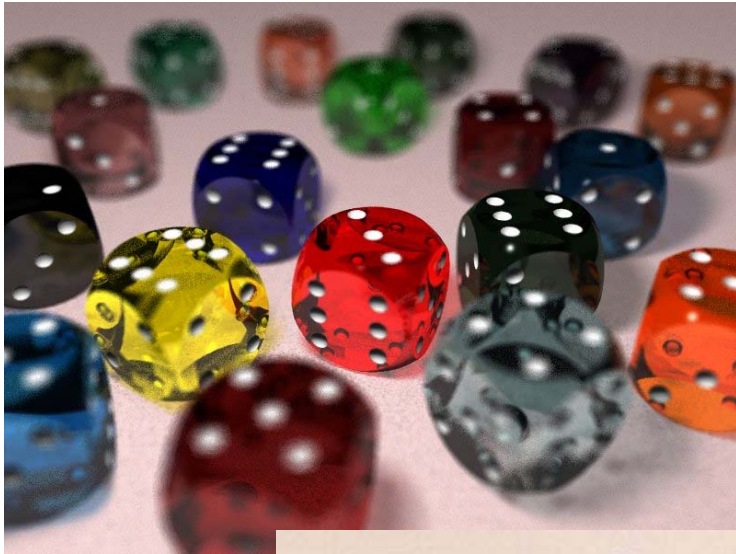
Random walk
Brownian motion in water

Course Goals

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- 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!

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- Click ██████████████ to dowNload ████████
  ██████████████
- 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…

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.

Engineering students take one of these courses:

- CS1112 – this course, Matlab
- CS1110 – Python

Each course satisfies the Engineering Computing Requirement. In 1112 you will learn procedural programming in depth and be introduced to object-oriented programming.
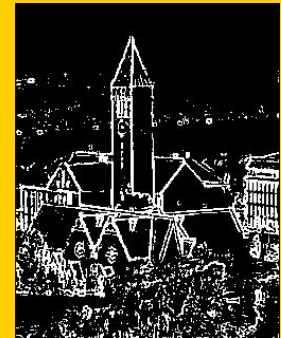
Each course can serve as the prerequisite for CS/ENGRD 2110 Object-Oriented Programming & Data Structure

CS1112 has a focus on *computational science & engineering*

Approximation, randomness, model building, sensitivity of models

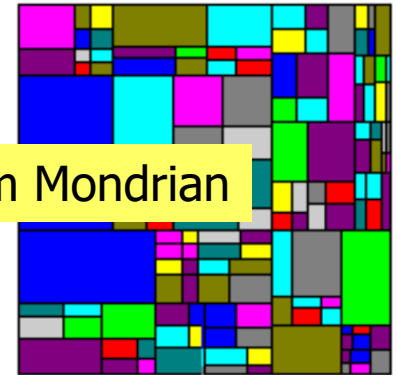- **Lecture examples and homework illustrate above themes**
  - Edge detection
  - Ranking web pages
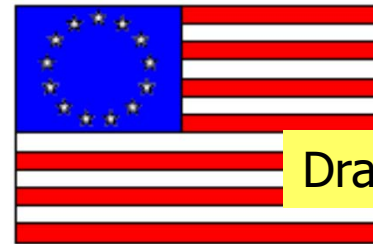 - Congressional apportionment

Some past programming assignments

Draw the random Mondrian

- Find the US population center from census data

- Organize protein data using structure arrays

Draw the "Betsy Ross Flag"

- Mozart's musical dice game
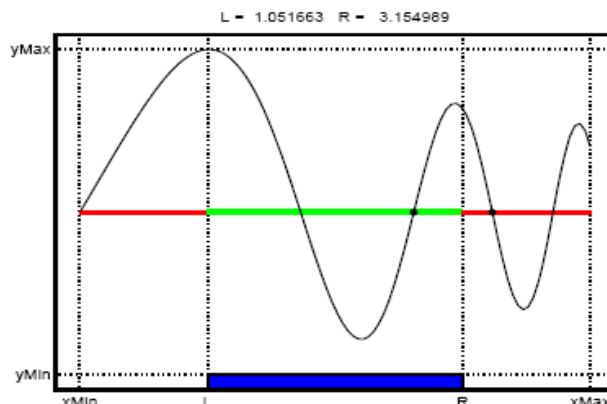
Pyramid of Khufu, Egypt Scale is 5.54 feet per unit length on axes
Select a path using multiple mouse clicks. Click outside the map to stop.
Total distance: 8379.3 feet

L = 1.051663 R = 3.154989
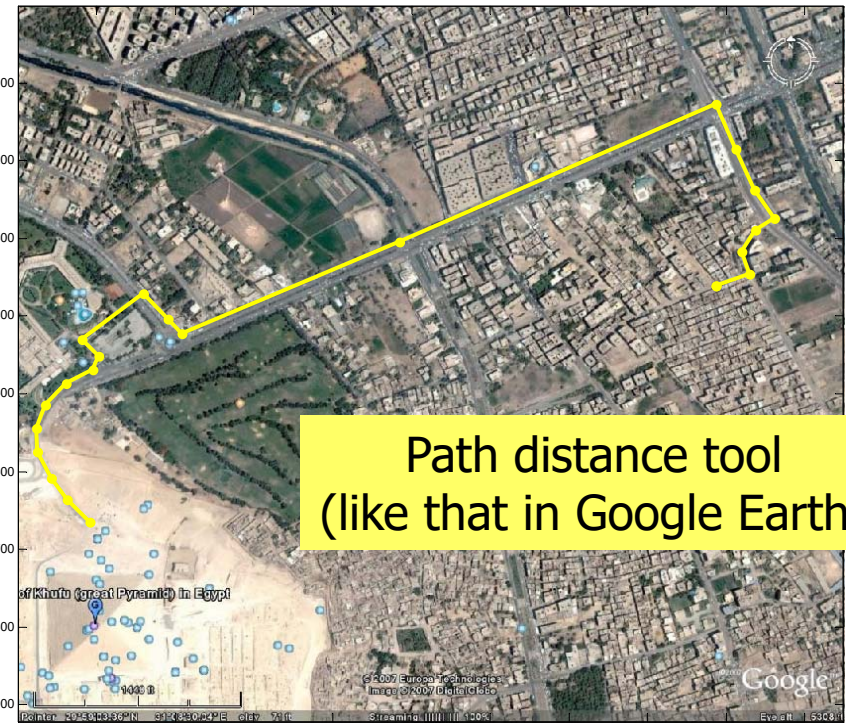
Root finding tool

Path distance tool
(like that in Google Earth)

CS1110 – in Python

- Switched from Java to Python because Python is a friendlier and more modern object-oriented language.

- Python is more relevant to non-computer scientists than Java—numerical libraries are available

Matlab and Python are just different vehicles we use to travel the "computational landscape."
→ Different scenery along the way
→ Both vehicles can get you there

CS1112

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

CS1110

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

- Python

Related to CS 1112: ENGRG 1112

- Taught by Prof. Andy Ruina of MAE, "Practical Computing for Engineering"

- 1 credit, optional, Fri 2:30-3:20pm, Kimball B11

- Course oriented towards numerical methods in engineering and includes symbolic computation, all in MATLAB

- "Intersection" of computing, engineering math, and engineering physics

https://classes.cornell.edu/browse/roster/FA18/class/ENGRG/1112

CS1112 requirements

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

- Attend lecture

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

- Monitor course announcements on website

- Do homework: best 5 of 6 programming projects

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

- Answer in-class quizzes (use your clicker)

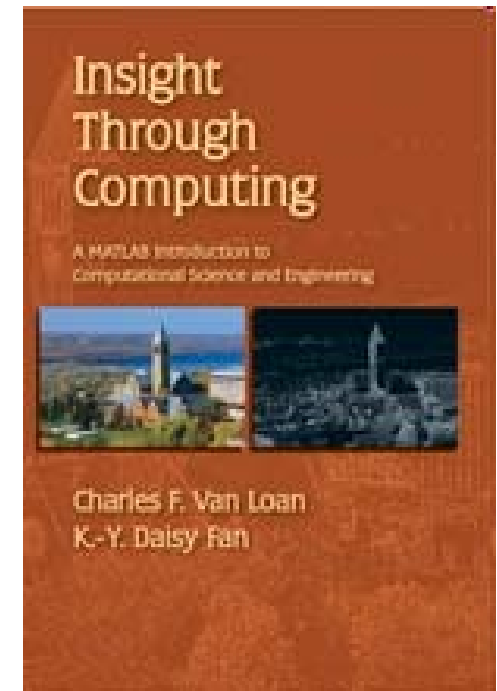- Adhere to the Code of Academic Integrity

Grading

- Best five* of six projects (25%)

  - Your lowest-scored project is eligible to be dropped only if you scored at least 50% on it

- Discussion exercises (4%)

- In-class quizzes (1%)

- Prelim 1 (20%)

- Prelim 2 (20%)

- Final exam (30%)

Course Materials

- ***Insight Through Computing***

  A Matlab introduction to Computational Science and Engineering

- An iClicker clicker (or mobile app)

- MATLAB Student Version (2008 or later) download your own copy or use public computer labs (Engineering Quad and RPCC)

FREE download for students. Get it!

Consulting & Computing

- ## Consulting in ACCEL Green Room (Engineering Library, Carpenter Hall). Check course website for hours.

- ## To download MATLAB, see course website

- ## Some labs that have MATLAB:
  - Upson 225
  - ACCEL
    - Carpenter Hall study area
  - North campus: RPCC

CS1112 Discussion Sections – start next week

Sec #	Time	Room
201	T 12:20-1:10p	UPS 225 lab & HLS 401
202	T 1:25-2:15p	UPS 225 lab & HLS 401
203	T 2:30-3:20p	UPS 225 lab & HLS 401
204	T 3:35-4:25p	UPS 225 lab & HLS 401
205	W 10:10-11:00a	UPS 225 lab & HLS 401
206	W 11:15a-12:05p	UPS 225 lab & HLS 401
207	W 12:20-1:10p	UPS 225 lab & HLS 401
208	W 1:25:2:15p	UPS 225 lab & HLS 401
209	W 2:30-3:20p	UPS 225 lab & HLS 401
210	W 3:35-4:25p	UPS 225 lab & HLS 401

Discussions are held in UPS (Upson) 225 lab the first two weeks