

Introduction to Computing Using Matlab

CS 1112 Fall 2012
(CSI 142)

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

Today's lecture

- An illuminating problem
- CS1112 philosophies & syllabus
- What is computer programming?
- Choosing between CS1112 & CS1110
- Course logistics/policies (highlights)

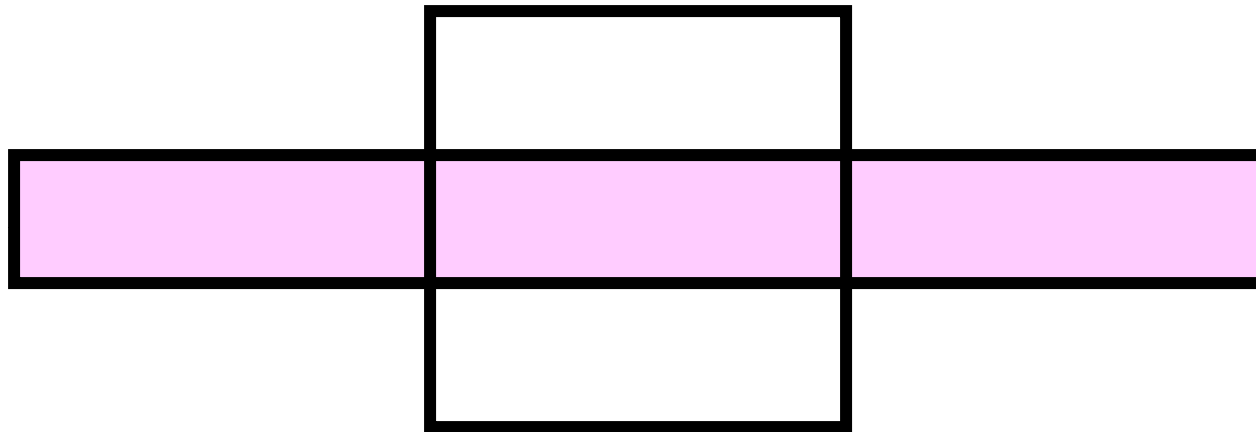
- How about CS1115? Introduction to Computational Science and Engineering Using Matlab Graphical User Interfaces

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}
- **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”?

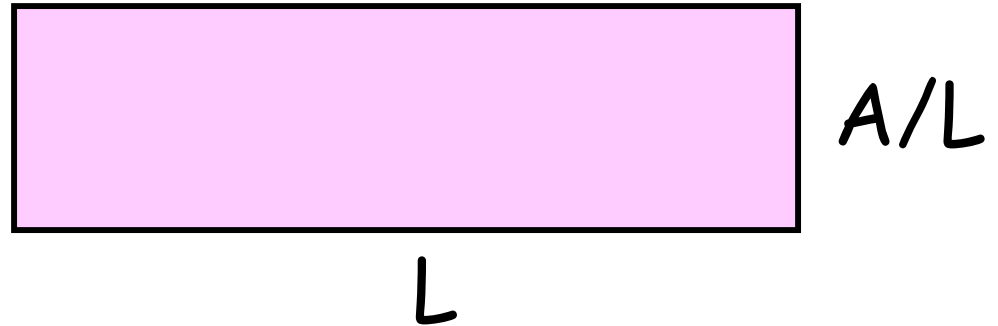
- If a square and a rectangle both have area A ...



- then \sqrt{A} is between the length and width of the rectangle

An improvement strategy

Current:



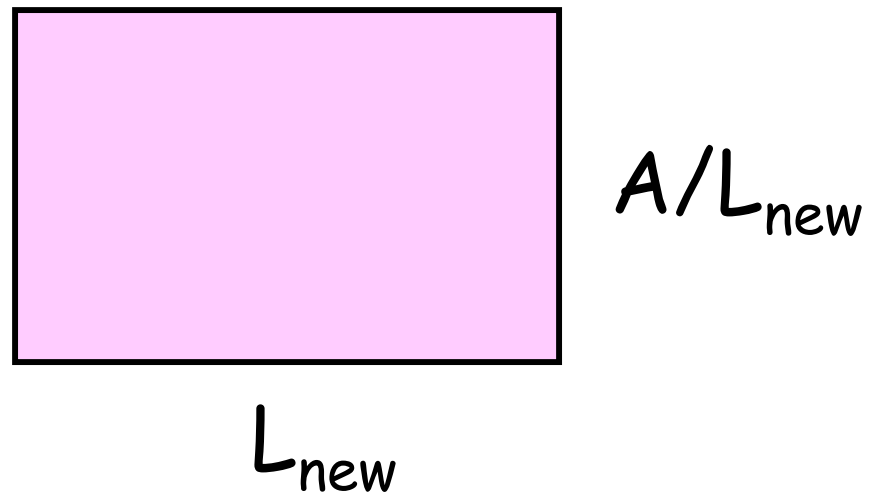
Recipe:

$$L_{\text{new}} = (L + A/L) / 2$$

The average of the length and width.



Next:



A Matlab program to make “increasingly square” rectangles

```
% 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...
```

The progression of rectangles with area 10

Length

Width

9.0000000000000000

1.0000000000000000

5.0000000000000000

1.8000000000000000

3.4000000000000000

2.647058823529412

3.023529411764706

2.976653696498055

3.000091554131380

2.999908448662588

3.000000001396984

2.999999998603016



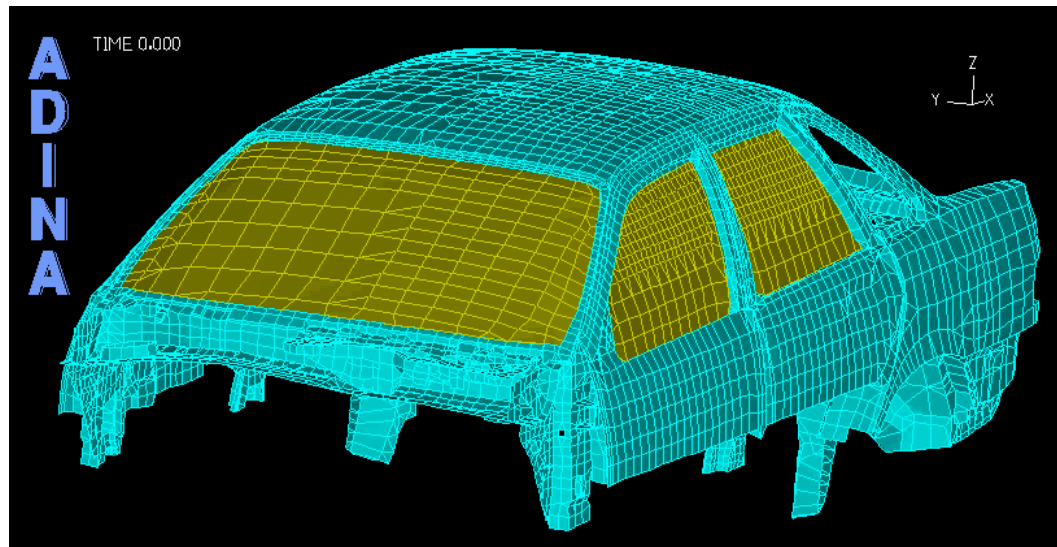
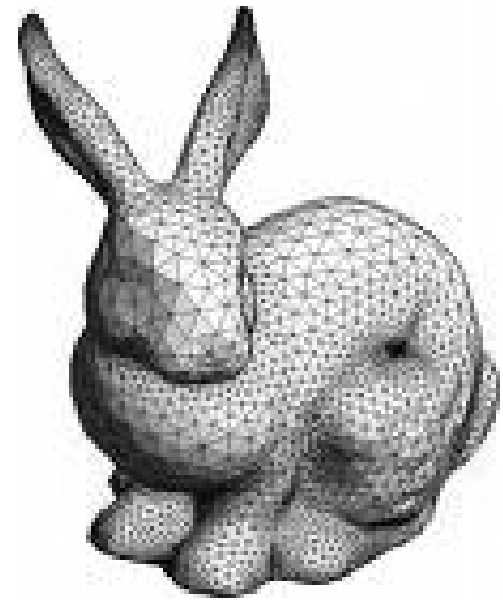
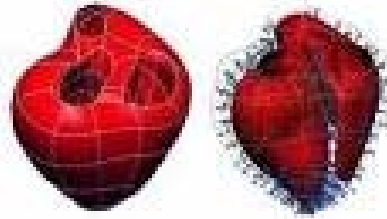
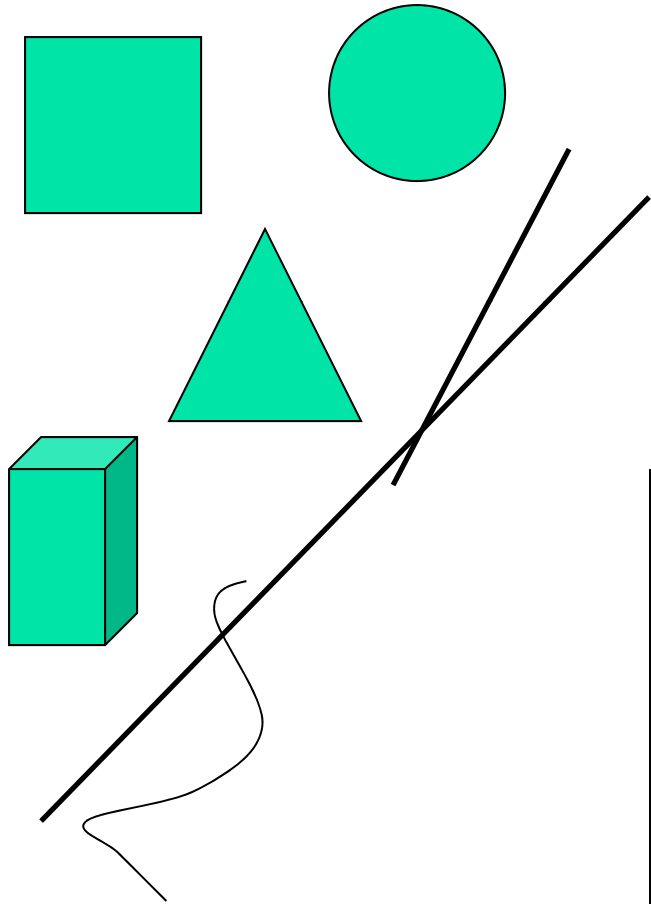
Some conclusions from square root finding problem

- 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



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



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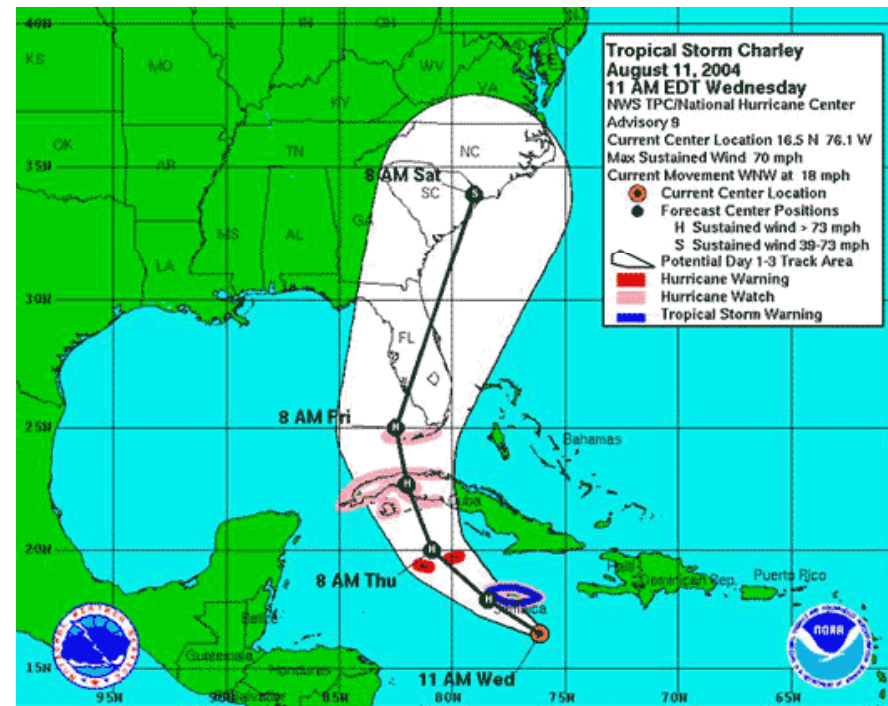
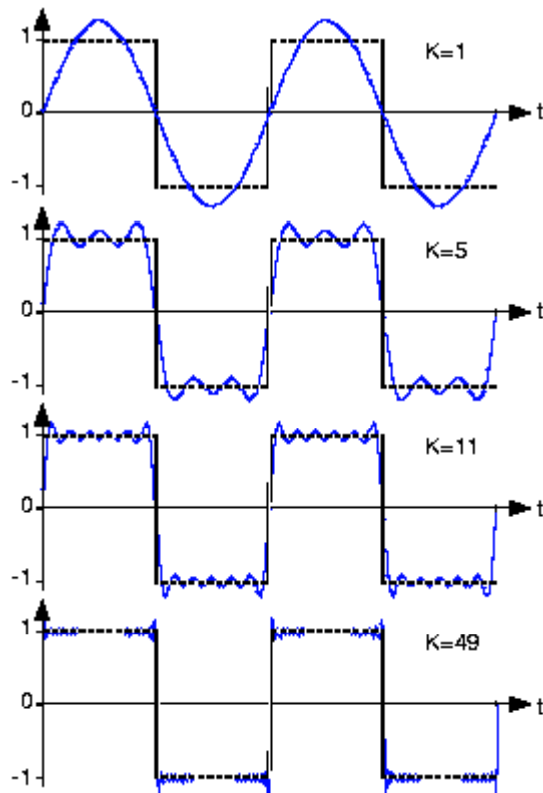
If a computer can process 1 billion itineraries a second, how long does it take to solve a 100-city problem?

About a century...

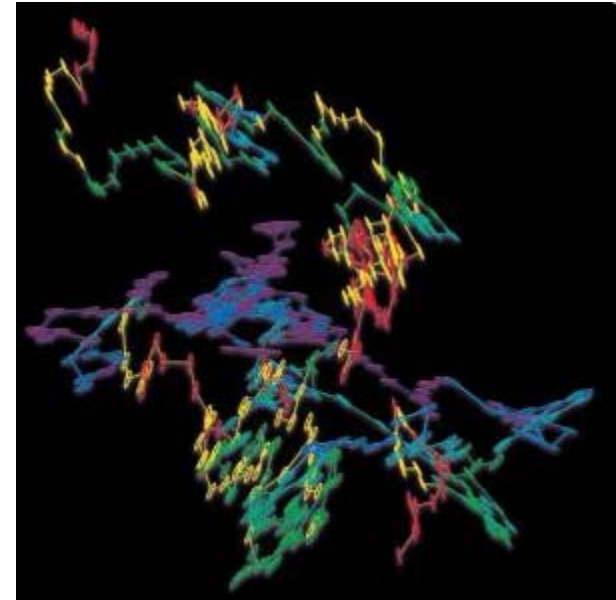
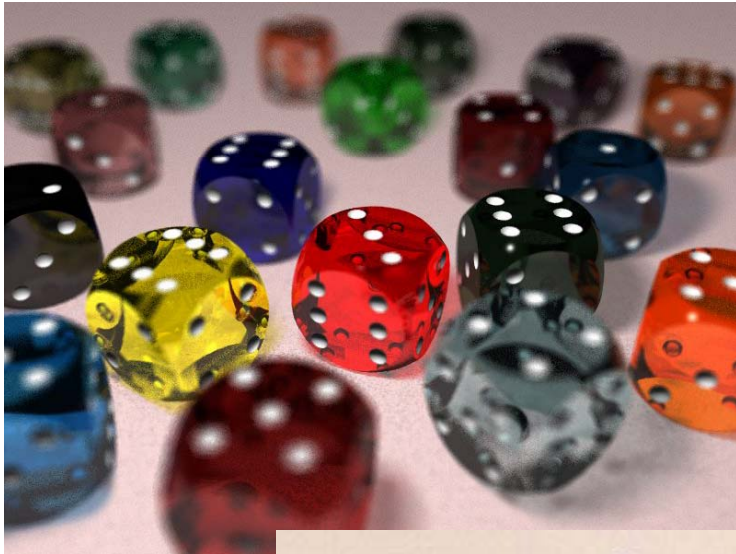
A sense of approximation & error

π

$1/3 = .33333\dots$



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!

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

- Find a website with MP3 or other audio files
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- Click [REDACTED] to download [REDACTED]
[REDACTED]
- 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 easily

- 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
- CS1115 – Matlab + GUI
- CS1110 – Python

Each course satisfies the Engineering Computing Requirement. 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

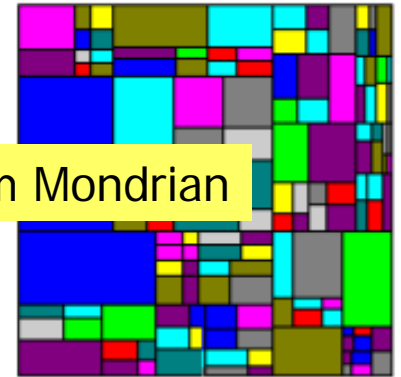
■ Lecture examples and homework illustrate above themes

- Edge detection
- Ranking web pages
- Congressional apportionment

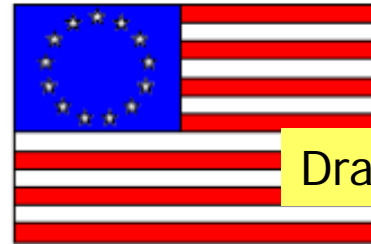


Some past programming assignments

- Find the US population center from census data
- Organize protein data using structure arrays
- Mozart's musical dice game

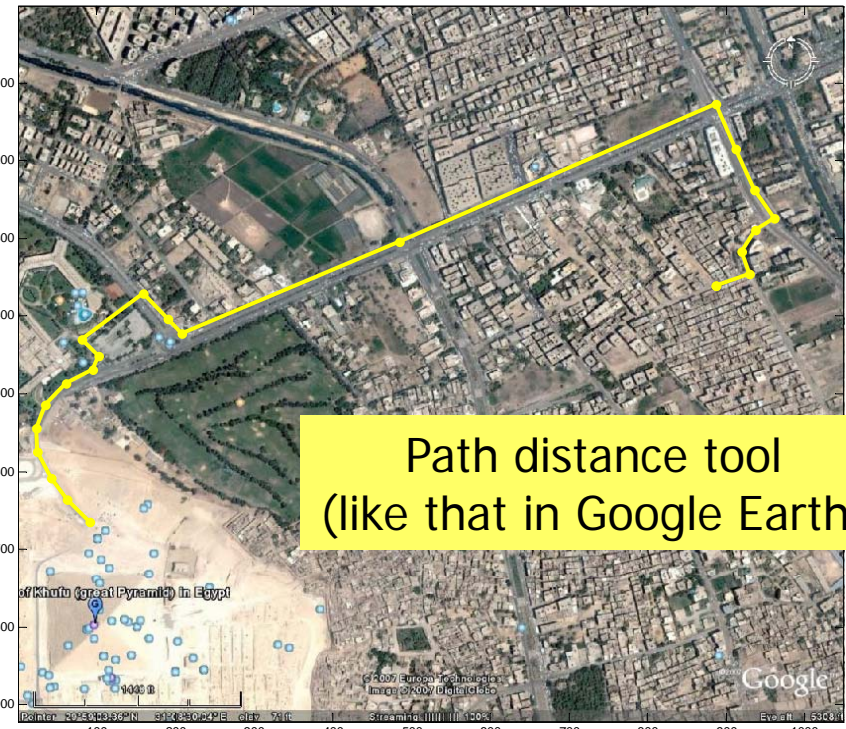


Draw the random Mondrian

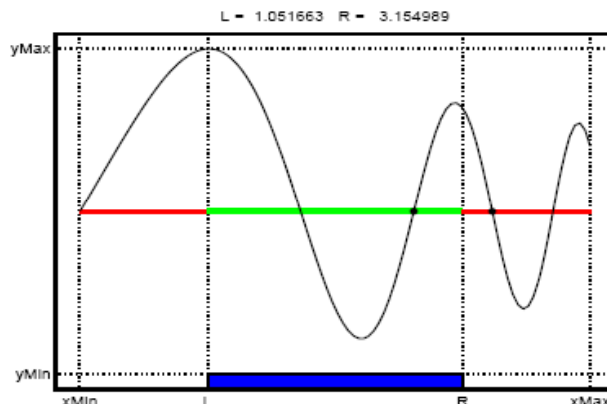


Draw the "Betsy Ross Flag"

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)



Root finding tool

CS1110 – Now 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 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
- Java

CS1115 Intro to Computational Science & Engineering Using Matlab Graphical User Interfaces

- A faster-paced course that teaches programming concepts through the development of **Graphical User Interfaces (GUIs)**
- Think of it as CS1112 + GUIs
- Not an honors course, but the introduction of GUIs is possible because students come with some programming experience
- **Pre-req:** a Calculus course and some programming experience in any programming language

CSI 112 requirements

- 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

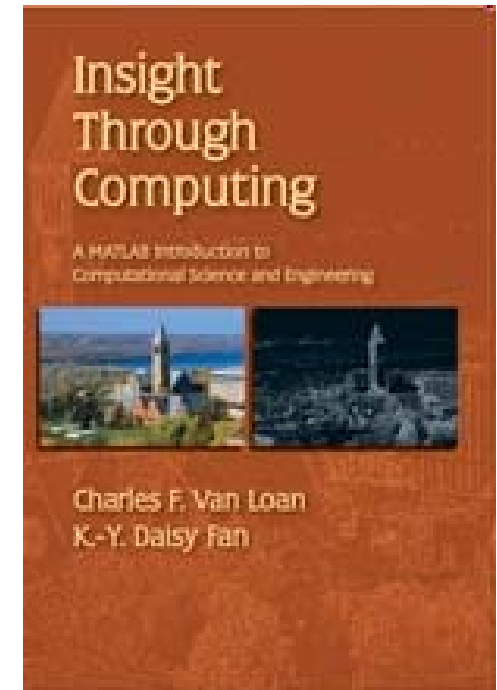
Grading

- Best five of six projects (25%)
- 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



- **MATLAB Student Version (2008 or later)** optional because you can use it in the public labs

Consulting & Computing

- Consulting in ACCEL Green Room (Engineering Library, Carpenter Hall). Check course website for hours.
- Some public labs that have Matlab:
 - Upson B-7
 - ACCEL
 - (Carpenter Hall, former Engrg Lib)
 - North campus: RPCC



What to do now?

- Pick a course

Take CS1112, CS1110, or CS1115

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

- Check course website
- Start reading (see listing on course website)
- Attend discussion in the **lab** (Upson B7) on Tues/Wed
- You must attend the discussion in which you are enrolled!

CS112 Discussion Sections

Sec #	Time	Room
201	T 12:20-1:10p	UPS B7 Right & HLS 314
202	T 1:25-2:15p	UPS B7 Right & HLS 314
203	T 2:30-3:20p	UPS B7 Right & HLS 401
204	T 3:35-4:25p	UPS B7 Right & HLS 401
205	W 10:10-11:00a	UPS B7 Right & HLS 401
206	W 11:15a-12:05p	UPS B7 Right & HLS 401
207	W 12:20-1:10p	UPS B7 Right & HLS 401
208	W 1:25-2:15p	UPS B7 Right & HLS 401
209	W 2:30-3:20p	UPS B7 Right & HLS 314
210	W 3:35-4:25p	UPS B7 Right & HLS 314
211	W 7:30-8:20p	UPS B7 Right & HLS 401

Discussions are held in UPS B7 the first two weeks