Introduction to Computing
Using Matlab

CS 1112 Spring 2013
(CS1142)
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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 CS1114? Introduction to Computational Science and Engineering Using Matlab and Robotics
An illuminating problem: computing square roots

- Suppose $A > 0$

- Observations: 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:** \( L_{\text{new}} = \frac{L + A/L}{2} \)

**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

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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

\[ \frac{1}{3} = .33333\ldots \]
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
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- Click **download** 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 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
- **CS1114** – Matlab + Robotics
- **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

Root finding tool

Path distance tool (like that in Google Earth)

Draw the “Betsy Ross Flag”

Draw the random Mondrian
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
CS1114: Intro to Computing using Matlab and Robotics

- An honors-level intro to CS using camera-controlled robots (Sony Aibo, Wowwee Rovio)
- Meets Tuesday / Thursday 11:15 – 12:05
- [http://www.cs.cornell.edu/courses/cs1114/](http://www.cs.cornell.edu/courses/cs1114/)
CS1112 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 CS1114
    (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!
## CS1112 Discussion Sections

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<tr>
<th>Sec #</th>
<th>Time</th>
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<tr>
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**Discussions are held in UPS B7 the first two weeks**