Introduction to Computing Using Matlab

CS 1112
(CS1142)
Dr. K.-Y. Daisy Fan

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)
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

Recipe: \[ L_{\text{new}} = \frac{L + A/L}{2} \]

The average of the length and width.
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...
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

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

3! = 6 possibilities

Add Seattle, NYC, Austin, Denver

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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

\[ \frac{1}{3} = 0.33333... \]
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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Reference: iTunes
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 **[http://starwars.wikia.com/wiki/Yoda](http://starwars.wikia.com/wiki/Yoda)**
- 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
- **CS1110** – Python

Each course satisfies the Engineering Computing Requirement. In **CS1112** 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 random Mondrian

Draw the “Betsy Ross Flag”
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 can get you there
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
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%)
  - 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

- MATLAB Student Version (2008 or later) purchase is optional because you can use it for free in the public labs
MATLAB software: to buy or not to buy, that is the question

<table>
<thead>
<tr>
<th></th>
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<th>Speed</th>
<th>Cost</th>
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<tbody>
<tr>
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<td>😞 Need to go to the lab (most labs are open 24-7)</td>
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<td><strong>TRIAL: remote access</strong></td>
<td>😞 Extra work to download and use supporting software and deal with file transfer</td>
<td>😞 Slow</td>
<td>😊😊 Free!</td>
</tr>
<tr>
<td></td>
<td>😊 Available on your machine with Internet connection</td>
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<td>😞 Expect hiccups as this is a TRIAL offering</td>
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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)
- North campus: RPCC
- ...
What to do now?

- Pick a course
  - Take CS1112 or CS1110
    (add/drop: lecture and discussion and optional AEW)
- Check course website
- Start reading (see listing on course website)
- Attend discussion in the lab (Upson B7 or Phillips 318) on Tues/Wed
- You must attend the discussion in which you are enrolled!
### CS1112 Discussion Sections – start NEXT WEEK

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<tr>
<th>Sec #</th>
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<tbody>
<tr>
<td>201</td>
<td>T 12:20-1:10p</td>
<td>UPS B7 Right &amp; HLS 314</td>
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<tr>
<td>202</td>
<td>T 1:25-2:15p</td>
<td>UPS B7 Right &amp; HLS 314</td>
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<tr>
<td>203</td>
<td>T 2:30-3:20p</td>
<td>UPS B7 Right &amp; HLS 401</td>
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<td>204</td>
<td>T 3:35-4:25p</td>
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<td>205</td>
<td>W 10:10-11:00a</td>
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<td>206</td>
<td>W 11:15a-12:05p</td>
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**Discussions are held in computer lab the first two weeks**