

# Introduction to Computing Using Matlab

CS 1112 Spring 2013  
(CSI 142)

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

# Today's lecture

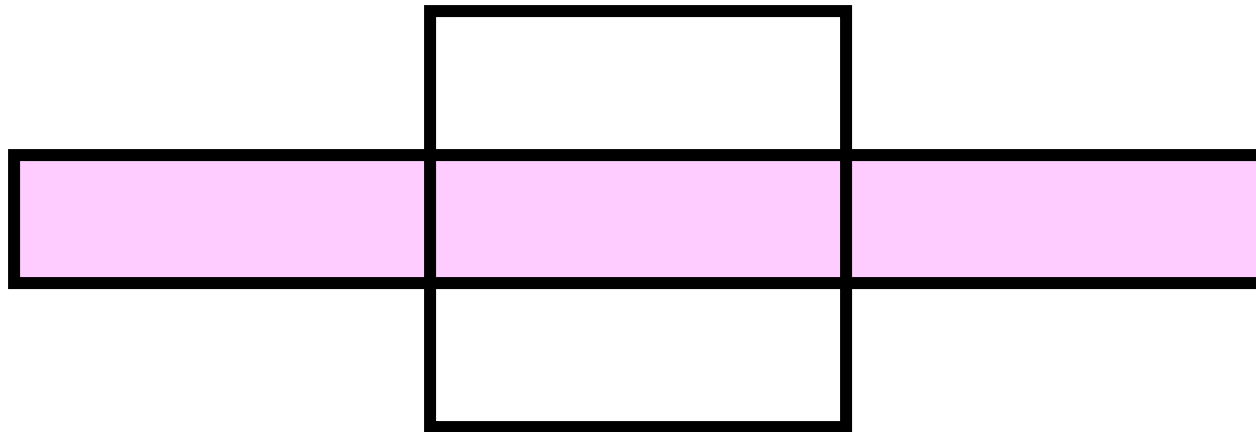
- An illuminating problem
  - CS1112 philosophies & syllabus
  - What is computer programming?
  - Choosing between CS1112 & CS1110
  - Course logistics/policies (highlights)
- 
- How about CS1114? Introduction to Computational Science and Engineering Using Matlab and Robotics

# 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”?

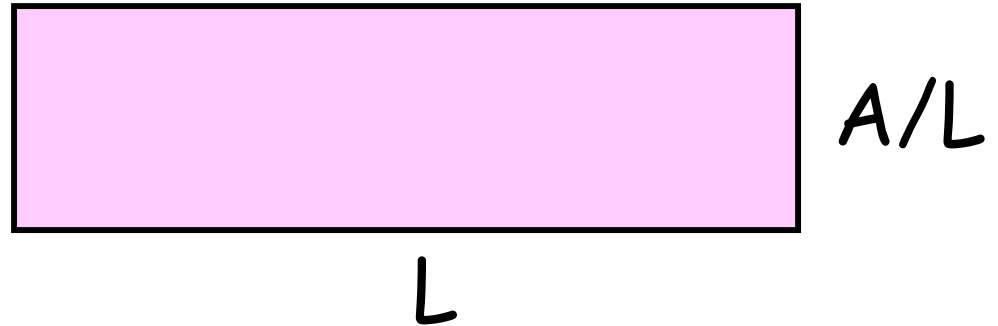
- If a square and a rectangle both have area  $A$  ...



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

## An improvement strategy

Current:



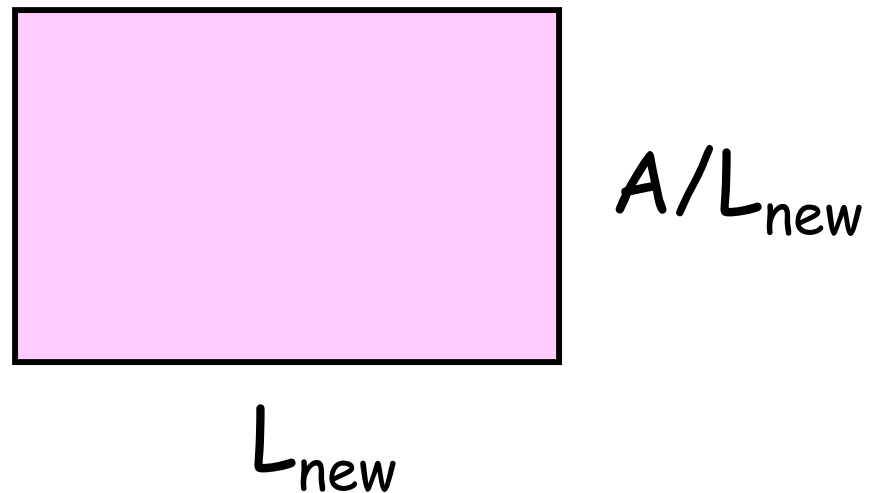
Recipe:

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

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

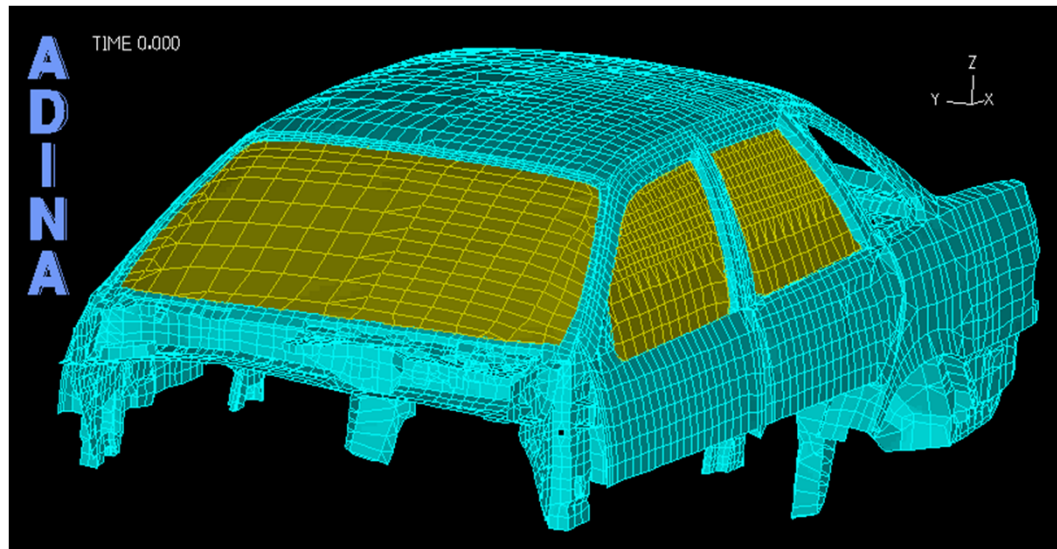
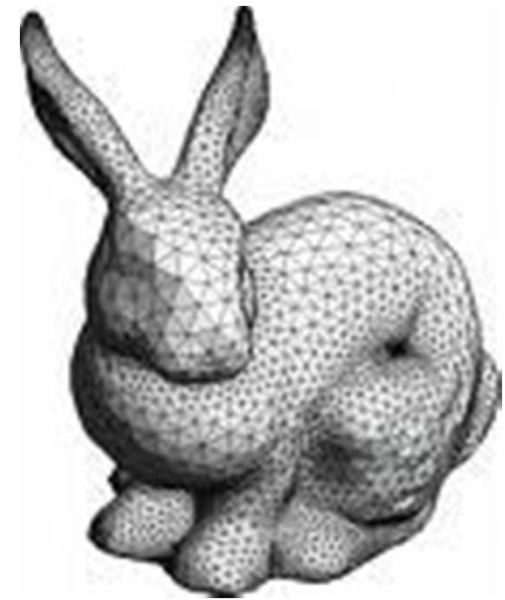
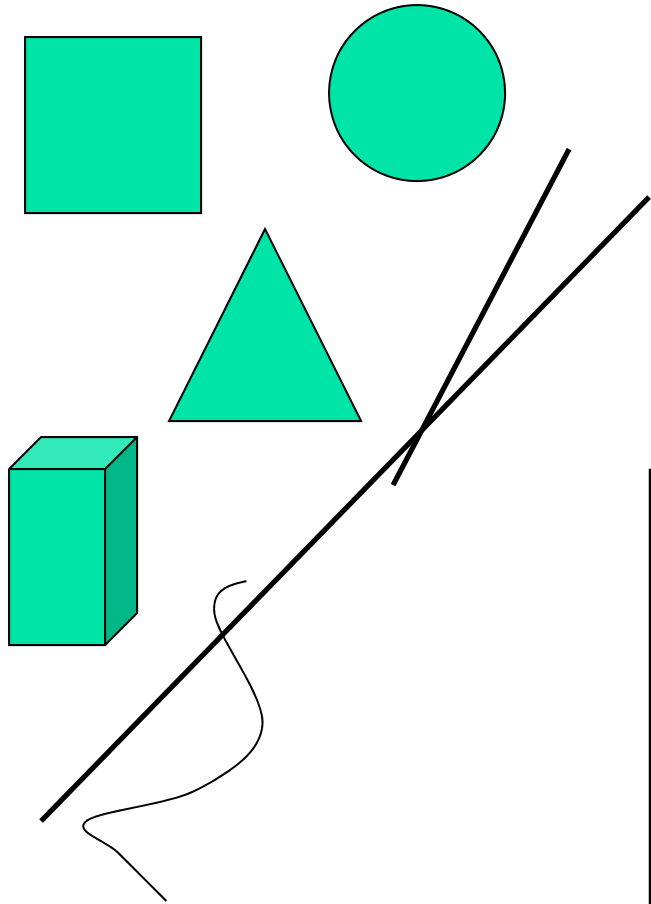
- It paid to have a geometric sense
- A complicated computation was reduced to a sequence of elementary calculations
- A program is like a formula (or sequence of formulas)



# 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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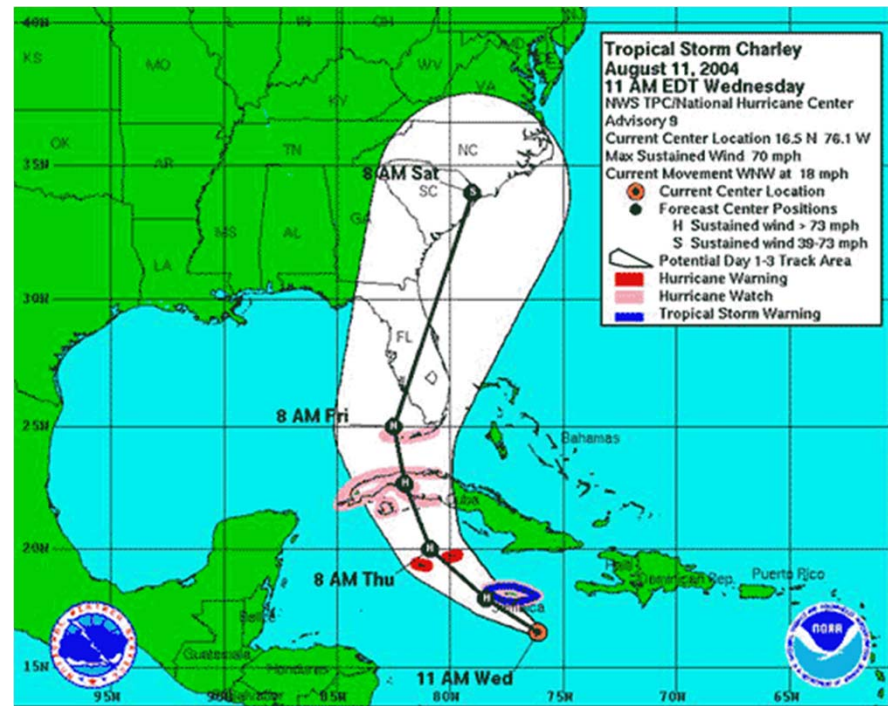
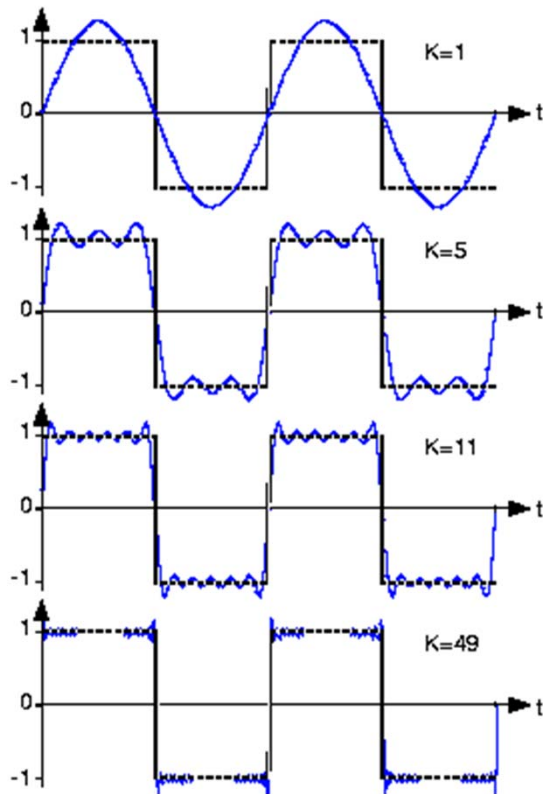
**About a century...**



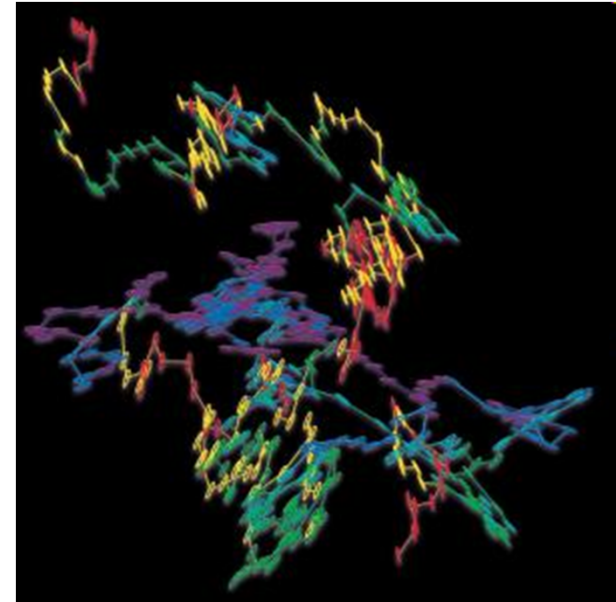
# A sense of approximation & error

$\pi$

$1/3 = .33333...$



# 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!*

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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.)
- 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
- 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

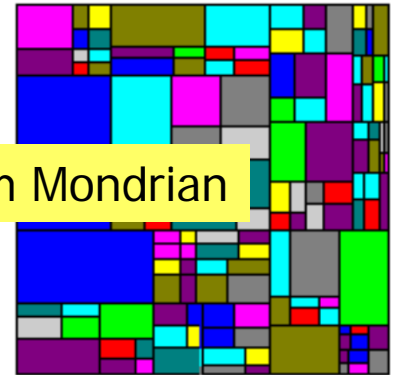
■ Lecture examples and homework illustrate above themes

- Edge detection
- Ranking web pages
- Congressional apportionment

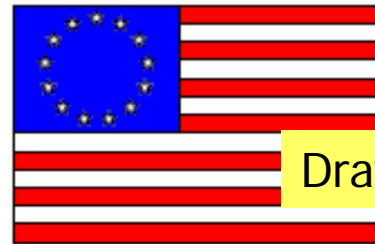


# Some past programming assignments

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



Draw the random Mondrian

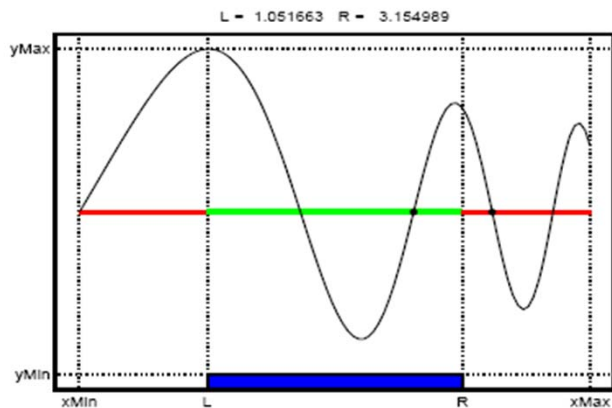


Draw the "Betsy Ross Flag"

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

# 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/>

# CS112 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

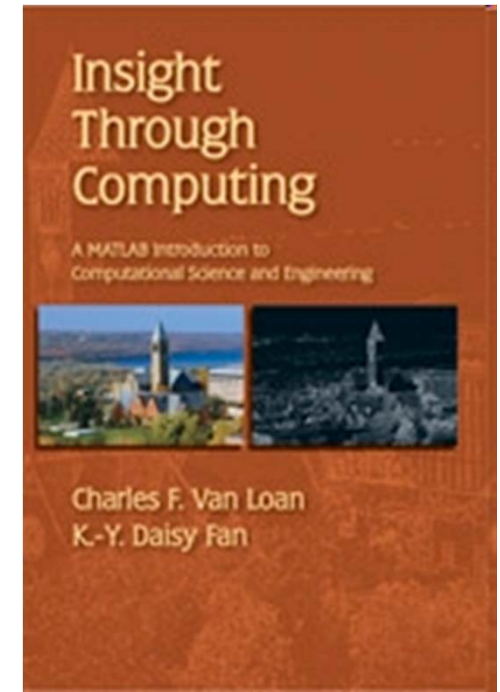
# Grading

- 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!

## 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 & UPS 207 |
| 204   | T 3:35-4:25p    | UPS B7 Right & UPS 207 |
| 205   | W 10:10-11:00a  | UPS B7 Right & HLS 320 |
| 206   | W 11:15a-12:05p | UPS B7 Right & HLS 314 |
| 207   | W 12:20-1:10p   | UPS B7 Right & PHL307  |
| 208   | W 1:25-2:15p    | UPS B7 Right & HLS 320 |
| 209   | W 2:30-3:20p    | UPS B7 Right & HLS 314 |
| 210   | W 3:35-4:25p    | UPS B7 Right & HLS 314 |

Discussions are held in UPS B7 the first two weeks