



## **Course Business:**

- http://www.cs.cornell.edu/Courses/cs401/2001fa - Contains syllabus, lecture notes, examples, homework
- Office Hours Monday & Tuesday, 11-1 in 3134 Snee (or by appointment)
- Registration:
  - get my signature or CS Undergrad office (303 Upson)
    S/U only, 1 credit
    Last day to add/drop: Monday, September 10 !

# **Outline**

- Homework I.
- Getting started: the Desktop & Workspace
- Matlab as calculator
- Variables
- Arrays
- Array Operations

## Homework I.

- Download from web page
- Use a text editor (e-mailer?) to insert answers
- Paste (DON'T ATTACH) into e-mail and send to me by 5PM Wed. next week.
- No atoms allowed, only bits!

## **Starting Up**

- On Windows:
  - Launch from START, or find matlab.exe & double click
- On UNIX/Linux
  - Open a terminal, type "matlab"
  - Problems:
    - "Command not found"--check your path
    - Splash window of 6.X hangs--try "matlab -nojvm"

#### Windows, windows, and more windows

- As of 6.0, Matlab has lots of windows inside a "Desktop"
- The Workspace is the center of the Matlab universe
  - Holds your data
  - Waits for your commands
  - (other windows are fluff)
- 5.X only has workspace

#### **Basic Math**

- Matlab is a command-line calculator
  - Simple arithmetic operators
  - + \* / ^
  - Basic functions
  - sin(), log(), log10(), exp(), rem()

- Constants • pi, e

## Big deal, a calculator's \$20

- Matlab is a fully-functional programming language
- This means we get variables – name = value
  - Name can be anything made of letters, numbers, and a few symbols (\_). Must start with a letter
     End line with ";" to avoid output
     Can also use ";" to put multiple commands on a line

  - List with who
  - Delete with clear
  - More info with whos

## **1D Arrays--aka Vectors**

- An array is anything you access with a subscript
- 1D arrays are also known as "vectors"
- Everything (nearly) in Matlab is a "double array"
- Create arrays with brackets [ ]
- Separate elements with commas or spaces
- Access with ()'s

### **Regular arrays**

- We can create regularly spaced arrays using ":"
  - A=st:en produces [st, st+1, st+2, ... en]
    - A=1:5 is [1 2 3 4 5] • A=-3.5:2 is [-3.5 -2.5 -1.5 0.5 1.5]---note, stops
    - before 2! • What happens if en < st ?
  - Can also insert a "step" size: A=st:step:en
    - A=0:2:6 is [0 2 4 6]
    - A=5:-2.5:0 is [5 -2.5 0];

#### Accessing vectors

- Matlab arrays start at 1
- In most languages (C, Java, F77) can only access arrays one element at a time: – a(1)=1; a(2)=2.5; a(3)=-3; etc.
- In Matlab, can access several elements at a time using an array of integers (aka an *index*)

   a(1:5) is [a(1),a(2),a(3),a(4),a(5)]
  - a(5:-2:1) is [a(5), a(3), a(1)]

### **Accessing vectors**

- Index vectors can be variables:
  - A=10:10:100; I=[1:2:9]; A(I) gives [10,30,50,70,90]
  - J=[2:2:10];A(J) gives [20,40,60,80,100];
  - What does A(I)=A(J) do?

#### **Column vectors**

- "row vectors" are 1-by-n
- "column vectors" are n-by-1
- Row/column distinction doesn't exist in most languages, but VERY IMPORTANT in MATLAB
- Create column vectors with semi-colons
- Can force to column vector with (:)
- Convert column-to-row and back with transpose (')
- Can access the same way as row vectors

#### **2D arrays--matrices**

- From using commas/spaces and semicolons
- A=[1 2 3; 4 5 6; 7 8 9];
- A(j,k)= j'th row, k'th column
- A(2:3,1:2)= rows 2 through 3 and columns 1 through 2
- A([1,3,4], :)= all of rows 1, 3 and 4
- A(:, 1)= first column

#### **Size matters**

- "A is m-by-n" means A has m rows and n columns
- [m,n]=size(A) gets size of A
- length(a) gets length of vectors.
- A(1:3,2)=v, v better have length 3
- A(1:2:5,2:3)=B, B better be 3-by-2

## **Array Arithmetic**

- C=A+B
  - if A and B are the same size, C(j,k)=A(j,k)+B(j,k)
  - If A is a scalar, C(j,k)=A+B(j,k)
- Same for -

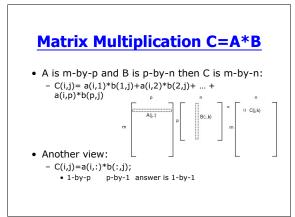
## **Array Multiplication**

• Multiplication is weird in Matlab

- Inherited from linear algebra

– To multiply by a scalar, use  $\ast$ 

To get C(j,k)=A(j,k)\*B(j,k) use ".\*"
 Also applies to ".^" and "./"



## **Matrix Multiplication**

- We'll defer matrix division for a while
- matrix multiplication can be useful-even to those who hate LA

   ones(3,1)\*[1:5]

## **Matlab History**

- Matlab stands for "Matrix Laboratory"
- Developed by from LAPACK--a series of routines for numerical linear algebra
- Consequences
  - \* is funny, / is even funnier
  - Matlab does linear algebra really well
  - Default type is double array

#### **ND arrays**

- Until V5, Matlab arrays could only be 2D
- Now has unlimited dimensions:
  - A=ones(2,3,2)
  - A is a 3D array of ones, with 2 rows, 3 columns, and 2 layers
  - A(:,:,1) is a 2-by-3 matrix