Matlab Fundamentals:

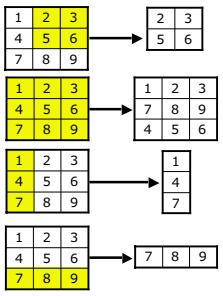
working with data

Outline

- Announcements
  - Homework I due 9/10, 5PM by e-mail
  - remember--plain text, Subject=CIS 401 Homework
- Matrix Multiplication
- ND-arrays
- Loading, saving, and plotting data

2D arrays--matrices

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



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 (max of m and n).
- A(1:3,2)=v, v better have length 3
- A(1:2:5,2:3)=B, B better be 3-by-2

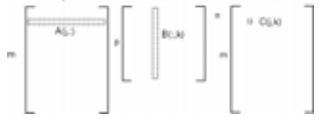
Matlab History

- 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

Matrix Multiplication C=A*B

- A is m-by-p and B is p-by-n then C is m-by-n:

$$C(i,j) = \sum_{k=1}^{p} A(i,k) * B(k,j)$$



  - C(i,j)= a(i,1)*b(1,j)+a(i,2)*b(2,j)+ … + a(i,p)*b(p,j)

Matrix Multiplication

- Another view:
  - C(i,j)=a(i,:)*b(:,j);
    - 1-by-p p-by-1 answer is 1-by-1
    - This is a vector (dot) product

Matrix Multiplication

- Special Cases of A*B

Name	size(A)	size(B)	size(C)
dot product u'*v	1-by-n (row)	n-by-1 (column)	
linear system b=A*x	m-by-n (matrix)	n-by-1 (column)	
outer product X=ones(5,1)*(1:3) Y=(1:5)'*ones(1,3)	m-by-1 (column)	1-by-n (row)	

Matrix Multiplication

- C=A*B is matrix multiplication
- If A & B are the same size, can do element-by-element multiplication:
  - C=A.*B
  - C(j,k)=A(j,k)*B(j,k);
- Analogous operators ./ and .^

Matrix Multiplication

- We'll defer matrix division for a while
- matrix multiplication can be useful--even to those who hate LA
  - outer products are very handy
  - Vectorized ops much faster than writing loops

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

Working with Data

- Data is central to applied scientific computing

	Data →	Program →	Output
Currents	SSH	Geostropic eq.	U,V,plot
Weather	T,V,M	Finite diff.	T,V,M in future
Bioinfomatics	ATCGCGTA…	Search for genes	Location of genes
Electronics	Signal	FFT	Plot of spectrum

Getting Data into Matlab

- Options
  - Cut & paste, or enter by hand
  - Read from a file

File Types

File Type	Efficiency (info/byte)	Matlab Factor	Intangibles
ASCII	Low	Good	Easy to edit and view, universal.
Binary	High	Not so good	Can't view, need to know how it was created
Proprietary (e.g. Excel)	??	Impossible-to-good	Some formats supported, some not
.mat	High	Best	Careful when loading to avoid variable-name collisions

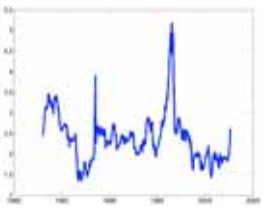
Loading Simple Text Files

- "load fname.txt" will create an array fname with the data
  - Each line of fname.txt must have same number of columns
  - Matlab will ignore lines starting with %
    - add to header lines, so Matlab will ignore

Saving data with save

- save
  - creates matlab.mat with all variables in workspace
- save fname
  - creates fname.mat with all variables
- save fname var1 var2
  - saves only variables var1 & var2
- save fname.txt var1 -ascii -tabs -double
  - saves var1 as a table of ASCII numbers called fname.txt

Tutorial 2



- Start with table of values in Excel

1. Make the file suitable for Matlab (e.g. a matrix)
2. Save as text
3. Load into Matlab
4. Rearrange the data with Matlab array operations
5. Save data to a .mat file
6. Create a plot of corn prices vs. time

Other help options

- help fname
  - bare-bones help for function fname
- helpwin
  - help info categorized and available through GUI
- Help menu
  - More tutorial-like

Summary

- Matrix mult: "Inner matrix dimensions must agree"
- Load ASCII or .mat files with load
- Save data to ASCII or .mat with save
- Create simple plots with plot
- Get help with help