Math 306 - Numerical Methods

Introduction to MATLAB

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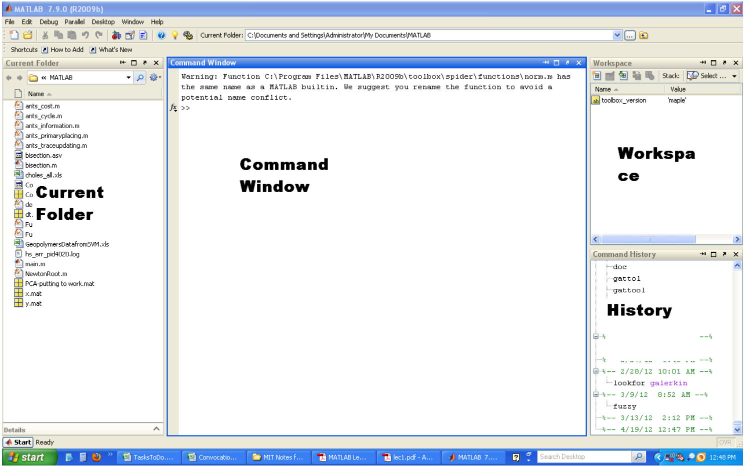
Outline

(1)Getting Started
(2)Making Variables
(3)Manipulating Variables
(4)Basic Plotting

The MATLAB Desktop



Name	Value
toolbox_version	'maple'

```
Warning: Function C:\Program Files\MATLAB\R2009b\toolbox\spider\functions\norm.m has
the same name as a MATLAB builtin. We suggest you rename the function to avoid a
potential name conflict.
>>
```

```
doc
gattol
gattool
%                        --%
%                        --%
%-- 2/28/12 10:01 AM --%
lookfor galerkin
%-- 3/9/12  8:52 AM --%
fuzzy
%-- 3/13/12  2:12 PM --%
%-- 4/19/12 12:47 PM --%
```

Getting Started

Customization

File -> Preferences

Allows you personalize your MATLAB experience

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Conversing with MATLAB

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  MATLAB replies with the variables in your workspace

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  The most important function for learning MATLAB on your own

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- More on help later

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- Other types are also supported: complex, symbolic, 16-bit and 8 bit integers, etc.

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  - NaN represents 'Not a Number'

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    - The format is C-syntax

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- To suppress output, end the line with a semicolon
  »m= 13/3;

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- MATLAB makes vectors easy!That's its power!

Row & Column Vectors

- Row vector: comma or space separated values between brackets

  ```
  »row = [1 2 5.4 -6.6];
  »row = [1, 2, 5.4, -6.6];
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- Column vector: semicolon separated values between brackets

  »column = [4;2;7;4];

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```
1   2   5   1   2   5
3   4   6   3   4   6
1   2   3   4   1   2
```

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- Can do the same for entire environment
  »save myenv; clear all; load myenv;

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- And here are the answers:

```
»r=[1 4 7 10 13];
»c=[13; 10; 7; 4; 1];
»save varExr c
»clear r c
»load varEx
```

Basic Scalar Operations

- Arithmetic operations (+, -, *, /)

```
»7/45
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- Complicated expressions, use parentheses
  ```
  »((2+3)*3)^0.1
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- Multiplication is NOT implicit given parentheses
  `»3(1+0.7)` gives an error
- To clear cluttered command window
  ```
  »clc
  ```

Built-in Functions

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- Call using parentheses – passing parameter to function

```
»sqrt(2)
»log(2), log10(0.23)
»cos(1.2), atan(-.8)
»exp(2+4*i)
»round(1.4), floor(3.3), ceil(4.23)
»angle(i); abs(1+i);
```

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- To search for a function by specifying keywords:
  »doc + Search tab
  »lookfor hyperbolic
  One-word description of what you're looking for

Exercise: Scalars

Verify that $e^{ix} = \cos(x) + i\sin(x)$ for a few values of x.

```
»x = pi/3;
»a = exp(i*x)
»b = cos(x)+ i*sin(x)
»a-b
```

size & length

- You can tell the difference between a row and a column vector by:

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  - To get a vector's length, use the length function

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  »a = [1 2 3 4]
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- For vectors of real numbers .'and ' give same result

Addition and Subtraction

- Addition and subtraction are element-wise; sizes must match (unless one is a scalar):

$$\begin{array}{cc} & [12 \quad 3 \quad 32 \quad -11] \\ + & [2 \quad 11 \quad -30 \quad 32] \\ \hline & [14 \quad 14 \quad 2 \quad 21] \end{array} \qquad \begin{bmatrix} 12 \\ 1 \\ -10 \\ 0 \end{bmatrix} - \begin{bmatrix} 3 \\ -1 \\ 13 \\ 33 \end{bmatrix} = \begin{bmatrix} 9 \\ 2 \\ -23 \\ -33 \end{bmatrix}$$

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- Can sum up or multiply elements of vector
  »s=sum(row);
  »p=prod(row);

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- Operators (* / ^) have two modes of operation

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    »f = [exp(1) exp(2) exp(3)];
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- Operators (* / ^) have two modes of operation
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Element-Wise Functions

- All the functions that work on scalars also work on vectors
    - »t = [1 2 3];
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- If in doubt, check a function's help file to see if it handles vectors elementwise
- Operators (* / ^) have two modes of operation
    - element-wise
    - standard

Operators: element-wise

- To do element-wise operations, use the dot. BOTH dimensions must match (unless one is scalar)!
  »a=[1 2 3];b=[4;2;1];
  »a.*b, a./b, a.^b → all errors
  »a.*b', a./b', a.^(b') → all valid

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- $$\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \quad .* \quad \begin{bmatrix} 4 \\ 2 \\ 1 \end{bmatrix} \quad = \quad \begin{bmatrix} 4 \\ 4 \\ 3 \end{bmatrix}$$
  $$3 \times 1 \quad .* \quad 3 \times 1 \quad = \quad 3 \times 1$$

Operators: element-wise (cont'd)

$$\begin{bmatrix} 1 & 1 & 1 \\ 2 & 2 & 2 \\ 3 & 3 & 3 \end{bmatrix} \quad .* \quad \begin{bmatrix} 1 & 2 & 3 \\ 1 & 2 & 3 \\ 1 & 2 & 3 \end{bmatrix} \quad = \quad \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{bmatrix}$$

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Operators: standard (cont'd)

$$\begin{bmatrix} 1 & 1 & 1 \\ 2 & 2 & 2 \\ 3 & 3 & 3 \end{bmatrix} * \begin{bmatrix} 1 & 2 & 3 \\ 1 & 2 & 3 \\ 1 & 2 & 3 \end{bmatrix} = \begin{bmatrix} 3 & 6 & 9 \\ 6 & 12 & 18 \\ 9 & 18 & 27 \end{bmatrix}$$

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- The general function call is:

$$var = zeros(M, N)$$

where M =Number of rows and N =Number of columns.

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- To initialize logarithmically spaced values use logspace
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- »d=c(1,:); $\Rightarrow$ d=[12 5];
- »e=c(:,2); $\Rightarrow$ e=[5;13];
- »c(2,:)=[3 6]; %replaces second row of c

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```
»x = linspace(0,2*pi,1000);
»y=sin(x);
»y(55)
»y(100:110)
»[minVal,minInd]=min(y)
»[maxVal,maxInd]=max(y)
»inds=find(y>-0.001 & y<0.001)
```

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  - »rs= sum(mat,2);

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  - »mat=zeros(3,100);
  - »x=linspace(0,10,100);
- Replace the first row of the matrix with cos(x)
  - »mat(1,:)=cos(x);
- Replace the second row of the matrix with log((x+2)^2)
  - »mat(2,:)=log((x+2).^2);
- Replace the third row of the matrix with a random vector of the correct size
  - »mat(3,:)=rand(1,100);
- Use the sum function to compute row and column sums of mat (see help)
  - »rs= sum(mat,2);
  - »cs= sum(mat); % default dimension is 1

Plotting Vectors

- Example

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  »x=linspace(0,4*pi,10);
  »y=sin(x);
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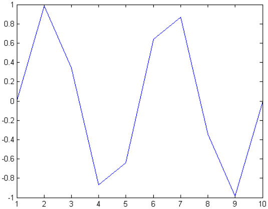
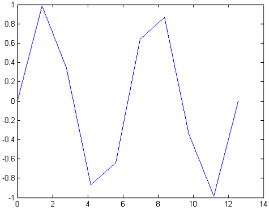


Index based



x-values based

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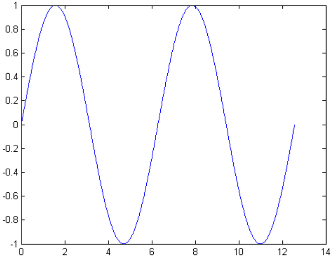

- x and y vectors must be same size or else there is an error

  plot([1 2], [1 2 3])

Plot Options

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```
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- Look at help document ofplot for a full list of colors, markers, and linestyles

Other Useful plot Commands

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  »hold on;
- To plot on a new figure
  »figure;
  »plot(x,y);
- Play with the figure GUI to learn more on how to
  add axis labels
  add a title
  add a grid
  zoom in/zoom out

Exercise: Plotting

- Plotf(x) = e^x*cos(x) on the intervalx = [0 10]. Use a red solid line with a suitable number of points to get a good resolution.

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-
  ```
  »x=0:.01:10;
  »plot(x,exp(x).*cos(x),'r');
  ```

Thank you