Introduction to MATLAB

Selim Aksoy
Bilkent University
Department of Computer Engineering
saksoy@cs.bilkent.edu.tr

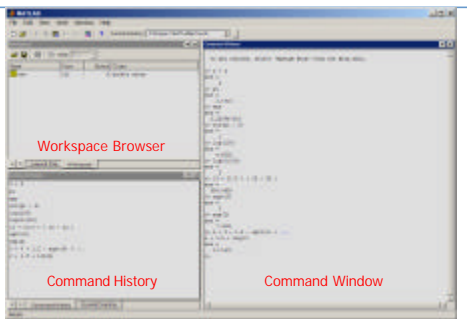# MATrix LABoratory

- http://www.mathworks.com
- Advantages of MATLAB
  - Ease of use
  - Platform independence
  - Predefined functions
  - Plotting
- Disadvantages of MATLAB
  - Can be slow
  - Expensive

MATLAB Desktop

Workspace Browser

Command History   Command Window

MATLAB Basics

- A program can be input
  - command by command using the command line (lines starting with "»" on the MATLAB desktop)
  - as a series of commands using a file (a special file called M-file)
- If a command is followed by a semicolon (;), result of the computation is not shown on the command window

---

MATLAB Basics: Getting Help

- help
  - help *toolbox* → e.g., help elfun
  - help *command* → e.g., help sin
- helpdesk, helpwin, "?" button
- lookfor
  - lookfor *keyword* → e.g., lookfor cotangent
- which
  - which *name* → e.g., which log
- demo

MATLAB Basics: Scratchpad

2 * 2

$$\cot(3)\sqrt{\left(\log(3)\right)^3} + \cos(3)*\sin(\log(3))$$

$$\cot(2.7)\sqrt{\left(\log(2.7)\right)^3} + \cos(2.7)*\sin(\log(2.7))$$

$$\log(\sin(0.5)+\cos(0.5)^2) + \sqrt[4]{\sin(0.5)+\cos(0.5)^2} - \left(\sin(0.5)+\cos(0.5)^2\right)^2$$

MATLAB Basics: Variables

- Variable is a name given to a reserved location in memory
  - class_code = 111;
  - number_of_students = 65;
  - name = 'Bilkent University';
  - radius = 5;
  - area = pi * radius^2;

MATLAB Basics: Variables

- Use meaningful names for variables
- MATLAB variable names
  - must begin with a letter
  - can contain any combination of letters, numbers and underscore (_)
  - must be unique in the first 31 characters
- MATLAB is case sensitive: "name", "Name" and "NAME" are considered different variables
- Never use a variable with the same name as a MATLAB command
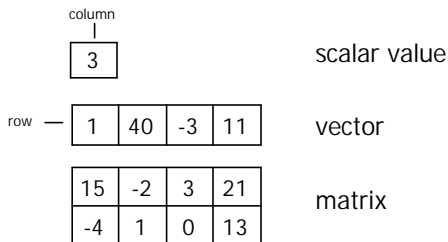- Naming convention: use lowercase letters

MATLAB Basics: Arrays

- The fundamental unit of data is array

column

| 3 |
scalar value

row —
| 1 | 40 | -3 | 11 |
vector

| 15 | -2 | 3 | 21 |
| -4 | 1 | 0 | 13 |
matrix

MATLAB Basics: Variables

- Initialization using assignment statements
  - x = 5
    x =
        5
  - y = x + 1
    y =
        6
  - v = [1 2 3 4]
    v =
        1   2   3   4
  - m = [1 2 3; 4 5 6]
    m =
        1   2   3
        4   5   6
  - m2 = [1 2 3; 4 5]
    ??? Error
  - a = [5 (2+4)]
    a =
        5   6

MATLAB Basics: Variables

- Initialization using shortcut statements
  - colon operator → first:increment:last
    - x = 1:2:10
      x =
          1   3   5   7   9
    - y = 0:0.1:0.5
      y =
          0   0.1   0.2   0.3   0.4   0.5

MATLAB Basics: Variables

- Initialization using built-in functions
  - zeros()
    - x = zeros(2)
      x =
          0   0
          0   0
    - z = zeros(2,3)
      z =
          0   0   0
          0   0   0
    - y = zeros(1,4)
      y =
          0   0   0   0
    - t = zeros(size(z))
      t =
          0   0   0
          0   0   0
  - ones(), size(), length()

MATLAB Basics: Variables

- Initialization using keyboard input
  - input()
    - value = input('Enter an input value: ')
      Enter an input value: 1.25
      value =
          1.2500
    - name = input('What is your name: ', 's')
      What is your name: Selim
      name =
      Selim

MATLAB Basics: Subarrays

- Array indices start from 1
- x = [-2 0 9 1 4];
  - x(2)
    ans =
        0
  - x(4)
    ans =
        1
  - x(8)
    ??? Error
  - x(-1)
    ??? Error

MATLAB Basics: Subarrays

- y = [1 2 3; 4 5 6];
  - y(1,2)
    ans =
        2
  - y(2,3)
    ans =
        6
  - y(2)
    ans =
        4   (column major order)
            (I don't recommend you to use this form)

MATLAB Basics: Subarrays

- y = [1 2 3; 4 5 6];
  - y(1,:)
    ans =
        1   2   3
  - y(:,2)
    ans =
        2
        5
  - y(2,1:2)
    ans =
        4   5
  - y(1,2:end)
    ans =
        2   3
  - y(:,2:end)
    ans =
        2   3
        5   6

MATLAB Basics: Subarrays

- x = [-2 0 9 1 4];
  - x(2) = 5
    x =
        -2   5   9   1   4
  - x(4) = x(1)
    x =
        -2   5   9   -2   4
  - x(8) = -1
    x =
        -2   5   9   -2   4   0   0   -1

MATLAB Basics: Subarrays

- y = [1 2 3; 4 5 6];
  - y(1,2) = -5
    y =
        1   -5   3
        4   5   6
  - y(2,1) = 0
    y =
        1   -5   3
        0   5   6
  - y(1,:) = [4 -1 9]
    y =
        4   -1   9
        0   5   6
  - y(:,2) = [3; 2]
    y =
        4   3   9
        0   2   6

MATLAB Basics: Subarrays

- z = [1 2 3; 4 5 6; 7 8 9];
  - z(3,:) = 0
    ```
    z =
        1   2   3
        4   5   6
        0   0   0
    ```
  - z(:,1) = -2
    ```
    z =
       -2   2   3
       -2   5   6
       -2   0   0
    ```
  - z(2,:) = [1 5]
    ??? Error
  - z(:,3) = [3 6 9]
    ??? Error

MATLAB Basics: Special Values

- pi: π value up to 15 significant digits
- i, j: sqrt(-1)
- Inf: infinity (such as division by 0)
- NaN: Not-a-Number (such as division of zero by zero)
- clock: current date and time as a vector
- date: current date as a string (e.g. 16-Feb-2004)
- eps: epsilon
- ans: default variable for answers

MATLAB Basics: Displaying Data

- Changing the data format
  - value = 12.345678901234567

format	short	$\rightarrow$ 12.3457
	long	$\rightarrow$ 12.34567890123457
	short e	$\rightarrow$ 1.2346e+001
	long e	$\rightarrow$ 1.234567890123457e+001
	rat	$\rightarrow$ 1000/81
	compact	
	loose	

MATLAB Basics: Displaying Data

- The disp(*array*) function
  - disp('Hello');
    Hello
  - disp(5);
    5
  - disp(['Bilkent ' 'University']);
    Bilkent University
  - name = 'Selim'; disp(['Hello ' name]);
    Hello Selim

MATLAB Basics: Displaying Data

- The num2str() and int2str() functions
  - d = [num2str(16) '-Feb-' num2str(2004)];
  - disp(d);
    16-Feb-2004
  - x = 23.11;
  - disp(['answer = ' num2str(x)]);
    answer = 23.11
  - disp(['answer = ' int2str(x)]);
    answer = 23

MATLAB Basics: Displaying Data

- The fprintf(*format, data*) function
  - %d   integer
  - %f   floating point format
  - %e   exponential format
  - \n   new line character
  - \t   tab character

MATLAB Basics: Displaying Data

- fprintf('Result is %d', 3);
  Result is 3
- fprintf('Area of a circle with radius %d is %f', 3, pi*3^2);
  Area of a circle with radius 3 is 28.274334
- x = 5;
- fprintf('x = %3d', x);
  x =   5
- x = pi;
- fprintf('x = %0.2f', x);
  x = 3.14
- fprintf('x = %6.2f', x);
  x =   3.14
- fprintf('x = %d\ny = %d\n', 3, 13);
  x = 3
  y = 13

MATLAB Basics: Scalar Operations

- *variable_name = expression*;
  - addition   a + b   →   a + b
  - subtraction   a - b   →   a - b
  - multiplication a x b   →   a * b
  - division   a / b   →   a / b
  - exponent   a^b →   a ^ b

MATLAB Basics: Scalar Operations

- x = 3 * 2 + 6 / 2
  - x = ?
- Processing order of operations is important
  - parenthesis (starting from the innermost)
  - exponentials (left to right)
  - multiplications and divisions (left to right)
  - additions and subtractions (left to right)
- x = 3 * 2 + 6 / 2
  - x = 9

MATLAB Basics: Built-in Functions

- *result = function_name(input)*;
  - abs, sign
  - log, log10, log2
  - exp
  - sqrt
  - sin, cos, tan
  - asin, acos, atan
  - max, min
  - round, floor, ceil, fix
  - mod, rem
- help elfun

MATLAB Basics: Debugging

- Syntax errors
  - Check spelling and punctuation
- Run-time errors
  - Check input data
  - Can remove ";" or add "disp" statements
- Logical errors
  - Use shorter statements
  - Check typos
  - Check units
  - Ask your friends, TAs, instructor, parents, ...

MATLAB Basics: Useful Commands

- help *command*   → Online help
- lookfor *keyword*   → Lists related commands
- which   → Version and location info
- clear   → Clears the workspace
- clc   → Clears the command window
- diary *filename*   → Sends output to file
- diary on/off   → Turns diary on/off
- who, whos   → Lists content of the workspace
- more on/off   → Enables/disables paged output
- Ctrl+c   → Aborts operation
- ...   → Continuation
- %   → Comments