

Lecture 2

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Variables in m-file Environments

- A variable is a named storage location that can be set for a particular value which can be used in subsequent computations
- For example, we can store a value 12 in the variable `x` with the statement `x = 12`. This value remains in `x` until we store a different value (e.g., typing the command `x = 200`) or we clear `x` using the command `clear x`

Examples

- E.g.1

Suppose we wish to compute the circumference of a circle of diameter 6 units using the formula $C = \pi d$. We could first of all set the variable d to 6, and so on.

Variables

- Variable names must begin with an upper –or– lower- case letter. They may contain letters, digits, and underscores; they may not contain spaces or punctuation characters
- Variable names are case sensitive. E.g., **A** and **a** are different variables
- Variables can contain several types of numerical values, namely:

Variables cont'

- Scalar - single value
- Vector – ordered series of numbers
- Matrices – a rectangular array of numbers
- Strings – Variables may contain string characters

Basics of files

- To save the expressions entered in the command window,
 - Click on file drop down menu
 - Select save workspace As...
 - Type in a file name
 - Click on save button

This method creates a MATLAB file which has a .MAT file extension in windows

Basics of files cont'

- There are at times when long sequences of operations can be typed and stored in a file so as to execute with a single command in the command window
- This is done by creating a script file known as MATLAB program and is saved in a file format with a .m extension. This makes to be called m-files.

Example

- Create a script file that will compute e^x for a few values of x .

Solution

Open the MATLAB editor.

% script file example1.m to compute
%exponential of a set of numbers

```
x = [1:2:3:4];
```

```
y = exp(x)
```

Basics of files cont'

- We can use m-files to create and store data.

For e.g.,

Examscore = [64, 28, 18, 32, 16]

We will store this as score.m

We can then use this data by doing some manipulation e.g.,

>> score

SeventyPercent = 0.7*Examscores

Assignment 1

1. Use MATLAB to compute the sine of $\frac{\pi}{3}$ expressed as a rational number.
2. Create a MATLAB m-file to display the results of $\sin\left(\frac{\pi}{4}\right)$, $\sin\left(\frac{\pi}{3}\right)$ and $\sin\left(\frac{\pi}{2}\right)$ as rational numbers.

Vectors

- MATLAB is exceptionally capable of handling array of numbers.
- A vector is a one dimensional array of numbers. With MATLAB, one can create column and row vectors

Column Vectors

- A column vector can be created by enclosing a set of semicolon delimited numbers in square brackets.

Example:

```
>> a = [3; 6; 2]
```

```
a =
```

```
3
```

```
6
```

```
2
```

Column Vectors cont'

- Basic operations on column vectors can be executed by referencing the variable name used to create them

Scalar Multiplication

Given that `>>a = [3; 6; 2];`

`>> b = 3`

`>> c = 3 * a`

Row Vectors

- A row vector can be created by enclosing a set of numbers in square brackets by using space or comma to delimit the numbers.
- E.g., `>> V = [6, 8, -2]` or `V = [6 8 -2]`

Transpose Operation

- Column vectors can be turned into row vectors and vice versa

Definition:

Suppose that we have a column vector with n elements denoted by

$$V = \begin{pmatrix} v_1 \\ v_2 \\ \cdot \\ \cdot \\ \cdot \\ v_n \end{pmatrix}$$

Then the transpose is given by

$$v^T = [v_1 \quad v_2 \quad \cdot \quad \cdot \quad \cdot \quad v_n]$$

Transpose Operation cont'

- In MATLAB, we represent the transpose operation with a single quote. Taking the transpose of a column vector produces a row vector

```
>> a = [2; 6; 7];
```

```
>> y = a'
```

Exercise

- Transpose a row vector to produce a column vector

```
>> Q = [12, 6, 5];
```

```
>> A = Q'
```

```
A =
```

```
12
```

```
6
```

```
5
```

Addition and Subtraction of Vectors

- In order to perform this operation, the vectors must both be of the same type and the same length, so we can add two column vectors to produce a new column vector or add two row vectors to produce a new row vector

Example 1

```
>> A = [1; 4; 5];
```

```
>> B = [2; 3; 3];
```

```
>> C = A + B
```

```
    C =
```

```
     3
```

```
     7
```

```
     8
```

Example 2

```
>> M = [2, 4, 7];
```

```
>> N = [1, 2, 5];
```

```
>> O = M - N
```

```
    O =
```

```
    1  2  2
```

Creating large Vectors from Existing Variables

- In MATLAB, we can append vectors together to create new ones.
- Let **u** and **v** be two column vectors with *m* and *n* elements respectively that have been created in MATLAB.
- A third vector **w** whose first elements are the elements of **u** and next *n* elements are the elements of **v**.
- This makes the newly created column vector to have $(m + n)$ elements

Syntax

- This is done by writing

$w = [u ; v]$

Example 1:

>> A = [2; 4 ;6];

>> B = [6; 8; 5];

>> C = [A;B]

C =

2

4

6

6

8

5

- Example 2

The same can be done using row vectors

$$P = [\quad];$$

$$Q = [\quad];$$

$$R = [\quad]$$

$$R =$$

.....

Creating Vectors with uniform spaced elements

- To create a vector $\mathbf{x}$ with uniformly spaced elements, where x_i is the first element and x_n is the final element. The increment is q ($q \in \mathbb{R}$)

Syntax:

$$x = [x_i : q : x_n]$$

Example 1

- Create a list of even numbers from 0 to 10

Solution

```
>> x = [0 : 2 : 10]
```

```
x =
```

```
0 2 4 6 8 10
```

Example 2

1. What is the output of $A = [0 : 0.1 : 1]$
2. Create a list of numbers from 100 to 80 decreasing by 5

Characterizing a vector

- The length command returns the number of elements that a vector contains.

Example 1

```
>> A = [2 ; 3 ; 3 ; 4 ; 5];
```

```
>> length (A)
```

```
ans =
```

```
5
```

Characterizing a vector

- Example 2

```
>> B = [2; 4; 6];
```

```
>> length (B)
```

```
ans =
```

```
3
```

Characterizing a vector

- We can also find the largest and smallest elements in a vector using **max** and **min** commands

Example

```
>> A = [6 8 9 12 13 6 3 2];
```

```
>> max (A)
```

```
.....
```

```
>> min (A)
```

Vector Dot and Cross Product

Definition

- The dot product of two vectors $A = (a_1, a_2, \dots, a_n)$ and $B = (b_1, b_2, \dots, b_n)$ is given by

$$A \cdot B = \sum_i^n a_i b_i$$

In MATLAB, the dot product of two vectors **a** and **b** can be calculated by using the **dot(a,b)** command

Dot Product

- Example1

```
>> a = [2, 3, 4];
```

```
>> b = [2, 6, 3];
```

```
>> c = dot(a,b)
```

c =

34

Cross Product

Example

```
>> A = [1, 2, 3];
```

```
>> B = [2, 3, 4];
```

```
>> C = cross(A, B)
```

```
    C =
```

Referencing Vector Components

- We can reference one or more components of a vector.
- The i th component of a vector can be referenced by writing $v(i)$. E.g.,

```
>> A = [12; 8; 6; 0; 4; 6; 13; 28];
```

```
>> A(3)
```

```
ans =
```

```
6
```

Referencing Vector Components

- Referencing the vector with a colon, lists all the elements of the vector. E.g.,

$A (:)$

To reference some components in a vector. E.g

$v = A (2: 3)$

Assignment 2

1. (a) Given that the vector $\mathbf{a} = [a_1; a_2; \dots a_n]$,
Demonstrate in two different ways how the magnitude of $\mathbf{a}$ is computed in MATLAB
(b) Hence, find the magnitude of a vector $\mathbf{a} = [2; 5; 7; 8]$
2. Using the colon operator and the transpose operator, create a column vector that has the value -1 to 1 in steps of 2

Assignment 2

3. Using the linspace function, create the following vectors:

(i) 4 6 8

(ii) -3 -6 -9 -12 -15

(iii) 9 7 5