Al-Mustaqbal University College
Department of Medical Instrumentation Techniques Engineering
Class: Third
Subject: Arrays, Built in functions, Basic Matrix Functions
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Lecture: (5)

Arrays

Scalars: Variables that represent single numbers, as considered to this point.

Arrays: Variables that represent more than one number. Each number is called an element of the array.

Row and Column Arrays: A row of numbers (called a row vector) or a column of numbers (called a column vector).

Two-Dimensional Arrays: A two-dimensional table of numbers, called a matrix.

Array Indexing or Addressing: Indicates the location of an element in the array.

EX1: consider computing, y = sin(x) for $0 \le x \le \pi$.

x	0	$0.1\ \pi$	$0.2\ \pi$	$0.3\ \pi$	$0.4\ \pi$	$0.5\ \pi$	$0.6\ \pi$	$0.7\ \pi$	$0.8\ \pi$	$0.9\ \pi$	π
y	0	.31	.59	.81	.95	1.0	.95	.81	.59	.31	0

EX2: Generate two vectors, x and y, then display the values such that x(1) and y(1) are on the same line,

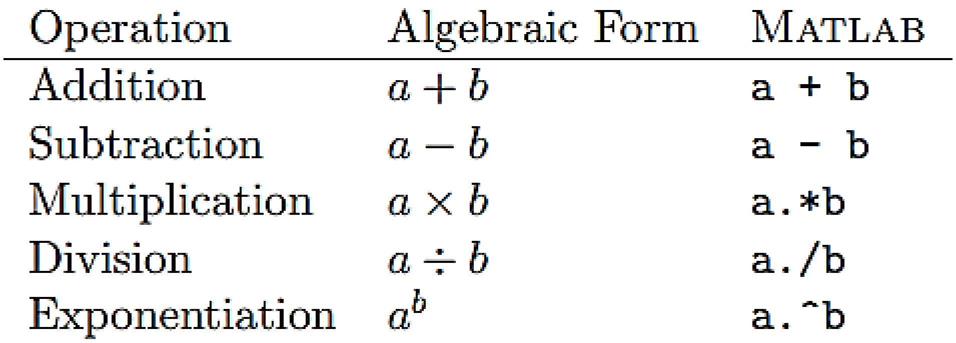
```
>> x = 0:4;
>> y = 5:5:25;
>> A = [x'  y']
A =
     0    5
     1   10
     2   15
     3   20
     4   25
```

Note that the matrix A has been created from the vectors x and y.

Array Operations

Element-by-Element Array-Array Mathematics

When two arrays have the same dimensions, addition, subtraction, multiplication, and division apply on an element-by-element basis.



Operation	Algebraic Form	MATLAB
Addition	$a+b$	`a + b`
Subtraction	$a-b$	`a - b`
Multiplication	$a \times b$	`a.*b`
Division	$a \div b$	`a./b`
Exponentiation	a^b	`a.^b`

Example:

```
>> A = [2   5   6];
>> B = [2   3   5];
>> C = A.*B
C =
     4    15     30

>> D = A./B

D =

     1.0000       1.6667       1.2000

>> E = A.^B

E =

         4             125             7776
```

Built-in function

A built-in function is part of the MATLAB executable. MATLAB does not implement these functions in the MATLAB language. Although most built-in functions have a .m file associated with them, this file only supplies documentation for the function.

MATLAB includes many built-in functions for math operations. Here are a number of the most important ones.

For these functions, you are specifying input arguments (i.e. 5 is the input argument in the example).

- sqrt(5) % square root of 5
- sin(pi) % sine of pi radians
- cos(pi/2) % cosine of pi/2
- asin(1) % arcsine of 1
- sind(75) % sine of 75 degrees
- abs(-5) % absolute value of -5
- log(5) % natural logarithm (base e) of 5
- log10(5) % logarithm (base 10) of 5
- exp(5) % e^5

If multiple arguments, separate them by commas, as in the example:

- round(5,3) % round 5.3 (.5 or greater rounds up)
- fix(5,3) % round towards 0
- floor(5,3) % round towards -inf

- ceil(5,3) % round towards +inf
- rem(15,2) % remainder of 15/2
- mod(15,2) % similar to rem % but can give negative (congruent) answers
- sign(x) % 1 for x>0, 0 for x=0, -1 for x<0

Basic Matrix Functions

MATLAB software provides functions that implement basic statistics. These are:

Function	**Description**	**Function**	**Description**
sum(x)	The sum of the elements of x matrix	Length(x)	Length of largest array dimension
max(x)	Find the largest element in a matrix	Size(x)	returns the sizes of each dimension of array
min(x)	Find the smallest element in a matrix	Sort(x)	Sort array elements
mean(x)	Find the average of the elements of matrix	prod(x)	Product of array elements
median(x)	Find the median value of the elements of matrix	Transpose(x)	Transpose array
diag(x)	Create diagonal matrix or get diagonal elements of matrix	Find(x)	Find indices and values of nonzero elements

Examples

```
>> A=[5 7 9; 4 6 5; 1 9 8]
>> sum(A)    %Create a matrix and compute the sum of the elements in each column.
ans =
       10    22    22
>> sum(A,2)    % Create a matrix and compute the sum of the elements in each row.
ans =
       21
       15
       18
>> max(A)    % find the row vector containing the maximum value of each column.
ans =
      5    9    9

>> max(A,[],2)    % compute the largest element in each row.

ans =
      9
      6
      9

>> min(A)    %find a row vector containing the minimum value of each column.

ans =

      1    6    5

>> min(A,[],2)    % compute the smallest element in each row.

ans =

       5

       4

       1
```

```
>> mean(A)     % compute the mean of each column.
ans =
   3.3333 7.3333   7.3333
>> mean(A,2)     % compute the mean of each row.
ans =
          7
          5
          6
>> median(A)    % Find the median value of each column.
ans =
       4     7     8
>> median(A,2)     % Find the median value of each row.
ans =
          7
          5
          8
>> p=prod(A)
p =
     20     378     360
>> p=prod(A,2)
p =
      315
      120
      72
```

```
>> v = [2 1 -1 -2 -5];
>> D = diag(v)    % create a matrix with the elements of v on the main diagonal.
D =
     2    0    0    0    0
     0    1    0    0    0
     0    0   -1    0    0
     0    0    0   -2    0
     0    0    0    0   -5
>> X = diag(A)     % Get the elements on the main diagonal of a random 3-by-3 matrix.
X =
     5
     6
     8
>>L= length(A)
L=
      3
>> [m,n]=size(A)   % return the number of rows (m) and columns (n)
m = 3
n = 3
>> S=sort(A,2)    % Create a matrix and sort each of its rows in ascending order.
S =
     5    7    9
     4    5    6
     1    8    9
```

```
>> T=transpose(A)     % T has the same elements as A, but the rows of T are the columns
                      of A and the columns of T are the rows of A.

T =

     5     4     1

     7     6     9

     9     5     8
```

Find function

If X is a vector, then find returns a vector with the same orientation as X.

If X is a multidimensional array, then find returns a column vector of the linear indices of the result.

```
>> k = find(A>5)      % Find indices of values greater than 5.
```

$$\begin{bmatrix} 5 & 7 & 9 \\ 4 & 6 & 5 \\ 1 & 9 & 8 \end{bmatrix} \rightarrow \begin{bmatrix} 0 & 1 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix}$$

matrix A   A>5   locations

```
k =

    4

    5

    6

    7

    9
```

```
>> [ row , col ] = find(A>5)        % Find indices of values greater than 5.
```

$$\begin{bmatrix} 0 & 1 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 1 & 1 \\ 2 & 2 & 2 \\ 3 & 3 & 3 \end{bmatrix} \qquad \begin{bmatrix} 0 & 1 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 2 & 3 \\ 1 & 2 & 3 \\ 1 & 2 & 3 \end{bmatrix}$$

A>5 row location A>5 col location

```
row =

    1

    2

    3

    1

    3

col =

    2

    2

    2

    3

    3
```