

ENME 303 LAB

Week 5: Vectors & Matrices I

Nameless Lab

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- I. Defining Vectors and Matrices
- II. Vector Dot Product
- III. Vector Cross Product
- IV. Vector Magnitude
- V. Vector Normalization
- VI. `rref()`
- VII. $A \setminus B$

I. Defining Vectors and Matrices

Matlab shines in the domain of performing linear algebra.

Vectors and matrices provide the data that linear algebra routines use in calculations

Row Vector

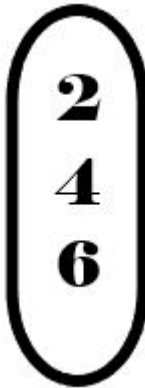
1 row



3 columns

Column Vector

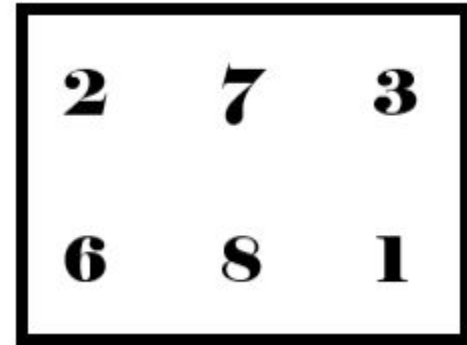
3 rows



1 column

2x3 Matrix

2 rows



3 columns

I. Defining Vectors and Matrices

More on defining vectors:

Defining vectors using a range:

%In this case, row vector 2 is the range from 11 to 15

```
rvec2 = [11:15];
```

```
fprintf('This is row vector 2, which ranges from 11 to 15: \n')
```

```
disp(rvec2)
```

This is row vector 2, which ranges from 11 to 15:

11 12 13 14 15

I. Defining Vectors and Matrices

More on defining matrices:

Defining matrices using ranges:

```
%Define matrix using ranges
```

```
mat2=[31:33;34:36];
```

```
fprintf('This is 2x3 matrix, defined using ranges: \n')
```

```
disp(mat2)
```

This is 2x3 matrix, defined using ranges:

```
31  32  33  
34  35  36
```

I. Defining Vectors and Matrices

More on defining matrices:

Checking the size of your matrix:

%To discover the size of your matrix, i.e dimensions i.e # of rows and cols

```
mat2size=size(mat2)
```

```
fprintf('This tells you the size of Mat2, 2 rows and 3 columns: \n')
```

```
disp(mat2size)
```

This tells you the size of Mat2, 2 rows and 3 columns:

2 3

II. Vector Dot Product

Remember, by hand the dot product of two vectors is a **scalar**

If $\bar{a} = \langle a_1, a_2, a_3 \rangle$ and $\bar{b} = \langle b_1, b_2, b_3 \rangle$
then the dot product is

$$\bar{a} \cdot \bar{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$$

In Matlab we can the [built-in function](#):

`dot (A, B)`

Which returns a scalar dot product of A and B, where A and B are the same size vectors

II. Vector Dot Product

Let's check it out in Matlab:

```
A=[3 5 8 9];
```

```
B=[5 2 1 7];
```

```
dotproduct=dot(A,B);
```

```
fprintf('The dot product of A and B is: %d \n', dotproduct)
```

The dot product of A and B is: 96

III. Vector Cross Product

Recall, the cross product of two vectors is another **vector** \perp to **A** and **B** vectors

Vector Cross Product Formula

$$\vec{A} \times \vec{B} = |\vec{a}| |\vec{b}| \sin\theta \hat{n}$$

$$\vec{A} \times \vec{B} = i (a_2 b_3 - a_3 b_2) + j (a_1 b_3 - a_3 b_1) + k (a_1 b_2 - a_2 b_1)$$

In Matlab we can use the [built-in function](#):

`cross(A, B)`

Which returns a vector cross product of A and B, where A and B are the same size vectors

III. Vector Cross Product

Lets try this in Matlab:

```
%Vectors A and B must be length of 3
```

```
%Vectors A and B must have the same size
```

```
A=[2 2 7];
```

```
B=[8 3 6];
```

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

```
fprintf('The cross product of vectors A and B is vector C:\n')
```

```
disp(C)
```

The cross product of vectors A and B is vector C:
-9 44 -10

IV. Vector Magnitude

The magnitude of a vector is a **scalar quantity**, calculated as:

$$\text{2D: } |\mathbf{v}| = \sqrt{x^2 + y^2}$$

$$\text{3D: } |\mathbf{v}| = \sqrt{x^2 + y^2 + z^2}$$

In Matlab we can use the [built-in function](#):

`norm(v)`

Which returns the magnitude of vector v

IV. Vector Magnitude

In Matlab this looks like:

```
v= [1 4 -3 6];
```

```
mag= norm(v);
```

```
fprintf('The magnitude of vector v is: %g \n', mag)
```

The magnitude of vector v is: 7.87401

V. Vector Normalization

Otherwise known as transforming any vector into a **unit vector**

To find a unit vector, **\vec{u}** , in the same direction of a vector, **\vec{v}** , we divide the vector by its magnitude.

$$\vec{u} = \frac{\vec{v}}{\|\vec{v}\|} = \frac{1}{\|\vec{v}\|} \vec{v}$$

V. Vector Normalization

Using the equation for finding a unit vector and Matlab's norm function, we can write the following script:

```
v=[4 5 5];  
  
v_mag=norm(v);  
  
unit_v = v/v_mag;  
  
fprintf('The unit vector for v is:\n')  
  
disp(unit_v)
```

$$\vec{u} = \frac{\vec{v}}{\|\vec{v}\|} = \frac{1}{\|\vec{v}\|} \vec{v}$$

The unit vector for v is:

0.4924 0.6155 0.6155

VI. `rref()`

Getting reduced row echelon form of a matrix using Matlab using [built-in](#) `rref()`

```
matrix= [8 1 6; 3 5 7; 4 9 2]
matrix =
      8      1      6
      3      5      7
      4      9      2

RRE= rref(matrix);

fprintf('The reduced row echelon for the matrix is:\n')

disp(RRE)
```

The reduced row echelon for the matrix is:

```
1  0  0
0  1  0
0  0  1
```

VII. $A \setminus b$

$x = A \setminus b$ solves the system of linear equations $Ax = b$

Matrices A and b must have the same # of rows to utilize the backslash command

- If A is scalar, use $A \setminus b$
- If A is square n -by- n matrix and b is matrix with n rows, use $A \setminus b$
- If A is m -by- n matrix where $m \sim n$ and b is a matrix of m rows, $A \setminus b$ returns a least-squares solution
- **Note:** $A \setminus b$ will ALWAYS give a solution, even if the system is inconsistent
 - it will be an approximate solution

VII. $A \setminus b$

%Solve a simple system of linear equations $A \cdot x = b$

```
A = [8 1 6; 3 5 7; 4 9 2]
```

A =

8	1	6
3	5	7
4	9	2

b =

15
15
15

```
b = [15; 15; 15;]
```

```
X = A\b;
```

```
fprintf('The solution for x is:\n')
```

```
disp(x)
```

The solution for x is:

1.0000
1.0000
1.0000

Acknowledgement

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