MATLAB: Matrix Calculations

1. Basic matrix operations
2. In-class exercise

MATLAB: Matrix Calculations

Basic Matrix Operations

Creating Vectors and Matrices

```
>> x = [1 2 3 4]

x =

     1     2     3     4

>> x = [1; 2; 3; 4]

x =

     1
     2
     3
     4
```

```
>> A = [1 2 3; 4 5 6]

A =

     1     2     3
     4     5     6

>> A = [1 2; 3 4; 5 6]

A =

     1     2
     3     4
     5     6
```

Common Vectors and Matrices

```
>> x = ones(3,1)
x =
     1
     1
     1
>> x = ones(1,3)
x =
     1     1     1
>> z = zeros(3,1)
z =
     0
     0
     0
>> z = zeros(1,3)
z =
     0     0     0
```

```
>> A = ones(2,3)
A =
     1     1     1
     1     1     1
>> A = zeros(2,3)
A =
     0     0     0
     0     0     0
>> A = eye(3)
A =
     1     0     0
     0     1     0
     0     0     1
```

Simple Vector and Matrix Operations

```
>> x = [1 2 3]
x =
    1    2    3
>> xT = x'
xT =
    1
    2
    3
>> A = [1 2; 3 4]
A =
    1    2
    3    4
>> AT = A'
AT =
    1    3
    2    4
>> A = [1 2 3; 4 5 6]
A =
    1    2    3
    4    5    6
>> B = [7 8 9; 10 11 12]
B =
    7    8    9
   10   11   12
>> C = A+B
C =
    8   10   12
   14   16   18
>> C = A-B
C =
   -6   -6   -6
   -6   -6   -6
```

Simple Vector and Matrix Operations

```
>> A = [1 2; 3 4; 5 6]
A =
     1     2
     3     4
     5     6
>> B = [7 8 9; 10 11 12]
B =
     7     8     9
    10    11    12
>> C = A*B
C =
    27    30    33
    61    68    75
    95   106   117
```

```
>> B = [7 8; 9 10; 11 12]
B =
     7     8
     9    10
    11    12
>> C = A*B
??? Error using ==> mtimes
Inner matrix dimensions
must agree.
>> size(A)
ans =
     3     2
>> size(B)
ans =
     3     2
```

Simple Vector and Matrix Operations

```
>> A = [1 2; 3 4; 5 6]
A =
     1     2
     3     4
     5     6
>> B = [7 8; 9 10; 11 12]
B =
     7     8
     9    10
    11    12
>> C = A.*B
C =
     7    16
    27    40
    55    72
```

```
>> x = [1 2 3 4]
x =
     1     2     3     4
>> y = 2*x
y =
     2     4     6     8
>> A = [1 2 3; 4 5 6]
A =
     1     2     3
     4     5     6
>> C = 2*A
C =
     2     4     6
     8    10    12
```

Matrix Rank

- rank(A) provides an estimate of the number of linearly independent rows or columns of a matrix A

```
>> A = [1 2 3; 2 -3 1; 4 1 8]

A =

     1     2     3
     2    -3     1
     4     1     8

>> rank(A)

ans =

     3
```

Matrix Rank

```
>> A = [1 2 3; 2 -3 1; 4 1 7]
A =
    1    2    3
    2   -3    1
    4    1    7
>> rank(A)
ans =
    2
>> A(1,:)
ans =
    1    2    3
>> 2*A(1,:)+A(2,:)-A(3,:)
ans =
    0    0    0
```

```
>> A = hilb(3)
A =
    1.0000    0.5000    0.3333
    0.5000    0.3333    0.2500
    0.3333    0.2500    0.2000
>> rank(A)
ans =
     3
>> A = hilb(10);
>> rank(A)
ans =
    10
>> A = hilb(15);
>> rank(A)
ans =
    12
```

Gauss Elimination

$$\begin{bmatrix} 3 & -2 & 2 \\ -5 & 4 & -3 \\ -4 & 3 & -2 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -1 \\ 3 \\ 1 \end{bmatrix} \quad \Rightarrow \quad \tilde{\mathbf{A}} = \begin{bmatrix} 3 & -2 & 2 & -1 \\ -5 & 4 & -3 & 3 \\ -4 & 3 & -2 & 1 \end{bmatrix}$$

```
>> A = [3 -2 2; -5 4 -3; -4 3 -2]
A =
     3    -2     2
    -5     4    -3
    -4     3    -2
>> b = [-1 3 1]'
b =
    -1
     3
     1
```

```
>> A1 = [A b]
A1 =
     3    -2     2    -1
    -5     4    -3     3
    -4     3    -2     1
```

Gauss Elimination

```
>> A2 = [A1(1,:); 5/3*A1(1,:)+A1(2,:); 4/3*A1(1,:)+A1(3,:)]
A2 =
    3.0000   -2.0000    2.0000   -1.0000
         0    0.6667    0.3333    1.3333
         0    0.3333    0.6667   -0.3333
>> A3 = [A2(1,:); A2(2,:); -1/2*A2(2,:)+A2(3,:)]
A3 =
    3.0000   -2.0000    2.0000   -1.0000
         0    0.6667    0.3333    1.3333
         0    0.0000    0.5000   -1.0000
```

Gauss Elimination

```
>> x3 = A3(3,4)/A3(3,3)
x3 =
   -2.0000
>> x2 = (A3(2,4)-A3(2,3)*x3)/A3(2,2)
x2 =
    3.0000
>> x1 = (A3(1,4)-A3(1,2)*x2-A3(1,3)*x3)/A3(1,1)
x1 =
    3.0000
>> x = [x1 x2 x3]'
x =
    3.0000
    3.0000
   -2.0000
```

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In-class Exercise