MATLAB Tutorial 07

ENME 303 Computational Methods for Engineers

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Useful Functions

- d = det(A)
  - Returns the determinant of square matrix A.
- Y = inv(X)
  - Computes the inverse of square matrix X.
  - X^(-1) is equivalent to inv(X).
  - x = A\b is computed differently than x = inv(A)*b and is recommended for solving systems of linear equations.
- k = rank(A)
  - Returns the rank of matrix A. The rank of a matrix is equal to the number of linearly independent rows/columns in it.
- R = rref(A)
  - Returns the reduced row echelon form of A using Gauss-Jordan elimination
- b = trace(A)
  - Calculates the sum of the diagonal elements of matrix A.

Useful Functions

- n = norm(v)
  - Returns the Euclidean norm of vector v. This norm is also called the 2-norm, vector magnitude, or Euclidean length.
- n = norm(v, p)
  - Returns the generalized vector p-norm.
- [V,D] = eig(A)
  - Returns diagonal matrix D of eigenvalues and matrix V whose columns are the corresponding right eigenvectors, so that A*V = V*D.
- tf = issymmetric(A)
  - Returns logical 1 (true) if A is a symmetric matrix. Otherwise, it returns logical 0 (false).
  - tf = issymmetric(A, skewOption) specifies the type of the test. Specify skewOption as "skew" to determine if A is skew-symmetric.
- B = transpose(A)
  - Returns the nonconjugate transpose of A and is an alternate way to execute A.’.

Example 1

- Consider Matrix A:

$$A = \begin{bmatrix} 1 & 2 & -2 \\ 2 & 3 & 1 \\ 3 & 0 & -1 \end{bmatrix}$$

- Find the transpose?
- Is this matrix symmetric?
- Find the determinant?
- Is this Matrix invertible (non-singular?)
- If it is invertible find the inverse?
- Find the Reduced Row Echelon form?
- What is the rank?
- Is this matrix full rank?

Example 2

- Consider Matrix $Sandwich^*$:

$$Sandwich = \begin{bmatrix} 9 & 5 & 24 \\ 7 & 8 & 31 \\ 9 & 4 & 21 \end{bmatrix}$$

- Find the transpose?
- Is this matrix symmetric?
- Find the determinant?
- Is this Matrix invertible (non-singular?)
- If it is invertible find the inverse?
- Find the Reduced Row Echelon form?
- What is the rank?
- Is this matrix full rank?

* Chosen by Ethan (comments on matrix nomenclature: ethbow1@umbc.edu)

Create Symbolic Variables Using “sym” Function

- Create Symbolic variables:

```
x = sym('x')
```

```
x = x
```

- Create Symbolic Vectors:

```
a = sym('a',[1 4])
```

```
a =

[a1, a2, a3, a4]
```

- Create Symbolic Matrices:

```
A = sym('A',[3 4])
```

```
A =

[A1_1, A1_2, A1_3, A1_4]
[A2_1, A2_2, A2_3, A2_4]
[A3_1, A3_2, A3_3, A3_4]
```

- Create Symbolic Numbers:

```
accurate1 = 1/sym(1234567)
```

```
accurate1 =
      1
---------
1234567
```

Create Symbolic Variables Using “syms” Function

- Create Symbolic variables:

```
syms x y
x
```

$$x = x$$

```
y
```

$$y = y$$

- Create Symbolic Vectors:

```
>> syms a b [1 4]
>> a

a =

[a1, a2, a3, a4]

>> b

b =

[b1, b2, b3, b4]
```

- Create Symbolic Matrices:

```
>> syms A B [3 4]
>> A

A =

[A1_1, A1_2, A1_3, A1_4]
[A2_1, A2_2, A2_3, A2_4]
[A3_1, A3_2, A3_3, A3_4]

>> B

B =

[B1_1, B1_2, B1_3, B1_4]
[B2_1, B2_2, B2_3, B2_4]
[B3_1, B3_2, B3_3, B3_4]
```

- Create Symbolic Expressions:

```
>> syms a b c x
>> f = a*x^2 + b*x + c

f =

a*x^2 + b*x + c
```

Create and Evaluate Symbolic Functions

```
1   clc; clear
2
3   syms f(x,y) g(z)
4
5
6   f(x,y) = x/y;
7   f(1,5)
8
9   g(z) = z^2 + 2*z + 5;
10  g(2)
11
12
```

Command Window

```
ans =

1/5


ans =

13
```

```
1   clc; clear
2
3   syms x y z
4
5
6   f(x,y) = x/y;
7   f(1,5)
8
9   g(z) = z^2 + 2*z + 5;
10  g(2)
11
12
```

Command Window

```
ans =

1/5


ans =

13
```

Useful Functions for Symbolic Expressions

- **expand**
  - Expand expressions

```
1   clc; clear
2   syms x a
3
4   f = (x-a)^3;
5   expand(f)
```

```
ans =

- a^3 + 3*a^2*x - 3*a*x^2 + x^3
```

- **factor**
  - changes an expression that is a polynomial to a product of polynomials of a lower degree.

```
7   f2 = x^3 + 4*x^2 - 11*x - 30;
8   factor(f2)
9
```

```
ans =

[x + 5, x - 3, x + 2]
```

- **simplify**
  - Algebraic simplification

```
10  f3 = -2*tan(x)/(tan(x)^2 -1);
11  simplify(f3)
12
```

```
ans =

tan(2*x)
```

- **collect**
  - collects the terms in the expression that have the variable with the same power.

```
13  f4 = (x + x^2)*(x^3 +1)*x;
14  collect(f4)
```

```
ans =

x^6 + x^5 + x^3 + x^2
```

“subs” and “double” Functions

- **subs**:
  - snew = subs(s,old,new) returns a copy of s, replacing all occurrences of old with new, and then evaluates s.

```
1   clc; clear
2
3   syms x y
4
5   f1 = (x + x^2)*(x^3 +1)*x;
6   subs(f1,x,2)
7
8   f2 = x/y;
9   subs(f2,[x,y],[1,5])
```

```
Command Window

ans =

108


ans =

1/5
```

- **double**:
  - d = double(s) converts the symbolic values s to double precision.

```
1   clc; clear
2
3   syms x y
4
5   f1 = (x + x/4)*(x^3 +1)*x/4 + sin(x);
6   f1_assigned = subs(f1,x,pi/2);
7   f1_double = double(f1_assigned)
8
9   f2 = x/y;
10  f2_assigned = subs(f2,[x,y],[1,5]);
11  f2_double = double(f2_assigned)
```

```
ommand Window

f1_double =

    4.7595


f2_double =

    0.2000
```

Solving Equations and System of Equations

```
1   clc; clear
2
3   syms a b c x
4   eqn = a*x^2 + b*x + c == 0;
5   S = solve(eqn)
```

Command Window

```
S =

-(b + (b^2 - 4*a*c)^(1/2))/(2*a)
-(b - (b^2 - 4*a*c)^(1/2))/(2*a)
```

```
1   clc; clear
2   syms u v
3
4   eqns = [2*u + v == 0, u - v == 1];
5   S = solve(eqns,[u v])
```

Command Window

```
S =

  struct with fields:

    u: 1/3
    v: -2/3
```

Differentiation and Integration

```
1   clc; clear
2
3   syms x
4   expr1 = -2*x/(1+x^2)^2;
5
6   F1 = int(expr1)
7
8   expr2 = x*log(1+x);
9   F2 = int(expr2,[0 1])
```

```
mmand Window

F1 =

1/(x^2 + 1)


F2 =

1/4
```

```
1   clc; clear
2
3   syms x t
4
5   expr1 = (1-4*x)^3;
6   diff(expr1)
7   diff(expr1,2)
8
9   expr2 = (sin(t)-4*x)^3;
0   diff(expr2,t)
```

```
mmand Window
ans =

-12*(4*x - 1)^2


ans =

96 - 384*x


ans =

3*cos(t)*(4*x - sin(t))^2
```

Thanks!