



NAVI MUMBAI

MATLAB

Unit 3-Lecture 8

BTech (CSBS) -Semester VII

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Solving Linear Equation

Solve System of Linear Equations Using linsolve:

A system of linear equations

$$a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n = b_1$$

$$a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n = b_2$$

...

$$a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n = b_m$$

can be represented as the matrix equation $A \cdot \vec{x} = \vec{b}$ where A is the coefficient matrix,



Solving Linear Equation...contd.

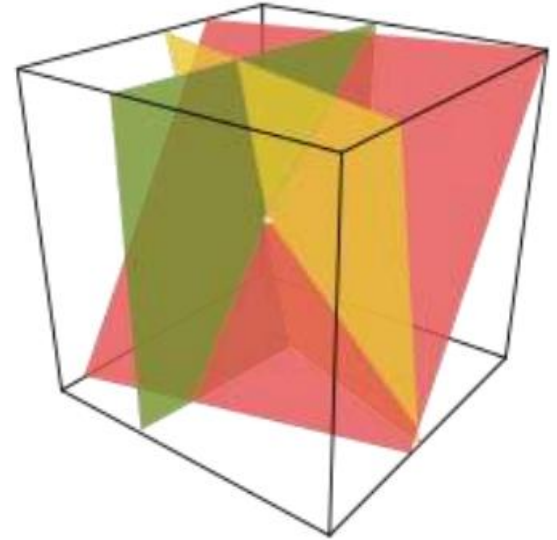
- Ex: Find values $x_1, x_2, x_3 \in \mathbb{R}$ that satisfy
 - $3x_1 + 2x_2 - x_3 - 1 = 0$
 - $2x_1 - 2x_2 + x_3 + 2 = 0$
 - $-x_1 - \frac{1}{2}x_2 - x_3 = 0$

Solution:

- Step 1: write the system of linear equations as a matrix equation

$$A = \begin{bmatrix} 3 & 2 & -1 \\ 2 & -2 & 1 \\ -1 & -\frac{1}{2} & -1 \end{bmatrix}, x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}, b = \begin{bmatrix} 1 \\ -2 \\ 0 \end{bmatrix}.$$

- Step 2: Solve for $Ax = b$





Example 1

```
>> A = [5 -3 2; -3 8 4; 2 4 -9]; % Enter matrix A
>> b = [10; 20; 9]; % Enter column vector b
>> x = A\b % Solve for x
x =
    3.4442
    3.1982
    1.1868

>> c = A*x
c =
    10.0000
    20.0000
     9.0000
```

The backslash (\) or the left division is used to solve a linear system of equations $[A]\{x\} = \{b\}$. For more information, type: help slash.
% check the solution



Question 1

- What's the A , x , and b for the following linear equations?
 - $2x_2 - 7 = 0$
 - $2x_1 - 3x_3 + 2 = 0$
 - $4x_2 + 2x_3 = 0$
 - $x_1 + 3x_3 = 0$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 2 & 0 & -3 \\ 0 & 4 & 2 \\ 1 & 0 & 3 \end{bmatrix}, x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}, b = \begin{bmatrix} 7 \\ -2 \\ 0 \\ 0 \end{bmatrix}.$$



Question

```
LinearEquation.m x +
1      syms x y z
2      eqn1= 5*x + y + 4*z == 12;
3      eqn2= -x + y - 2*z == 43;
4      eqn3= x - y + z == -10;
5      [A,B]=equationsToMatrix([eqn1,eqn2,eqn3], [x,y,z])
6      X=lin_solve(A,B)
```

Command Window

```
>> LinearEquation
```

```
A =
```

```
[ 5,  1,  4]
[-1,  1, -2]
[ 1, -1,  1]
```

```
B =
```

```
12
43
-10
```

```
X =
```

```
167/6
29/6
-33
```



Solve System of Linear Equations Using solve

Use **solve** instead of **linsolve** if you have the equations in the form of expressions and not a matrix of coefficients.

```
8 %-----using solve function-----
9 sol=solve([eqn1, eqn2, eqn3], [x,y,z])
10 xSol = sol.x
11 ySol = sol.y
12 zSol = sol.z
```

```
sol =
```

```
struct with fields:
```

```
x: 167/6
```

```
y: 29/6
```

```
z: -33
```

```
xSol =
```

```
167/6
```

```
ySol =
```

```
29/6
```

```
zSol =
```

```
-33
```




Question

1. **Linear algebraic equations:** Find the solution of the following set of linear algebraic equations, as advised below.

$$x + 2y + 3z = 1$$

$$3x + 3y + 4z = 1$$

$$2x + 3y + 3z = 2.$$

- Write the equation in matrix form and solve for $\mathbf{x} = [x \ y \ z]^T$ using the left division `\`.



Gaussian elimination method

MATLAB has a built-in function, `rref`, that does precisely this reduction, i.e., transforms the matrix to its row reduced echelon form.

```
A=[1 2 3; 3 3 4; 2 3 3];  
B=[1; 1; 2];  
%C=B\A  
%linsolve(A,B)  
%transpose (C)  
%-----Gaussian elimination method  
C=[A B];  
Cr=rref(C)
```

Cr =

1.0000	0	0	-0.5000
0	1.0000	0	1.5000
0	0	1.0000	-0.5000



Find eigenvalues and eigenvectors

Step 1: Enter matrix A and type $[V, D] = \text{eig}(A)$

```
>> A = [ 5 -3 2; -3 8 4; 2 4 -9];
```

```
>> [V, D] = eig(A)
```

V =

-0.1709	0.8729	0.4570
-0.2365	0.4139	-0.8791
0.9565	0.2583	-0.1357

D =

-10.3463	0	0
0	4.1693	0
0	0	10.1770

Step 2: Extract what you need:

'V' is an 'n x n' matrix whose columns are eigenvectors

D is an 'n x n' diagonal matrix that has the eigenvalues of 'A' on its diagonal.



Question

2. **Eigenvalues and eigenvectors:** Consider the following matrix.

$$\mathbf{A} = \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$$

- Find the eigenvalues and eigenvectors of \mathbf{A} .
- Show, by computation, that the eigenvalues of \mathbf{A}^2 are square of the eigenvalues of \mathbf{A} .
- Compute the square of the eigenvalues of \mathbf{A}^2 . You have now obtained the eigenvalues of \mathbf{A}^4 . From these eigenvalues, can you guess the structure of \mathbf{A}^4 ?
- Compute \mathbf{A}^4 . Can you compute \mathbf{A}^{-1} without using the `inv` function?