Amrita School of Engineering, Bengluru-35
23MAT117-Linear Algebra
Lab Practice Sheet-1

(Matrix operations, Generation of random matrices with given rank)

- X = [1 2 3 4 5 6 7]
- X = [1, 2, 3, 4, 5, 6, 7]

Creates a row vector

- Y = [1; 2; 3; 4; 5]

Creates a column vector

- A = [1 2 3; 4 5 6; 7 8 9]
  B = [20, 12, 16, 44; 54, 4, 62, 28]

Entry of a matrix

- length(x), length(y)
- size(A), size(B)
- B', transpose(B)
- x1 = ones(1,10)

Creates a 1 x 10 row vector with all components as ones

- y0 = zeros(5,1)

Creates a 5 x 1 column vector with all components as ones

- M = zeros(3,4)

Creates a 3 x 4 matrix with all components as zero

- eye(4)
  eye(5,8)

Creation of identity matrix

- z1 = 1:10

Creation of a row vector from 1 to 10 with a default increment 1

- z2 = 5:3:26
  z3 = 26:-3:5

a:c:b
Creation of a row vector from a to b with an increment of c

- L = [1, 2, 3; 4, 5, 6; 7, 8, 9; 8, 3, 4]
  u = L(2, :)
  v = L(:, 3)
  w = L(1:2, 2:3)

extracts the specific rows, columns, submatrices

- E = [2, 9, 12; 9, 6, -2; 2, 8, 10]
  a = E(2, 3)
  b = E(1, 2)

Extracts a specific element from matrix

- E, p = [9 8 7], F = [E; p]
- F, q = [1 2 3 4], G = [F q']

appends E with a new row vector p

appends F with a new column vector q

- M = [1, 2; 3, 4]; M(:, 2)= M(:,2)+1

Replaces the second column $[2, 4]^T$ to $[3, 5]^T$

- x = [9 3 1 5 7]
  sort(x, 'ascend'), sort(x, 'descend')

Sorts the vector in ascending or descending order

- sum(x)
  max(x), min(x)
  mean(x), var(x), std(x)

Finds the sum, maximum value, minimum value, mean, variance and standard deviation of elements in x

- dot(p, q)
- cross(p, q)

dot product and cross product of vectors

- p = [30 20 50]; q = [-20 40 70]; A = [1, 2, 3; 2, 3, 4; 4, 5, 6]; B = [4, 9, 4; 1, 9, 16; 25, 9, 4];
- p+q, A+B, p-q, A-B

Addition and subtraction of Vectors/Matrices

- 2*q, 3*A, B/4

Scalar multiplication to a vector/matrix

- p+2, A+3

Adds two to every element of the vector/matrix

- exp(p), log(p), sqrt(B), sin(A), etc

component wise evaluation

- A*B, p*q', p'*q, A^2

Matrix multiplication

- p.*q, A.*B

component wise multiplication of vectors/matrices of equal size

Eg: [1 2 3].*[2 3 4]=[2 6 12]

- M = [1, 2; 3, 4]; N = M.^2

Each element of the matrix is squared

- L = [1 2 3; 4 5 6; 7 8 10];
  D = det(L)
  I = inv(L)
  T = trace(L)

Finds the determinant, inverse, trace of the matrix

DE = diag(L)

Finds the diagonal elements and write it as a vector

- V = [2, 3, 4]; diag(V)

Forms a diagonal matrix with elements from vector V

- P = [1, 2, 3, 6; 2, 3, 4, 9; 3, 4, 5, 12];
  rref(P)

Gives row reduced echelon form of the matrix M

Rank, Random number/matrix generation, Generation of matrices with given rank

- rank(A) ← Finds the rank of matrix A
- rand(1) ← Generation of a random number between 0 and 1
- rand(2) ← Generation of a random matrix(square/rectangular) with elements between 0 and 1
- rand(2,3)
- randi(5) ← Generates an integer random number between 0 and 5
- randi([3,15]) ← Generates an integer random number between 3 and 15
- randi([0,5],2) ← Generates random square matrix of order 2, with elements between 0 and 5
- randi([2,6],3,4) ← Generates random 3×4 matrix with elements between 2 and 6

Generation of random integer matrices with given rank

Results used
1. Maximum Rank of an m×n matrix is min(m, n)
2. Rank (AB) ≤ min (Rank(A), Rank(B))

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A = randi([0 9], 3, 1)*randi([0 9], 1, 3)      % Generates a random 3×3 matrix of rank 1.
rank(A)
B = randi([0 9], 5, 2)*randi([0 9], 2, 7)      % Generates a random 5×7 matrix of rank 2.
rank(B)
C = randi([0 9], 6, 3)*randi([0 9], 3, 4)      % Generates a random 6×4 matrix of rank 3.
rank(C)
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Generation of a random symmetric matrix

- From a random square matrix
  A = randi([0, 9], 4, 4); S = A+A'

- From a random rectangular matrix
  A = randi([0, 9], 4, 2);
  S1 = A'*A; % 2x2 symmetric matrix with rank 2
  S2 = A*A'; % 4x4 symmetric matrix with rank 2

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Practice Problems:

1. Obtain a random square matrix of order 20 and find the rank of it.
2. Obtain 2 random integer square matrices A and B of order 5.
   (a) Find the rank of A
   (b) Find the rank of B
   (c) Find the rank of A+B
   (d) Find the rank of A-B
   (e) Find the rank of A*B
   (f) Find the rank of kB, by choosing k as any real number
3. Generate a 5x5 matrix A of rank 4.
   (a) Retrieve an element with row index 3, and column index 5.
   Ans: a = A (3,5)
   (b) Retrieve first row from A and store in b

Ans: b = A (1, :)

(c) Retrieve first and third row from A and store in C.
Ans: C = A ([1, 3], :)

(d) Retrieve second column from A and store in d
Ans: d = A (:, 2)

(e) Retrieve second and fourth column from A and store in E.
Ans: E = A (:, [2, 4])

4. Using MATLAB generate a 9× 9 matrix A of rank 2. Obtain a symmetric matrix B = A+A' and find rank of B.
5. Using MATLAB generate a 10×5 matrix A of rank 3.
   (a) Obtain a symmetric matrix S1 = $A*A^T$ and S2 = A^T*A
   (b) Find the rank of S1 and S2.