Department of Computer Scince and Engineering

Scilab

LINEAR ALGEBRA AND ITS APPLICATIONS -UE19MA251

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NAME OF THE STUDENT : Palak Kothari

SRN : PES1UG19CS321

BRANCH : COMPUETR SCIENCE AND ENGINEERING

SEMESTER & SECTION : IV

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Topic: Gaussian Elimination

Solve the following system of equations by Gaussian Elimination. Identify the pivots in each case.

1. 2x + 5y + z = 0 , 4x + 8y + z = 2, y –z = 3

Code

```
clc;clear;
A = [2,5,1;4,8,1;0,1,-1], b = [0;2;3];
disp("Matrix before Gaussian Elimination: ")
disp(A);
Ab = [A b];
a = Ab;
n = 3;
for i = 2:n
    for j=2:n+1
        a(i,j) = a(i,j) - a(1,j)*a(i,1)/a(1,1);
    end
    a(i,1) = 0;
end
for i=3:n
    for j=3:n+1
        a(i,j) = a(i,j)-a(2,j)*a(i,2)/a(2,2);
    end
    a(i,2) = 0;
end

x(n) = a(n,n+1)/a(n,n);
for i=n-1:-1:1
    sumk = 0;
    for k=i+1:n
        sumk = sumk+a(i,k)*x(k);
    end
    x(i) = (a(i,n+1) - sumk)/a(i,i);
end

disp("Values of x,y,z:")
disp(x);
disp("Matrix after Gaussian Elimination: ")
disp(a);
disp("The pivots are: ");
disp(a(3,3),a(2,2),a(1,1));
```

Output

```
"Matrix before Gaussian Elimination: '

 2.   5.   1.
 4.   8.   1.
 0.   1.  -1.

"Values of x,y,z:"

 0.5
 0.3333333
-2.6666667

"Matrix after Gaussian Elimination: "

 2.   5.   1.     0.
 0.  -2.  -1.     2.
 0.   0.  -1.5    4.

"The pivots are: "

-1.5

-2.

 2.
```

Topic: LU decomposition of a matrix

Factorize the following matrices as A = LU

(1) A=2 3 1

4 7 5

1 −2 2

Code

```
clear;clc;;
A = [2 3 1;4 7 5; 1 -2 -2];
U = A;
disp(A, "The given matrix is:");
m = det(U(1,1));
n = det(U(2,1));
a = n/m;
U(2,:)= U(2,:) - U(1,:)/(m/n);
n = det(U(3,1));
b = n/m;
U(3,:) = U(3,:) - U(1,:)/(m/n);
m = det(U(2,2));
n = det(U(3,2));
c = n/m;
U(3,:) = U(3,:) - U(2,:)/(m/n);
disp(U,"The upper triangular matrix is:");
L = [1,0,0;a,1,0;b,c,1];
disp(L,"The lower triangular matrix is:");
```

Output

```
   2.   3.   1.
   4.   7.   5.
   1.  -2.  -2.

  "The given matrix is:"

   2.   3.   1.
   0.   1.   3.
   0.   0.   8.

  "The upper triangular matrix is:"

   1.    0.    0.
   2.    1.    0.
   0.5  -3.5   1.

  "The lower triangular matrix is:"

-->
```

Topic: The Gauss - Jordan method of calculating A^{-1}

Find the inverse of the following matrices: 21

(�� �� ��

�� �� ��

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Code

```
clc;clear;
A = [1 0 0;1 1 1;0 0 1];
n = length(A(1,:));
Aug = [A,eye(n,n)];
//Forward Elimination
for j=1:n-1
    for i=j+1:n
        Aug(i,j:2*n) = Aug(i,j:2*n)-Aug(i,j)/Aug(j,j)*Aug(j,j:2*n);
    end
end
//Backward Elimination
for j = n:-1:2
    Aug(1:j-1,:) = Aug(1:j-1,:)-Aug(1:j-1,j)/Aug(j,j)*Aug(j,:);
end
//Diagonal Normalization
for j=1:n
    Aug(j,:) = Aug(j,:)/Aug(j,j);
end
B = Aug(:,n+1:2*n);
disp("The inverse of A is:");
disp(B);
```

Output

```
"The inverse of A is:"

  1.    0.    0.
 -1.    1.   -1.
  0.    0.    1.

-->
```

Topic: Span of the Column Space of A

Identify the columns that span the column space of A in the following cases.

(1)A=(2 4 6 4

2 5 7 6

2 3 5 2)

Code

```
clc;clear;
a = [2 4 6 4;2 5 7 6;2 3 5 2];
disp("The given matrix is:");
disp(a);
a(2,:) = a(2,:)-(a(2,1)/a(1,1))*a(1,:);
a(3,:) = a(3,:)-(a(3,1)/a(1,1))*a(1,:);
disp(a);
a(3,:) = a(3,:)-(a(3,2)/a(2,2))*a(2,:);
disp(a);
a(1,:) = a(1,:)/a(1,1);
a(2,:) = a(2,:)/a(2,2);
disp(a);
for i=1:3
    for j=i:4
        if(a(i,j)<>0)
            disp("is a pivot column",j,"column");
            break;
        end
    end
end
```

Output

```
"The given matrix is:"

 2.    4.    6.    4.
 2.    5.    7.    6.
 2.    3.    5.    2.

 2.    4.    6.    4.
 0.    1.    1.    2.
 0.  - 1.  - 1.  - 2.

 2.    4.    6.    4.
 0.    1.    1.    2.
 0.    0.    0.    0.

 1.    2.    3.    2.
 0.    1.    1.    2.
 0.    0.    0.    0.

"is a pivot column"

 1.

"column"

"is a pivot column"

 2.

"column"
```

Topic: The Four Fundamental Subspaces

1. Find the four fundamental subspaces of

A= (1 2 0 1

0 1 1 0

1 2 0 1)

Code

```
clc;clear;
A = [1 2 0 1;0 1 1 0;1 2 0 1];
disp("The given matrix is:");
disp(A);
[m,n] = size(A);
disp(m,"m = ");
disp(n,"n = ");
[v,pivot] = rref(A);
disp(rref(A),"Row Reduced Echelon Form: ");
r = length(pivot);
disp(r,"Rank: ");
colspace = A(:,pivot);
disp(colspace,"Column Space: ");
nullspace = kernel(A);
disp(nullspace,"Null Space: ");
rowspace = v(1:r,:)';
disp(rowspace,"Row Space: ");
leftnullspace = kernel(A');
disp(leftnullspace,"Left Null Space: ");
```

Output

```
 "The given matrix is:"

  1.   2.   0.   1.
  0.   1.   1.   0.
  1.   2.   0.   1.

  3.

 "m = "

  4.

 "n = "

  1.   0.  -2.   1.
  0.   1.   1.   0.
  0.   0.   0.   0.

 "Row Reduced Echelon Form: "

  2.

 "Rank: "

  1.   2.
  0.   1.
  1.   2.
```

```
"Column Space: "

 3.909D-17  -0.8660254
-0.4082483   0.2886751
 0.4082483  -0.2886751
 0.8164966   0.2886751

"Null Space: "

 1.   0.
 0.   1.
-2.   1.
 1.   0.

"Row Space: "

-0.7071068
 1.106D-16
 0.7071068

"Left Null Space: "
```

Topic: Projections by Least Squares

1. Solve Ax = b by least squares where

A= (1 0

0 1

1 1)

b= (1

1

0)

Code

```
clc;clear;
A = [1 0;0 1;1 1];
b = [1;1;0];
disp("The given matrix A is:")
disp(A);
disp(b, "b: ");
x = (A'*A)\(A'*b)
C = x(1,1);
D = x(2,1);
disp(C,"C: ");
disp(D,"D: ");
disp("The best fit line is b = C+Dt")
```

Output

```
"The given matrix A is:"

 1.   0.
 0.   1.
 1.   1.

 1.
 1.
 0.

"b: "

 0.3333333

"C: "

 0.3333333

"D: "

"The best fit line is b = C+Dt"

-->
```

Topic: The Gram- Schmidt Orthogonalization

Apply the Gram – Schmidt process to the following set of vectors and find the orthogonal matrix:

1. (1, 1, 0) , (1, 0, 1) , (0, 1, 1)

Code

```
clc;clear;
A= [1 1 0;1 0 1;0 1 1];
disp(A, "The given matrix A is:");
[m,n] = size(A);
for k=1:n
    V(:,k) = A(:,k);
    for j=1:k-1
        R(j,k) = V(:,j)'*A(:,k);
        V(:,k) = V(:,k)-R(j,k)*V(:,j);
    end
    R(k,k) = norm(V(:,k));
    V(:,k) = V(:,k)/R(k,k);
end
disp(V,"Q: ");
```

Output

```
 1.   1.   0.
 1.   0.   1.
 0.   1.   1.

"The given matrix A is:"

 0.7071068   0.4082483  -0.5773503
 0.7071068  -0.4082483   0.5773503
 0.          0.8164966   0.5773503

"Q: "

-->
```

Topic: Eigen values and Eigen vectors of a given square matrix

Find the Eigen values and the corresponding Eigen vectors of the following matrices:

(8 −6 2

−6 7 −4

2 −4 3)

Code

```
clc;clear;
A = [8 -6 2;-6 7 -4;2 -4 3];
disp(A,"The given matrix A is: ")
lam = poly(0,"lam");
charMat = A-lam*eye(3,3);
disp(charMat,"The Characteristic Matrix is: ");
charPoly = poly(A,"lam");
disp(charPoly,"The Characteristic Polynomial is:");
lam = spec(A);
disp(lam,"Eigen  Values: ");
function[x,lam] = eigenvectors(A)
    [n,m] = size(A);
    lam = spec(A)';
    x = [];
    for k=1:3
        B = A-lam(k)*eye(3,3);
        C = B(1:n-1,1:n-1);
        b = -B(1:n-1,n);
        y = C\b;
        y = [y;1];
        y = y/norm(y);
        x = [x y];
    end
endfunction
[x,lam] = eigenvectors(A);
disp(x,"Eigen Vectors of A: ");
```

Output

```
 8.  -6.   2.
-6.   7.  -4.
 2.  -4.   3.

"The given matrix A is: "

8 -lam  -6      2
-6      7 -lam  -4
2       -4      3 -lam

"The Characteristic Matrix is: "

-7.128D-14 +45lam -18lam² +lam³

"The Characteristic Polynomial is:"

 1.584D-15
 3.
 15.

"Eigen  Values: "

 0.3333333  -0.6666667   0.6666667
 0.6666667  -0.3333333  -0.6666667
 0.6666667   0.6666667   0.3333333

"Eigen Vectors of A: "

->
```