MA202 LAB7

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TASK1: Write a C-program to implement LU decomposition scheme to solve a set of N coupled linear equations of the type: Ax=b. Here A is a NxN matrix, whereas x, b are column matrices with elements.

Solution Code:

Taking USER Input

```
/*MA202 LAB7 Q1 DIPEAN DASGUPTA 202151188 Code for LU decomposition*/
#include<stdio.h>
#include<conio.h>
void main()
{
    float A[N][N]= {0},L[N][N]= {0}, U[N][N];               //initializing arrays for matrix
    float B[N]= {0}, X[N]= {0},Y[N]= {0};
    int i,j,k,N;                                                //initializing variables required
    printf("Enter the order of square matrix: ");               //input of matrix order
    scanf("%d",&N);
    printf("\nEnter matrix element:\n");
    for(i=0; i<N; i++)
    {
        for(j=0; j<N; j++)
        {                                                       //entering all entries of matrix
            printf("Enter A[%d][%d] element: ", i,j);
            scanf("%f",&A[i][j]);
        }
    }
    printf("\nEnter the constant terms: \n");
    for(i=0; i<N; i++)
    {                                                       //entering constant terms
        printf("B[%d]",i);
        scanf("%f",&B[i]);
    }
```

LU calculation

```
for(j=0; j<N; j++)
{
    for(i=0; i<N; i++)
    {
        if(i<=j)
        {
            U[i][j]=A[i][j];
            for(k=0; k<=i-1; k++)
                U[i][j]-=L[i][k]*U[k][j];
            if(i==j)
                L[i][j]=1;
            else
                L[i][j]=0;
        }
        else
        {
            L[i][j]=A[i][j];
            for(k=0; k<=j-1; k++)
                L[i][j]-=L[i][k]*U[k][j];
            L[i][j]/=U[j][j];
            U[i][j]=0;
        }
    }
}
printf("[L]: \n");
for(i=0; i<N; i++)
{
    for(j=0; j<N; j++)                                          //printing L matrix
        printf("%9.4f",L[i][j]);
    printf("\n");
}
printf("\n[U]: \n");
for(i=0; i<N; i++)
{
    for(j=0; j<N; j++)
```

```
    for(i=0; i<N; i++)
    {
        Y[i]=B[i];
        for(j=0; j<i; j++)                              //calculation of intermediate Y values
        {
            Y[i]-=L[i][j]*Y[j];
        }
    }
    printf("\n[Y]: \n");
    for(i=0; i<N; i++)
    {
        printf("%9.4f",Y[i]);                           //printing intermediate Y values
    }
    for(i=N-1; i>=0; i--)
    {
        X[i]= Y[i];
        for(j=i+1; j<N; j++)
        {
            X[i]-=U[i][j]*X[j];                         //calculating  values of X
        }
        X[i]/=U[i][i];
    }
    printf("\n[X]: \n");
    for(i=0; i<N; i++)
    {                                                   //printing x Values
        printf("%9.4f",X[i]);
    }
    getch();
}
```

TASK2:

2. Using the above program solve for x for $A = \begin{pmatrix} 4 & 1 & 0 \\ 1 & 4 & 1 \\ 0 & 1 & 4 \end{pmatrix}$ and $b = \begin{pmatrix} 6 \\ 12 \\ 14 \end{pmatrix}$.

Implementing the code in task 1,

```
D:\Cprogramming>cd "d:\Cprogramming\" && gcc ludec.c -o ludec && "d:\Cprogramming\"ludec
Enter the order of square matrix: 3

Enter matrix element:
Enter A[0][0] element: 4
Enter A[0][1] element: 1
Enter A[0][2] element: 0
Enter A[1][0] element: 1
Enter A[1][1] element: 4
Enter A[1][2] element: 1
Enter A[2][0] element: 0
Enter A[2][1] element: 1
Enter A[2][2] element: 4

Enter the constant terms:
B[0]6
B[1]12
B[2]14
[L]:
   1.0000   0.0000   0.0000
   0.2500   1.0000   0.0000
   0.0000   0.2667   1.0000


[U]:
   4.0000   1.0000   0.0000
   0.0000   3.7500   1.0000
   0.0000   0.0000   3.7333


[Y]:
   6.0000  10.5000  11.2000

[X]:
   1.0000   2.0000   3.0000
```

So solution is X[1 2 3]

TASK 3:

3. Use the same program to now solve the linear problem when

$$A = \begin{pmatrix} 14 & 14 & -9 & 3 & -5 \\ 14 & 52 & -15 & 2 & -32 \\ -9 & -15 & 36 & -5 & 16 \\ 3 & 2 & -5 & 47 & 49 \\ -5 & -32 & 16 & 49 & 79 \end{pmatrix} \text{ and } b = \begin{pmatrix} -15 \\ -100 \\ 106 \\ 329 \\ 463 \end{pmatrix}.$$

Implementing the code in task 1,

```
Enter the order of square matrix: 5

Enter matrix element:
Enter A[0][0] element: 14
Enter A[0][1] element: 14
Enter A[0][2] element: -9
Enter A[0][3] element: 3
Enter A[0][4] element: -5
Enter A[1][0] element: 14
Enter A[1][1] element: 52
Enter A[1][2] element: -15
Enter A[1][3] element: 2
Enter A[1][4] element: -32
Enter A[2][0] element: -9
Enter A[2][1] element: -15
Enter A[2][2] element: 36
Enter A[2][3] element: -5
Enter A[2][4] element: 16
Enter A[3][0] element: 3
Enter A[3][1] element: 2
Enter A[3][2] element: -5
Enter A[3][3] element: 47
Enter A[3][4] element: 49
Enter A[4][0] element: -5
Enter A[4][1] element: -32
Enter A[4][2] element: 16
Enter A[4][3] element: 49
Enter A[4][4] element: 79
```

```
Enter the constant terms:
B[0]-15
B[1]-100
B[2]106
B[3]329
B[4]463
[L]:
    1.0000    0.0000    0.0000    0.0000    0.0000
    1.0000    1.0000    0.0000    0.0000    0.0000
   -0.6429   -0.1579    1.0000    0.0000    0.0000
    0.2143   -0.0263   -0.1103    1.0000    0.0000
   -0.3571   -0.7105    0.2912    1.0941    1.0000


[U]:
   14.0000   14.0000   -9.0000    3.0000   -5.0000
    0.0000   38.0000   -6.0000   -1.0000  -27.0000
    0.0000    0.0000   29.2669   -3.2293    8.5226
    0.0000    0.0000    0.0000   45.9745   50.3013
    0.0000    0.0000    0.0000    0.0000    0.5130


[Y]:
 -15.0000  -85.0000   82.9361  339.1287    2.0521

[X]:
    0.0000    1.0000    2.0000    3.0001    3.9999
```

So, solution is x[0 1 2 3 4]