Computer Aided Numerical Methods – I

Report on Assignment – 1

Problem Statement:

Solve = using LU Decomposition.

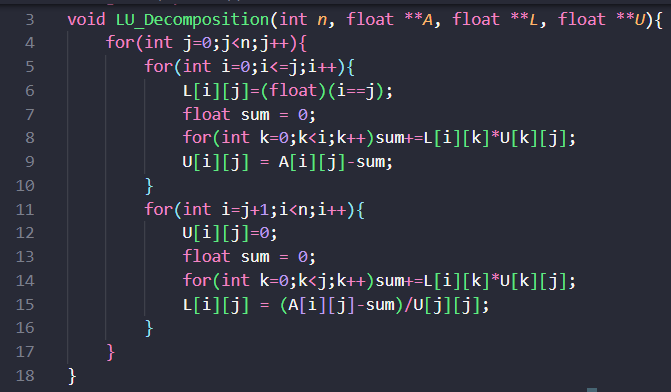
1. Find the L and U matrices.
2. Find the solution vector .

Explanation of Code:

0 – Preprocessing

This program has been coded in C++ language. Hence, the main library ‘iostream’ has been included to allow use of the basic input and output functions of C++. ‘Using namespace std;’ prevents having to prefix those functions with “std::’.

I – LU Decomposition Function

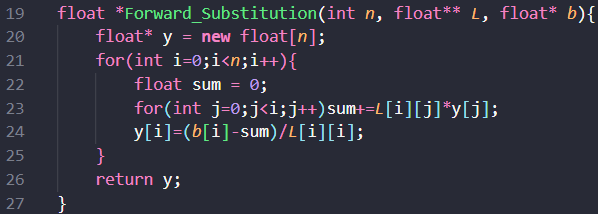
This function takes a pointer to the matrix ‘A’, size of A ‘n’ and two empty pointers ‘L’ and ‘U’ as input.

Functionality:

1. Performs LU decomposition to factorize A into a lower triangular matrix L and an upper triangular matrix U, such that .
2. The outer loop iterates through each column j of matrix A.
3. In the first inner loop, we iterate through each row such that:
   * The diagonal elements L of are set to 1, whereas the upper diagonal elements of L are set to 0.
   * For each row we compute .
4. In the second inner loop, we iterate through each row such that:
   * The lower diagonal elements of U are set to 0.
   * For each row we compute .
5. At the end of the function, we get both matrices L and U.

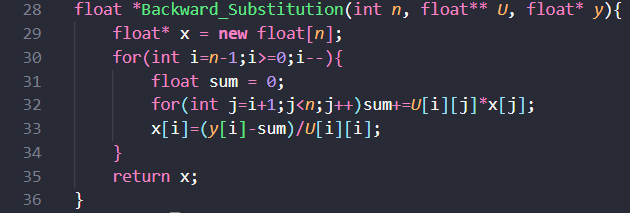
II – Forward Substitution Function

This function takes a pointer to Lower Triangular Matrix ‘L’, size of L ‘n’, a pointer to nx1 vector ‘b’ as input and returns a pointer to solution vector ‘y’ such that .

Functionality:

1. Performs Forward Substitution to return the solution vector ‘y’ to , where L is Lower Triangular Matrix and b is nx1 vector.
2. Iterates from row to .
3. For each y[i] we compute
4. The obtained solution vector y satisfies .

III – Backward Substitution Function

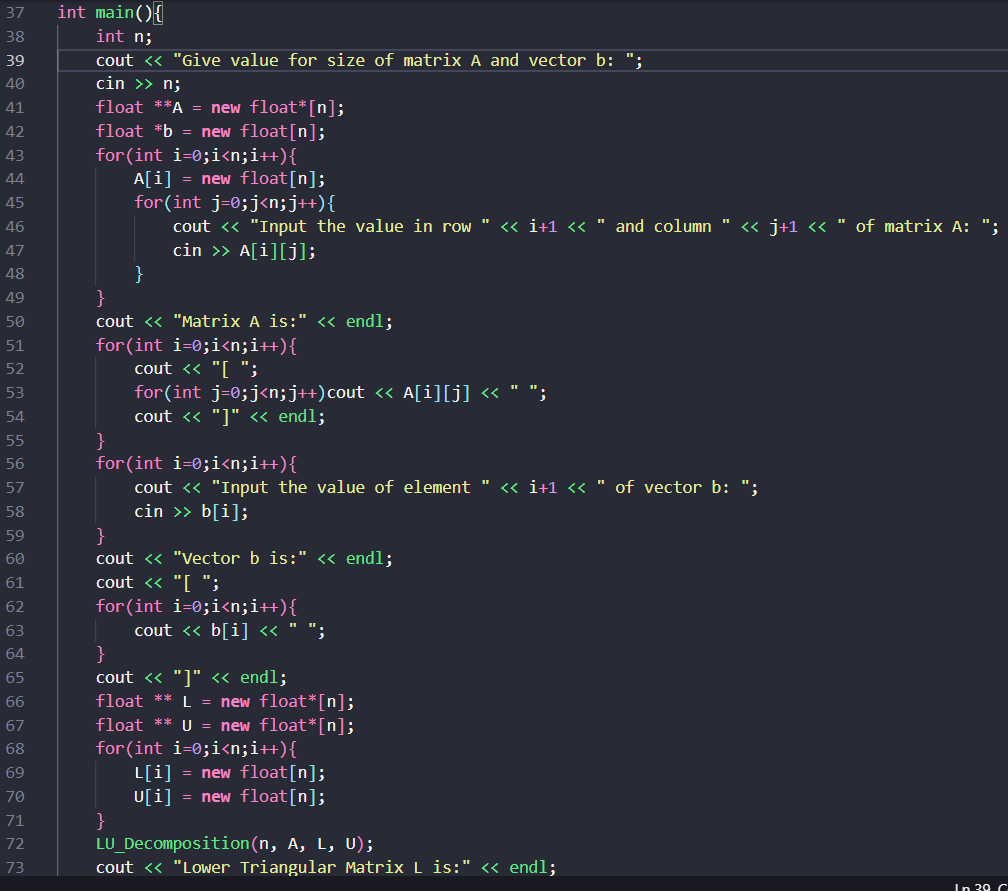
This function takes a pointer to Upper Triangular Matrix ‘U’, size of U ‘n’, a pointer to nx1 vector ‘y’ as input and returns a pointer to solution vector ‘x’ such that .

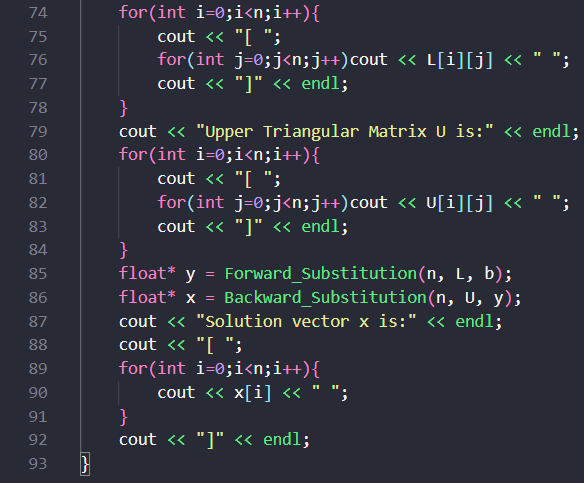
Functionality:

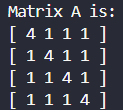
1. Performs Backward Substitution to return the solution vector ‘x’ to , where U is Upper Triangular Matrix and b is nx1 vector.
2. Iterates in reverse from row to .
3. For each x[i] we compute
4. The obtained solution vector x satisfies .

IV – Main Function

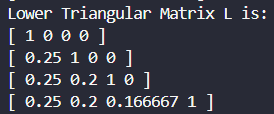
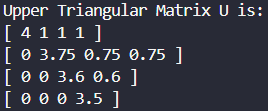
This function handles user input, LU decomposition, and solving the system.

Functionality:

1. User Input:
   * Reads matrix size n.
   * Dynamically allocates memory for matrices A, L and U.
   * Accepts user input for A and vector b.
   * Displays the input matrices.
2. LU Decomposition:
   *  Calls the LU\_Decomposition(n, A, L, U) function.
   * Displays matrices L and U.
3. Solving the Linear System:
   * Calls Forward\_Substitution(n, L, b) to compute .
   * Calls Backward\_Substitution(n, U, y) to compute .
   * Displays the solution vector x.

Solution to Assignment





1. 