22/03/2021

Algo Lab- 8

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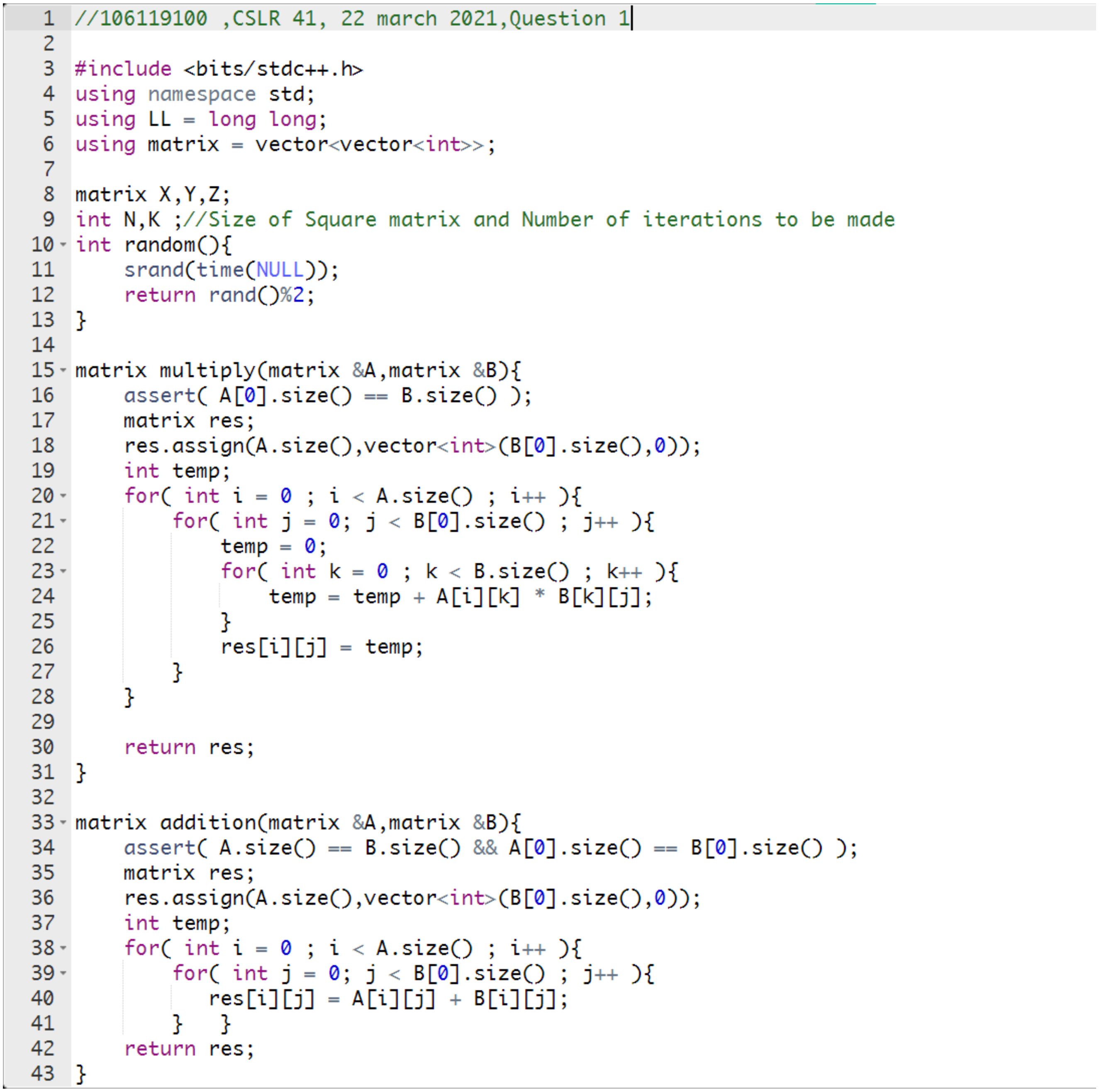
Question

1. Write a program to check whether Frievald's algorithm. Also state the time complexity of Frievald's algorithm and which type of Randomization algorithm it comes under?

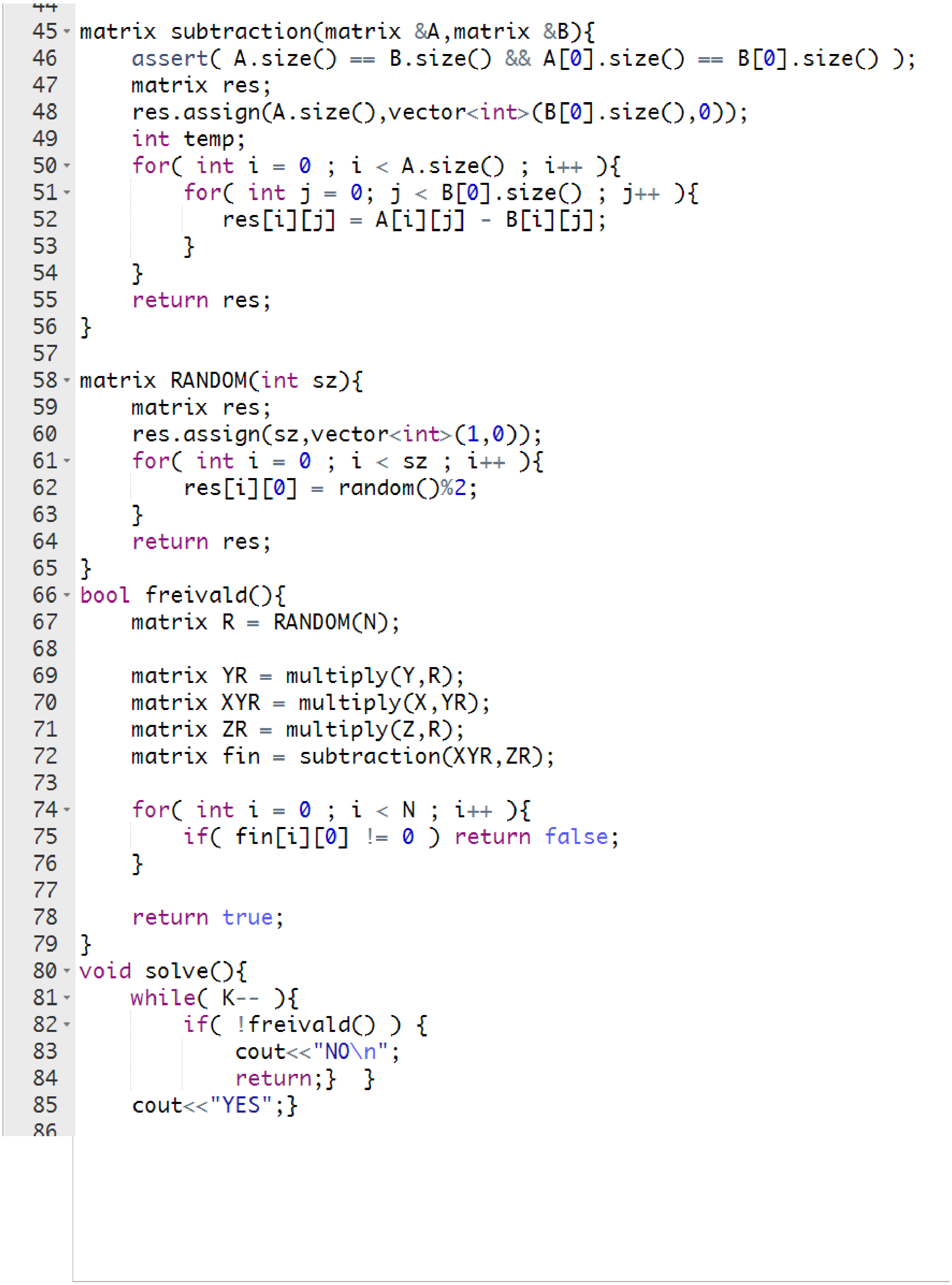
   Given three matrices A, B and C, find if C is a product of A and B.

The time complexity of Freivald's Algorithm is $O(n^2)$. In $O(kn^2)$ time ,it can verify a matrix product with probability of failure less than 2^{-k}.

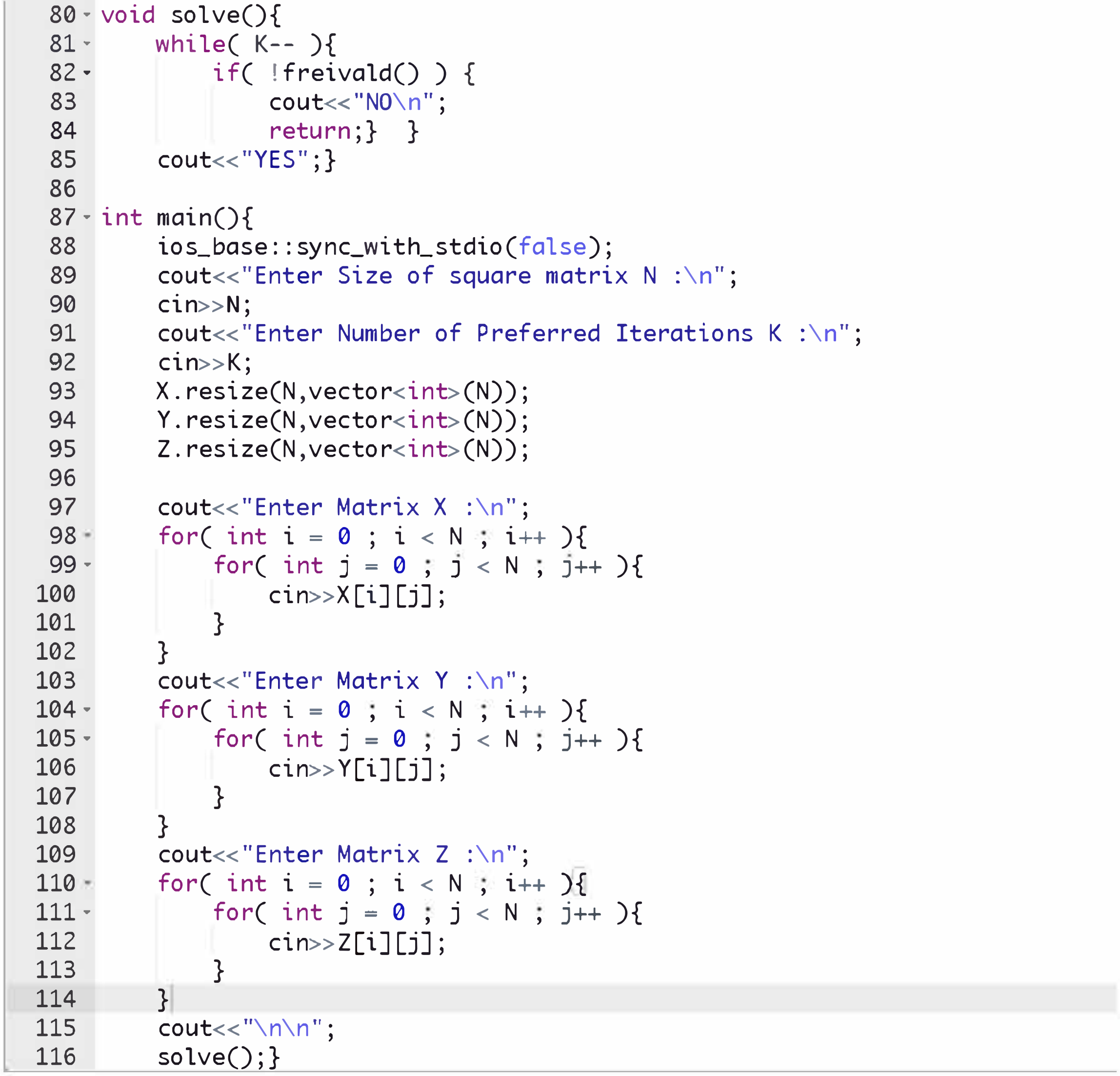
This is a Monte Carlo Randomizatin Algorithm ,since its running time is fixed ,but the correctness of results is not guaranteed.



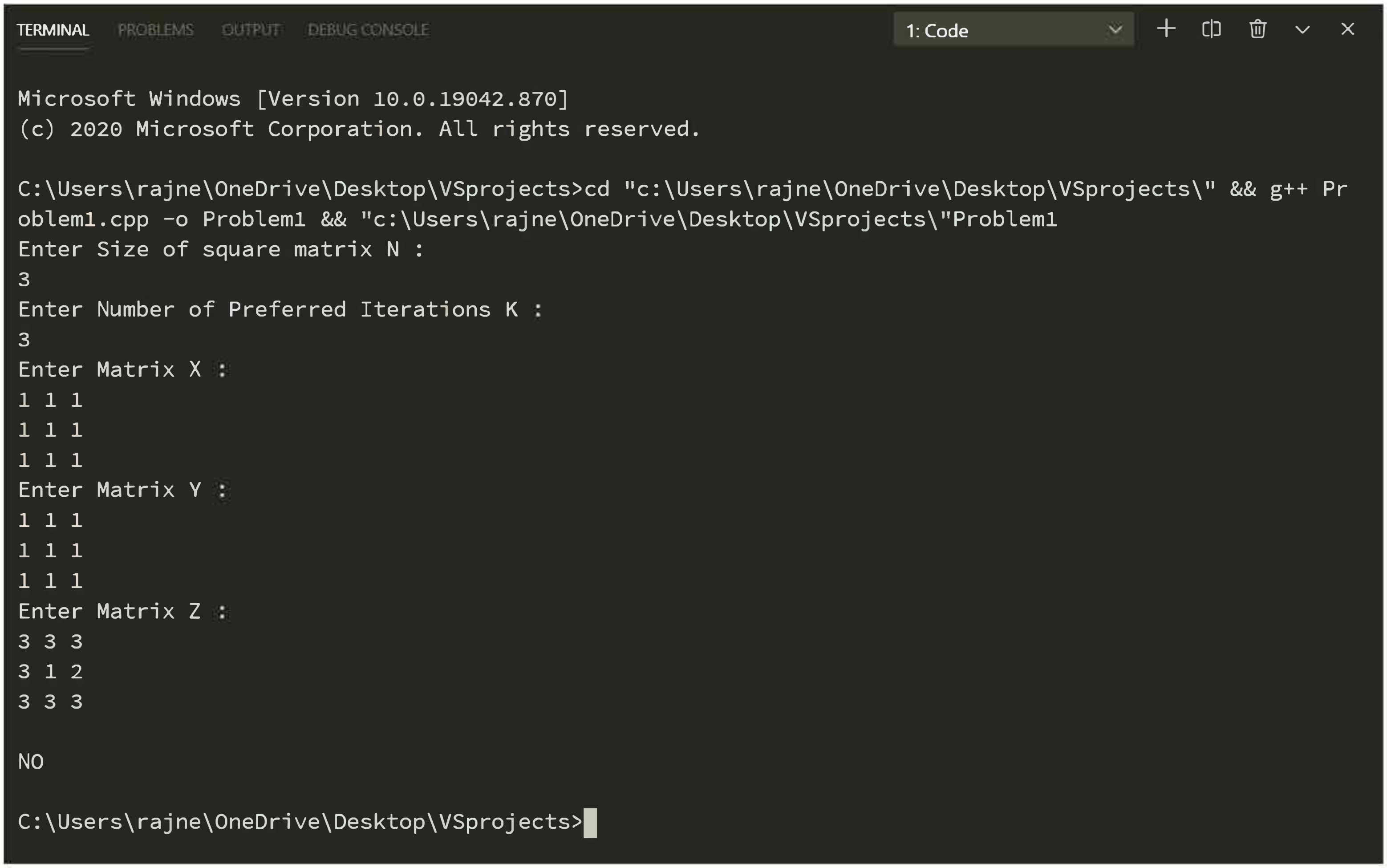
```cpp
//106119100 ,CSLR 41, 22 march 2021,Question 1

#include <bits/stdc++.h>
using namespace std;
using LL = long long;
using matrix = vector<vector<int>>;

matrix X,Y,Z;
int N,K ;//Size of Square matrix and Number of iterations to be made
int random(){
    srand(time(NULL));
    return rand()%2;
}

matrix multiply(matrix &A,matrix &B){
    assert( A[0].size() == B.size() );
    matrix res;
    res.assign(A.size(),vector<int>(B[0].size(),0));
    int temp;
    for( int i = 0 ; i < A.size() ; i++ ){
        for( int j = 0; j < B[0].size() ; j++ ){
            temp = 0;
            for( int k = 0 ; k < B.size() ; k++ ){
                temp = temp + A[i][k] * B[k][j];
            }
            res[i][j] = temp;
        }
    }

    return res;
}

matrix addition(matrix &A,matrix &B){
    assert( A.size() == B.size() && A[0].size() == B[0].size() );
    matrix res;
    res.assign(A.size(),vector<int>(B[0].size(),0));
    int temp;
    for( int i = 0 ; i < A.size() ; i++ ){
        for( int j = 0; j < B[0].size() ; j++ ){
           res[i][j] = A[i][j] + B[i][j];
        }   }
    return res;
}
```



```
matrix subtraction(matrix &A,matrix &B){
    assert( A.size() == B.size() && A[0].size() == B[0].size() );
    matrix res;
    res.assign(A.size(),vector<int>(B[0].size(),0));
    int temp;
    for( int i = 0 ; i < A.size() ; i++ ){
        for( int j = 0; j < B[0].size() ; j++ ){
           res[i][j] = A[i][j] - B[i][j];
        }
    }
    return res;
}

matrix RANDOM(int sz){
    matrix res;
    res.assign(sz,vector<int>(1,0));
    for( int i = 0 ; i < sz ; i++ ){
        res[i][0] = random()%2;
    }
    return res;
}
bool freivald(){
    matrix R = RANDOM(N);

    matrix YR = multiply(Y,R);
    matrix XYR = multiply(X,YR);
    matrix ZR = multiply(Z,R);
    matrix fin = subtraction(XYR,ZR);

    for( int i = 0 ; i < N ; i++ ){
        if( fin[i][0] != 0 ) return false;
    }

    return true;
}
void solve(){
    while( K-- ){
        if( !freivald() ) {
            cout<<"NO\n";
            return;}  }
    cout<<"YES";}
```



```cpp
void solve(){
    while( K-- ){
        if( !freivald() ) {
            cout<<"NO\n";
            return;}  }
    cout<<"YES";}

int main(){
    ios_base::sync_with_stdio(false);
    cout<<"Enter Size of square matrix N :\n";
    cin>>N;
    cout<<"Enter Number of Preferred Iterations K :\n";
    cin>>K;
    X.resize(N,vector<int>(N));
    Y.resize(N,vector<int>(N));
    Z.resize(N,vector<int>(N));

    cout<<"Enter Matrix X :\n";
    for( int i = 0 ; i < N ; i++ ){
        for( int j = 0 ; j < N ; j++ ){
            cin>>X[i][j];
        }
    }
    cout<<"Enter Matrix Y :\n";
    for( int i = 0 ; i < N ; i++ ){
        for( int j = 0 ; j < N ; j++ ){
            cin>>Y[i][j];
        }
    }
    cout<<"Enter Matrix Z :\n";
    for( int i = 0 ; i < N ; i++ ){
        for( int j = 0 ; j < N ; j++ ){
            cin>>Z[i][j];
        }
    }
    cout<<"\n\n";
    solve();}
```



```
Microsoft Windows [Version 10.0.19042.870]
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C:\Users\rajne\OneDrive\Desktop\VSprojects>cd "c:\Users\rajne\OneDrive\Desktop\VSprojects\" && g++ Pr
oblem1.cpp -o Problem1 && "c:\Users\rajne\OneDrive\Desktop\VSprojects\"Problem1
Enter Size of square matrix N :
3
Enter Number of Preferred Iterations K :
3
Enter Matrix X :
1 1 1
1 1 1
1 1 1
Enter Matrix Y :
1 1 1
1 1 1
1 1 1
Enter Matrix Z :
3 3 3
3 1 2
3 3 3

NO

C:\Users\rajne\OneDrive\Desktop\VSprojects>
```
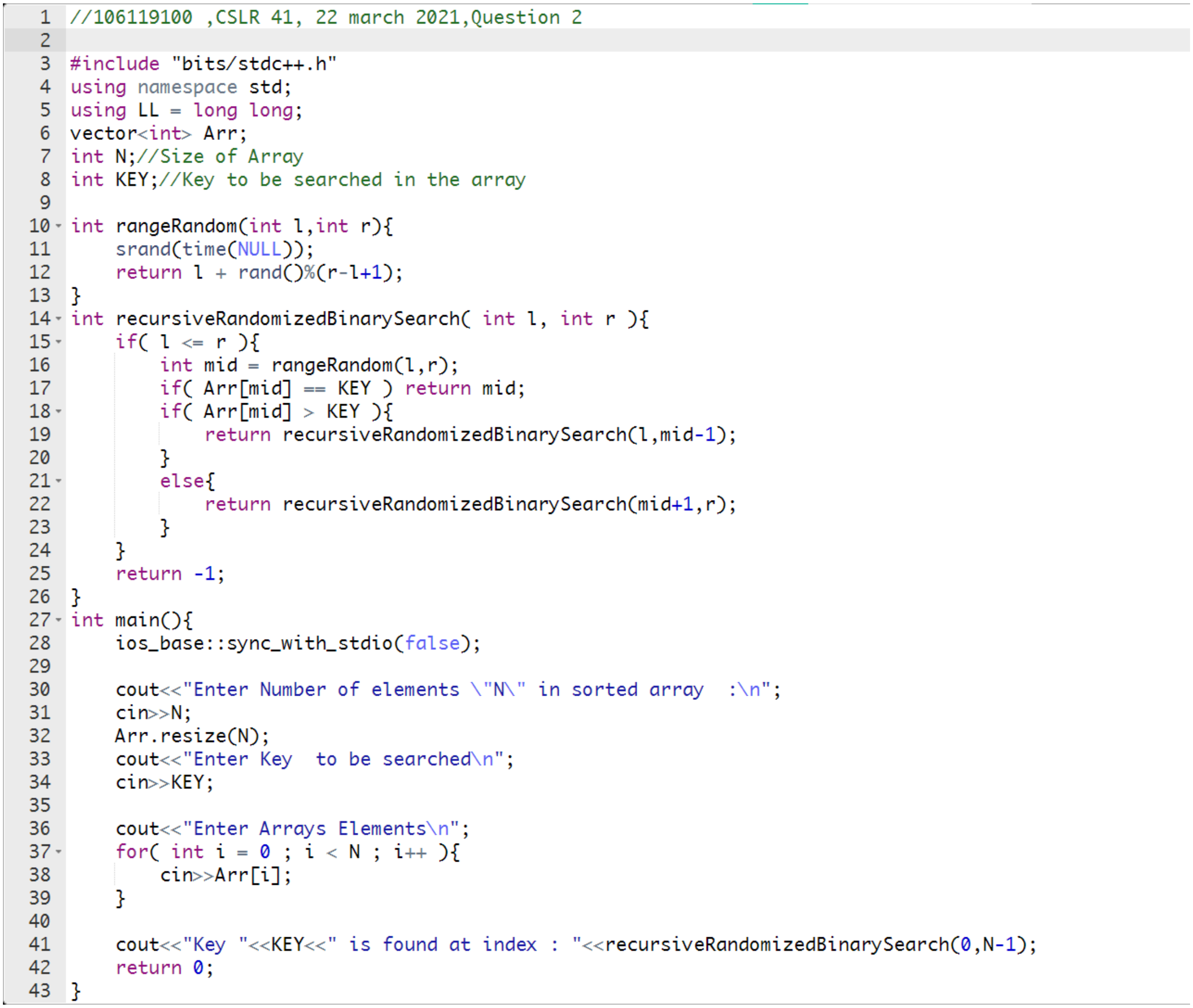

Question 2 :

2. Write a program to implement Recursive Randomized Binary Search Algorithm

In Binary Search we had
middle = (start + end)/2

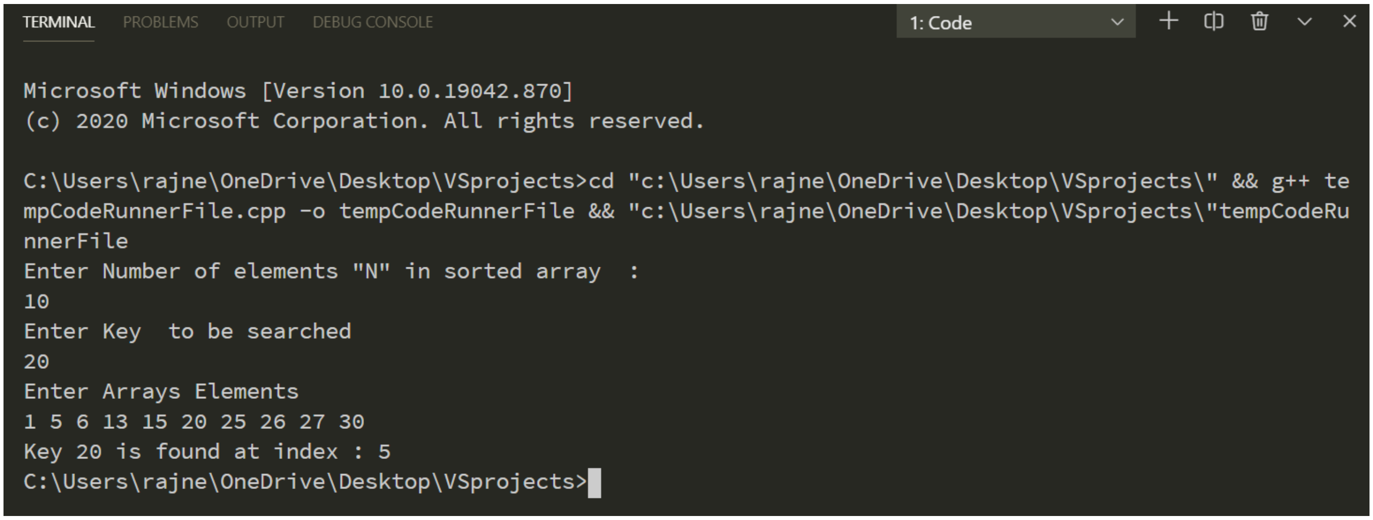
In Randomized binary search we do following
Generate a random number t
Since range of number in which we want a random number is [start, end]
Hence we do, t = t % (end-start+1)
Then, t = start + t;
Hence t is a random number between start and end

Input: list of array and No. to be searched
Output: Position of number in the arrays



```cpp
//106119100 ,CSLR 41, 22 march 2021,Question 2

#include "bits/stdc++.h"
using namespace std;
using LL = long long;
vector<int> Arr;
int N;//Size of Array
int KEY;//Key to be searched in the array

int rangeRandom(int l,int r){
    srand(time(NULL));
    return l + rand()%(r-l+1);
}
int recursiveRandomizedBinarySearch( int l, int r ){
    if( l <= r ){
        int mid = rangeRandom(l,r);
        if( Arr[mid] == KEY ) return mid;
        if( Arr[mid] > KEY ){
            return recursiveRandomizedBinarySearch(l,mid-1);
        }
        else{
            return recursiveRandomizedBinarySearch(mid+1,r);
        }
    }
    return -1;
}
int main(){
    ios_base::sync_with_stdio(false);

    cout<<"Enter Number of elements \"N\" in sorted array  :\n";
    cin>>N;
    Arr.resize(N);
    cout<<"Enter Key  to be searched\n";
    cin>>KEY;

    cout<<"Enter Arrays Elements\n";
    for( int i = 0 ; i < N ; i++ ){
        cin>>Arr[i];
    }

    cout<<"Key "<<KEY<<" is found at index : "<<recursiveRandomizedBinarySearch(0,N-1);
    return 0;
}
```

Input /Output



```
Microsoft Windows [Version 10.0.19042.870]
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C:\Users\rajne\OneDrive\Desktop\VSprojects>cd "c:\Users\rajne\OneDrive\Desktop\VSprojects\" && g++ te
mpCodeRunnerFile.cpp -o tempCodeRunnerFile && "c:\Users\rajne\OneDrive\Desktop\VSprojects\"tempCodeRu
nnerFile
Enter Number of elements "N" in sorted array  :
10
Enter Key  to be searched
20
Enter Arrays Elements
1 5 6 13 15 20 25 26 27 30
Key 20 is found at index : 5
C:\Users\rajne\OneDrive\Desktop\VSprojects>
```