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//Program-4
//Name:Divyashree H B
//This program accepts a square matrix and outputs the matrix after gaussian elimination. Finally, prints the determinant of the inputted matrix.

#include<iostream>
#include<vector>
#include <math.h>//exp
#include<iomanip>//precission
#include<fstream>
#include<algorithm>

using namespace std;
ofstream out;
long double d;

//Matrix input
vector<vector<long double>> getIniMatrix() {
	int N;
	cout << "Enter the size of square matrix A :\t";
	cin >> N;
	vector<vector<long double>> A(N, vector<long double>(N));
	cout << "Enter the co-efficients of matrix A :\n";
	for (int i = 0; i<N; i++) {
		for (int j = 0; j<N; j++) {
			cout << " A[" << i << "][" << j << "] =  ";
			cin >> A[i][j];
			cout << endl;
		}
	}
	return A;
}

//prints matrix to file
void printMatrix(vector< vector<long double> > A) {
	int n = A.size();
	for (int i = 0; i<n; i++) {
		for (int j = 0; j<n; j++) {
			out << A[i][j] << "\t";
		}
		out << "\n";
	}
	out << endl;
}

//gaussian elimination algorithm
vector<vector<long double>> gauss(vector< vector< long double> > A) {
	int n = A.size();

	for (int i = 0; i<n; i++) {
		// Search for maximum in this column
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                double maxEl = abs(A[i][i]);
                int maxRow = i;
                for (int k = i + 1; k<n; k++) {
                        if (abs(A[k][i]) > maxEl) {
                                maxEl = abs(A[k][i]);
                                maxRow = k;
                        }
                }

                // Swap maximum row with current row (column by column)
                for (int k = i; k<n; k++) {
                        double tmp = A[maxRow][k];
                        A[maxRow][k] = A[i][k];
                        A[i][k] = tmp;
                }

                // Make all rows below this one 0 in current column
                for (int k = i + 1; k<n; k++) {
                        double c = -A[k][i] / A[i][i];
                        for (int j = i; j<n; j++) {
                                if (i == j) {
                                        A[k][j] = 0;
                                }
                                else {
                                        A[k][j] += c * A[i][j];
                                }
                        }
                }
        }
        return A;
}


long double det(int n, vector<vector<long double>> mat)
{
        int c, subi, i, j, subj;
        vector<vector<long double>> submat(n, vector<long double>(n));
        //if the Matrix is 1X1
        if (n == 1)
                return mat[0][0];
        //if the Matrix is 2X2
        if (n == 2)
        {
                return((mat[0][0] * mat[1][1]) - (mat[1][0] * mat[0][1]));
        }
        else
        {
                //for NXN matrix where N >2
                for (c = 0; c < n; c++)
                {
                        subi = 0;
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                        for (i = 1; i < n; i++)
                        {
                                subj = 0;
                                for (j = 0; j < n; j++)
                                {
                                        if (j == c)
                                        {
                                                continue;
                                        }
                                        submat[subi][subj] = mat[i][j];
                                        subj++;
                                }
                                subi++;
                        }//cross multiply
                        d = d + (pow(-1, c) * mat[0][c] * det(n - 1, submat));
                }
        }
        return d;
}

//printing the content to file
void printToFile() {
        out << "Divyashree H B\n" << endl;
        out << "Gaussian Elimination and Determinant of the matrix\n" << endl;
        out << "5/1/2017\n" << endl;
        vector<vector<long double>> Amat, A;
        A = getIniMatrix();
        Amat = A;
        out << "The co-efficients of matrix A is : \n";
        printMatrix(Amat);
        Amat = gauss(A);
        out << endl;
        out << "Matrix A after Gaussian Elimination :\n";
        printMatrix(Amat);
        out << endl;
        out << "The determinant of matrix A is " << std::setprecision(6) << det(A.size(), A) << endl;
}

int main() {

        std::cout << std::fixed;
        std::cout << std::setprecision(9);
        out.open("output.txt");
        printToFile();
        system("pause");
        cout << endl;
}
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