Project 1

Matrix

Calculator

Version 1.0

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Contents

1. Introduction(https://en.wikipedia.org/wiki/Matrix_(mathematics)):

In mathematics, a matrix (plural matrices) is a rectangular array—of numbers, symbols, or expressions, arranged in rows and columns—that is interpreted and manipulated in certain prescribed ways. One such way is to state the dimensions of the matrix.

In this program, the main program is the calculator including function add/ subtract /multiply two matrices, and the transpose, determinant, and inverse of matrix. In addition, there is an easy matrix game for users to play.

2. Summary:

Total Line of Code	1000+
Comment Line	-
Variable	-
Function	-

This game contains most concepts that we have learned in the class. I have my own Linked List template class which is used in Record Class. There are also file stream and quick sort in Record Class. I use the STL library to get a statistic of all the records. In the Matrix Class, I use recursion to solve the determinant problems. I use the 2-dimention array to store the matrix.

3. Problems during coding

a) Get the determinant

At the beginning, it's hard for me to get the determinant. Therefore, I divided into some parts. First, I have a function to get the cofactor of a position. Then, I calculate the determinant with cofactors.

b) Sort with my own Linked List

In the Record Class, I use my own linked list to store the record inputted from the file. In the quick sort function parameter, I didn't use reference variables to my linked list. Thus, I tried so many times, the result of sort is the original record. Afterward, I realized that I didn't use the reference variables, and I fixed it.

When I did the project two weeks ago, I wanted to use my own linked list to store the matrix. After I append a matrix class into the list, the content of the class is changed. Two days later, I realized that the copy constructor and "=" (overload operator) have to be utilized in the append function of my list class. Therefore, I fixed that problems after I added copy constructor and "=" (overload operator) in my Matrix Class.

c) Formatted Output the result

Since the element of matrix might have more one digit, I need to formatted output the matrix. In addition, In the Record Class, the names of players have different lengths, so I should also formatted output the name and the record relative to the name.

4.Pseudo Code

Set seed for random number

Display main menu

If choose Matrix Calculator

    Get into calculator function

If choose Game

    Get into Game Function

If choose Exit

    Exit the program

Matrix Calculator

1. Ask user what he need to calculate (add, subtract, multiply, inverse, determinant, transpose)
2. Get the matrix/matrices from the user
3. Calculate and output

Game

1. Randomly create a 2*2 matrix, and 5 times randomly choose a question from determinant, multiply by a number, transpose, a cofactor of a position, and multiply by a matrix.
2. Ask player for the answer
3. Compare the answer inputted and the real answer
4. Call the Record Class
5. Input the record
6. Quick sort records
7. Display records

5. Screen Shot

a) Main menu

```
***********     Main  Menu     ***********
1. MATRIX CALCULATOR
2. GAME
0. Exit
You choose(0-2):
```

b) After choosing 1, get into matrix calculator

```
**********   MATRIX CALCULATOR   **********
************     Menu     ************
1. Add a matrix
2. Subtract a matrix
3. Multiply by a matrix
4. Multiply by a number
5. Determinant
6. Transpose
7. Inverse
0. Exit
You choose(0-8):
```

c) Choose 1 for add a matrix. Input the row and column of matrix

```
*********   MATRIX CALCULATOR   *********
************     Menu     ************
1. Add a matrix
2. Subtract a matrix
3. Multiply by a matrix
4. Multiply by a number
5. Determinant
6. Transpose
7. Inverse
0. Exit
You choose(0-8): 1
Row and Column of matrix: 2 2
```

d) Input two matrices with same size, and it will output the result

```
You choose(0-8): 1
Row and Column of matrix: 2 2
Row#1: 5 8
Row#2: 2 3
Please input the other matrix:
Row and Column of matrix: 2 2
Row#1: 7 6
Row#2: 4 2
[ 5 8 ]
[ 2 3 ]
  +
[ 7 6 ]
[ 4 2 ]
The result of two matrix addition:
[ 12 14 ]
[ 6 5 ]
```

e) Choose 3 to multiply matrix by matrix

```
Press Enter to continue

*********   MATRIX CALCULATOR   *********
************     Menu     ************
1. Add a matrix
2. Subtract a matrix
3. Multiply by a matrix
4. Multiply by a number
5. Determinant
6. Transpose
7. Inverse
0. Exit
You choose(0-8): 3
Row and Column of matrix: 2 2
Row#1: 5 7
Row#2: 0 2
Please input the other matrix:
Row and Column of matrix: 2 2
Row#1: 7 0
Row#2: 2 1
[ 5 7 ]
[ 0 2 ]
  *
[ 7 0 ]
[ 2 1 ]
The result of two matrix multiplication:
[ 49 7 ]
[ 4 2 ]

Press Enter to continue
```

f) Choose 0 to exit to calculator

```
*********   MATRIX CALCULATOR   *********
************     Menu     ************
1. Add a matrix
2. Subtract a matrix
3. Multiply by a matrix
4. Multiply by a number
5. Determinant
6. Transpose
7. Inverse
0. Exit
You choose(0-8): 0
The end of MATRIX CALCULATOR
Click Enter to continue...
***********     Main  Menu     ***********
1. MATRIX CALCULATOR
2. GAME
0. Exit
You choose(0-2):
```

g) Play the Matrix game

```
***********     Main  Menu     ***********
1. MATRIX CALCULATOR
2. GAME
0. Exit
You choose(0-2): 2
GAME TIME
You will have 5 matrix problems to solve

Problem #1:
Here is the matrix:
[ 5 4 ]
[ 3 7 ]

The matrix multiply by 5:
Row#1: 25 20
Row#2: 15 35
You got it
```

h) After answer 5 problems, output the record

```
The matrix multiply by 1:
Row#1: 7 4
Row#2: 7 4
You got it
You got 5/5
Your name(without space): Benjamin
Rank#     Name     Record
  1      Benjamin      5
  2      Jimmy      3

**************************************
The statistics of the record:
Average: 4
Median: 4
There is no mode
**************************************
Click Enter to continue...
```

6. Libraries

a. System libraries

- ✓ < #include <iostream>
- ✓ #include <string>
- ✓ #include <vector>
- ✓ #include <fstream>
- ✓ #include <set>
- ✓ #include <map>
- ✓ #include <algorithm>
- ✓ #include <iterator>

✓ *b.* User libraries

- ✓ #include "Matrix.h"
- ✓ #include "LnkList.h"
- ✓ #include "Record.h"

7. Concept covered

Concept	Type	Code	Location(line)
Linked List	LnkList<T>	LnkList<string> name;	23 in Record.h
File i/o	fstream	fstream inFile("Record.txt",ios::in);	125 in Record.cpp
Sort		void quickSort(LnkList<string> &,LnkList<int> &,int,int);	27 in Record.h
Template function	template <class T>	template <class T> void swap(T &a,T &b)	31 in Record.h
Constructor		Matrix(int,int,int **,string);	30 Record.h
Destructor		~Matrix();	32 Record.h
2-d array	int **	int **array;	19 Record.h
STL <vector>	vector<int>	vector<int> vec;	21 Record.cpp
STL <set>	set<int>	set<int> s;	22 Record.cpp
Iterator	set<int> :: iterator	set<int>::iterator pos;	23 Record.cpp
STL<map>	map<int,int>	map<int,int> m;	24 Record.cpp
Recursion		In the determinant function, call determinant(temp,tRow)	342 Matrix.cpp
Recursion		In the Quick Sort	101 Record.cpp
Operator Overloading		void operator=(const Matrix &right);	54 in Matrix.h

Sort	Quick Sort	void Record::quickSort(LnkList<string> &nm, LnkList<int> &cr, int beg, int end) {
		int p;
		if(beg<end) {
		p=pivot(nm,cr,beg,end);
		quickSort(nm,cr,beg,p-1);
		quickSort(nm,cr,p+1,end);
		}
		}
			97 Record.cpp

Operator Overloading		void operator=(const Matrix &right);	54 in Matrix.h

8. Flowchart (A function beginning at Line#290 in Matrix.cpp)