CS2413: Assignment 1

Total Points: 100

Due: Sep 9 midnight.

Introduction

We have introduced sparse matrix and its efficient representation, which (as an example) refers to the right table in Figure 1. In that table, each row represents a non-zero element in the matrix, with the 1st column being its row index in the matrix, the 2nd column being its column index in the matrix, and the last column being its value in the matrix. All absent elements are zeros. See Lecture 0828 for more explanations.

0	2	0	0	0	6	0
0	0	0	0	5	0	0
0	0	0	0	0	0	0
3	0	0	0	0	1	0

Row	Column	Value
0	1	2
0	5	6
1	4	5
3	0	3
3	5	1

Fig. 1. An Example Sparse Matrix (left) and its Efficient Representation (right). Taken from lecture 0828.

Specific Tasks

Let X and Y be two 5-by-8 sparse matrices, and $Z1$, $Z2$ and $Z3$ be three properly-sized matrices. You are required to input or output these matrices based on their efficient representations. For example, suppose X is the matrix in Fig 1; if you are asked to input or output X, you need to input or output the right table.

Please write a program that fulfills the following three tasks:

(1) It gets the transpose of X, and stores it as $Z1 = X^T$. Size of $Z1$ is 8-by-5.

(2) It gets the sum of X and Y, and stores it as $Z2 = X + Y$. Size of $Z2$ is 5-by-8.

(3) It gets the product of X^T and Y, and stores it as $Z3 = X^T Y$. Size of $Z3$ is 8-by-8.

In addition, the program needs to fulfill the following requirements

(1) It takes two inputs (through re-directed input) and gives one output.

- The first input is an integer that indicates which task is being executed.
  - input 1 = perform task 1 and output the transpose matrix $Z1$
  - input 2 = perform task 2 and output the sum matrix $Z2$
  - input 3 = perform task 3 and output the product matrix $Z3$
- The second input is X.

(2) It initializes matrix Y based on the sparse matrix in Fig 2.[1]

[1] You need to first get its efficient representation (in any way) before initialization.

1			9		5		
				2			3
	4					8	
		2					
1				7			

Fig. 2. Input matrix Y. All absent elements are 0's.

Restrictions

(1) The only library you can include is "iostream".[2]

(2) You must implement the efficient representation using arrays, e.g., 1D array, 2D array, ...

(3) Please strictly follow the following input format (for Gradescope grading).

– the first input is the integer that indicates the selected task: transpose, sum, product.

– the next input is matrix X, row by row and sequentially in each row, e.g., 0 1 2 0 5 6 1 4 5 3 0 3 3 5 1.

– all numbers are separated by space (or change of line)

– You need to take all input data through the re-directed input configuration, and place your input data in 'input.txt'. In 'input.txt', your data should look like those in Fig 3: the first line is an integer that indicates the task being performed (transpose, sum, product); the second line is input matrix X.

We have a tutorial re-directed input configuration on Sep 2, at the beginning of the class. Tutorial slides and recorded video will be posted online. If you still have questions, please get help from us or your peers asap.

```
1
0 2 2 0 6 9 1 0 1 1 4 5 2 1 3 2 5 6 3 0 4 3 3 7 4 7 8
```

Fig. 3. Example input file of the program.

(4) Please strictly follow the following output format (for Gradescope grading).

– output a matrix Z, row by row and sequentially in each row, e.g., 0 1 7 0 5 2 1 4 10 3 0 1 3 5 2.

(5) Please name your submitted code as `cs2413_hw1.cpp`.

Rubrics

- Task 1. Transpose. 20 points.

- Task 2. Addition. 30 points.

- Task 3. Multiplication. 40 points.

- Documentation: 10 points. (Comments in your submitted code)

[2] If you include any library related to sparse matrix, and use any functions from it, your submission will be voided.