Assignment 2

Deadline:	Friday, 27 September, 11:59pm
Evaluation:	30 marks (30% of your final grade)
Late Submission:	Deduct 10% per day late
Individual Work	You should complete this assignment by yourself (you must NOT share your code with others or use others' code including the code generated by Artificial Intelligence platforms such as ChatGPT)
Purpose:	Reinforce Data Structures and OOP programming, especially LinkedList

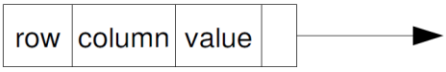
There are several areas in Physics and Engineering where computer programs have to be developed that make use of sparse matrices. A sparse matrix is an extremely large two-dimensional array of integer numbers that has very few elements of interest and all the other elements are set to zero.

These matrices are sometimes too big to store in computer memory and are then represented by linked lists instead. It is common to have 1000000x1000000 matrices, however only a few thousand elements would be different than zero (usually very small floating-point numbers can be rounded up to zero).

Each node in the list contains the following information:

row;
column;
matrix value at position [row, column];
pointer to next node in the list;

The node of a linked list representing sparse matrices could look like this:



Any element of the matrix where the value is zero does not have a node in the linked list.

We will assume that sparse matrices are always square, i.e. max rows = max columns.

E.g., a matrix as below can be represented by the following LinkedList.

$$\begin{vmatrix} 1 & 3 & 4 \\ 2 & 0 & 0 \\ 0 & 0 & 0 \end{vmatrix}$$

Write code to complete a program that reads in two sparse matrices from *.txt files and stores them as linked lists.

The prototype reads text files in a specific format, with the first lines indicating the number of rows and columns (see "matrix1.txt" on Stream).

E.g., in "matrix1.txt", the first line indicates the number of rows is 4 and the number of columns is 4. Lines 2-5 is a 4x4 matrix.

4 4
0 1 0 0
0 0 2 0
0 3 0 4
0 0 0 5

Write the function that adds the two matrices together and produce a result matrix. The result matrix must also be stored as a linked list. We are assuming that the matrices are too large to fit into memory as arrays, thus all calculations must be carried out with the matrices stored in their linked list format.

Write a display function that shows all three **matrices** in the usual matrix format.
Write a display function that shows all three **linked lists** in order of elements.

Note 1: The programs should read the matrices from the *.txt files, NOT from keyboard.

Note 2: Make sure that values of zero are not nodes in the linked list (after all, that's the point in implementing the sparse matrix code!).

Note 3: The output must be in this format. This example has 4x4 matrices:

Matrix 1: 1 2 3 4 5
0 1 0 0
0 0 2 0
0 3 0 4
0 0 0 5
Matrix 2: 1 1 2 3 4 10 3 3
1 1 2 0
0 0 3 0
0 4 0 10
0 0 3 3
Matrix Result: 1 2 2 5 7 14 3 8
1 2 2 0
0 0 5 0
0 7 0 14
0 0 3 8

If the matrix is all zeros, it should be printed like this, indicating that the corresponding LinkedList is empty:

Matrix 2:
0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0

Other Specifications

You **should** follow the following specifications when completing this assignment:

1) Place appropriate comments in your program – e.g.:
   ```
   /** explain what the program file is doing . . . */
   // explain what a part/method of the program is doing...
   ```
2) **DO NOT** add any package name (for example ‘package Assignment2;’) to the beginning of your .java file (for marking purpose)
3) **DO NOT** use any function to clean the screen at any stage of a program

Submission Requirement:

Zip all your **.java files (source codes)** together and submit as a single file to Stream