CSC211: Practical 2 [50 Marks].
DEADLINE: Friday <mark>03 March</mark>, 2023 @ 10:00 PM.
NB: <mark>Please no excuses for late hand-ins</mark>

Welcome to your second practical assignment. This assignment will give you some practice on algorithm analysis, among others. Please read and adhere to all the instructions. You should clearly detail your solution with justification, and submit a final solution with your report. (**NB:** For your report, font type should be Times New Roman with 12pt min and 13 pt. maximum; **No hand-written solutions will be accepted. Also, only submissions made on iKamva will be graded, so please DO NOT email your solution and plan to submit your work ahead of the deadline.**)

Crèche Contact Tracing   **[25]**

Consider a crèche that experienced a sudden outbreak of an infection. This infection caused **n** number of babies to get sick at different periods (NB: **n** is an integer).

For each i = 1, … ,n, a baby that enters the crèche at time a_i leaves at time $d_i >= a_i$, suppose we are interested in knowing **how many distinct pairs of babies are ever at the crèche at the same time**? (**NB**: pair (i, j) is the same as pair (j, i)).

For example, **consider Table 2**: Suppose there are 5 babies with the following arrival and departure times:

Table2: Babies Arrival and Departure Times at the Crèche

Baby	Arrival time (a_i)	Departure time (d_i)
1	2	4
2	3	6
3	8	9
4	10	11
5	7	11

In table 2, clearly, *Baby1* arrived at time 2 and left at time 4, but note that *Baby 2* also arrived at time 3, which is before *Baby 1* left the crèche. Hence, the number of distinct pairs of babies who are at the crèche **simultaneously** is three:

These pairs are {(1, 2), (4, 5), (3, 5)}

Considering the input $(a_1, d_1) (a_2, d_2)…(a_n, d_n)$ as earlier described, there is a straightforward algorithm that takes about n^2 time complexity to compute the number of pairs of babies that are at the crèche at the same time.

Your task is to:

1) Give the algorithm (step by step) and explain/justify why it takes about n^2 time complexity.

2) Write a program called "*contactTracing.java*", which implements the algorithm in 1.
   a) Ask the user to input the number of babies in the creche
   b) Followed by arrival and departure times (separated by ",") for each baby
   c) Store these data into a data structure
   d) Apply algorithm 1 on the data structure and determine the pairs

3) Write a 1–2 page report (max) detailing how you structured your *contactTracing* algorithm. Explain how you traversed the data structure you used and how to compare the adjacent elements. Your final report should follow as thus:

CSC 211 Practical 2 Report
(Name, Surname and Student number)

1.0 Introduction
(The solution presented in this report is about/summarises ...)

2.0 Contact Tracing Algorithmic Solution
(Give the stepwise algorithmic solution)

3.0. Explanation of Algorithmic Solution in (2.0)
(Explain your solution step by step)

4.0. *(Add an appropriate header if you need another section)*

5.0. Response to Bonus Question (Improvement and Explanation**)**
(summarise and explain your answer as required)

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4) (**Bonus Mark**) Could we possibly improve on the time complexity of the algorithm in question (2)? If yes, give a detailed algorithm and justification for your answer. If no, also justify your answer with some clear explanation.

NB: We will use some other random test cases to check the correctness of your code. So please pay attention to your solution.

Sample Input
How many pairs of baby: 5
Give the times of arrival (i) and departure (j), e.g.: 2,4
2,4
Give the times of arrival (i) and departure (j), e.g.: 2,4
3,6
Give the times of arrival (i) and departure (j), e.g.: 2,4
8,9
Give the times of arrival (i) and departure (j), e.g.: 2,4
10,11
Give the times of arrival (i) and departure (j), e.g.: 2,4
7,11

Sample Output

The distinct pairs of babies who are at the crèche simultaneously are

(1, 2) (3, 5) (4, 5)

SUBMISSION AND GRADING

Please submit a (zipped) folder that contains your java implementation (code) and solution report (in .pdf format). Marks will be allocated as follows:

Ques	Task & Marks	Points
Q1	Java Implementation • User Input • Implementing Algorithm • Correct Output	25
Q2	Report • Pseudo Code or step by step code • Algorithm Explanation • Report Format	20
Bonus	Improvement and Explanation	5
	TOTAL (OBTAINABLE) MARKS	**50**

WARNING: ACADEMIC DISHONESTY/PLAGIARISM

We cannot over emphasize this. Please be warned that tutors and markers will run your report/solution through a plagiarism checker. Any person/group found guilty of plagiarizing will get zero for this assignment and will face the university's disciplinary unit. We do encourage you to share ideas, but we draw a careful line between that and plagiarism.

Note that any group/person that allow their work to be copied will also be guilty. So, please guide your assignment will all diligence and describe the solution in your own way as much as possible.

Good luck!