(S1-21_DSECLZG519)
(Data Structures and Algorithms Design)
Academic Year 2020-2021

Assignment 2 – PS9 - [Car Race] - [Weightage 13%]

1. Problem Statement

A car race is organized among N cars of the world. Every car has a speed (in km/hr) that is denoted by an array speed[ ] where speed[i] represents the speed of the ith car. The indexing of the array is **0-based.**

All the cars are standing at different starting positions. The starting position of every car is represented by an array pos[ ] where pos[i] denotes the starting position of the ith car. The indexing of the array is **0-based**. The pos[ ] array is a permutation of integers 0 to N-1. A car who is standing at i position is considered to be ahead of the car which is standing at position j if and only if i > j.

The finish line of the race is 100000 kilo meters ahead. An overtake occurs when car A, whose starting position is less than car B, finishes the race earlier than car B. Your task is to determine the number of overtakes that has occurred during the race.

Input format

- First line: An integer N denoting the number of cars that are participating in the race (2≤N≤105)
- Next line: N space-separated integers denoting the speed of the ith car (1≤speed[i]≤107)
- Next line: N space-separated integers denoting the starting position of ith car (1≤pos[i]≤N)

Note: Array is a permutation of integers 0 to N-1 integers

Ex:

    4
    2 1 4 3
    1 2 3 4

Output format

Print a single integer denoting the number of overtakes that has occurred during the race.

Explanation

Car at start point 1 will overtake Car at start point 2. Car at start point 3 will overtake Car at start point 4.

Display the output in **outputPS9.txt**.

Note that the input/output data shown here is only for understanding and testing, the actual file used for evaluation will be different.

2. Deliverables

1. Word document **designPS9_<group id>.docx** detailing your design and time complexity of the algorithm.
2. **[Group id]_Contribution.xlsx** mentioning the contribution of each student in terms of percentage of work done. Download the Contribution.xlsx template from the link shared in the Assignment Announcement.
3. **inputPS9.txt** file used for testing
4. **promptsPS9.txt** file used for testing (If applicable)
5. **outputPS9.txt** file generated while testing
6. **.py file** containing the python code. Create a single *.py file for code. Do not fragment your code into multiple files

Zip all of the above files including the design document and contribution file in a folder with the name:

[Group id]_A2_PS9_CarRace.zip and submit the zipped file.

Group Id should be given as **Gxxx** where xxx is your group number. For example, if your group is 26, then you will enter G026 as your group id.

3. Instructions

1. It is compulsory to make use of the data structure(s) / algorithms mentioned in the problem statement.
2. Ensure that all data structure insert and delete operations throw appropriate messages when their capacity is empty or full. Also ensure basic error handling is implemented.
3. For the purposes of testing, you may implement some functions to print the data structures or other test data. But all such functions must be commented before submission.
4. Make sure that your read, understand, and follow all the instructions
5. Ensure that the input, prompt and output file guidelines are adhered to. Deviations from the mentioned formats will not be entertained.

6. The input, prompt and output samples shown here are only a representation of the syntax to be used. Actual files used to evaluate the submissions will be different. Hence, do not hard code any values into the code.

7. Run time analysis is to be provided in asymptotic notations and not timestamp based runtimes in sec or milliseconds.

8. Please note that the design document must include
    a. The data structure model you chose with justifications
    b. Details of each operation with the time complexity and reasons why the chosen operations are efficient for the given representation
    c. One alternate way of modelling the problem with the cost implications.

9. Writing good technical report and well document code is an art. Your report cannot exceed 4 pages. Your code must be modular and quite well documented.

Instructions for use of Python:

1. Implement the above problem statement using Python 3.7.

2. Use only native data types like lists and tuples in Python, do not use dictionaries provided in Python. Use of external libraries like graph, numpy, pandas library etc. is not allowed. The purpose of the assignment is for you to learn how these data structures are constructed and how they work internally.

3. Create a single *.py file for code. Do not fragment your code into multiple files.

4. Do not submit a Jupyter Notebook (no *.ipynb). These submissions will not be evaluated.

5. Read the input file and create the output file in the root folder itself along with your .py file. Do not create separate folders for input and output files.

4. Deadline

1. The strict deadline for submission of the assignment is **Saturday, 12th Mar, 2022.**

2. The deadline has been set considering extra days from the regular duration in order to accommodate any challenges you might face. No further extensions will be entertained.

3. Late submissions will not be evaluated.

5. How to submit

1. This is a group assignment.

2. Each group has to make one submission (only one, no resubmission) of solutions.

3. Each group should zip all the deliverables in one zip file and name the zipped file as mentioned above.

4. Assignments should be submitted via Canvas > Assignment section. Assignment submitted via other means like email etc. will not be graded.

6. Evaluation

1. The assignment carries 13 Marks.
2. Grading will depend on
   a. Fully executable code with all functionality working as expected
   b. Well-structured and commented code
   c. Accuracy of the run time analysis and design document.
3. Every bug in the functionality will have negative marking.
4. Marks will be deducted if your program fails to read the input file used for evaluation due to change / deviation from the required syntax.
5. Use of only native data types and avoiding libraries like numpy, graph and pandas will get additional marks.
6. **Plagiarism will not be tolerated. Copy / Paste's from web resources / or your friends' submission will attract severe penalty to the extent of awarding negative 10 percent. We will not measure the extent of such blatant copy pastes and details of who copied from whom and such details while awarding the penalties. It's the responsibility of the team to solve and protect your original work.**
7. Source code files which contain compilation errors will get at most 25% of the value of that question.

7. Readings

Text book: Algorithms Design: Foundations, Analysis and Internet Examples Michael T. Goodrich, Roberto Tamassia, 2006, Wiley (Students Edition). **Chapters:** 5.2