भारतीय सूचना प्रौद्योगिकी संस्थान गुवाहाटी

Indian Institute of Information Technology Guwahati

ALGORITHMS LAB (CS210)

MID-SEMESTER EXAMINATION, MONSOON, 2020

Thanos, a superhero, has attacked the earth. His objective is to randomly move half of the people from the earth to another parallel universe called "AfterLife" and to save the earth from over-crowding. Avengers, a bunch of idiotic super-villains, are trying to destroy the earth by over-crowding. Thanos, therefore, needs to fight with the Avengers. He has brought n fighter spaceships, such that the, i-th spaceships has the length $l_i \in \mathbb{R}^+$ units. You help Tony, one of the Avengers, to write his programs, and hence, are trying to help the Avengers. You have picked up $m > n$ number of smart-missiles designed by Morgan, the daughter of Tony. Smart-missiles can not harm Thanos; Tony would take care of him. What you can do is to buy Tony some time to prepare by destroying Thano's spaceships. The spaceships are in a linear formation. When you attack the i-th spaceship with a smart-missile, the i-th spaceship gets destroyed beyond repair, and both the $(i-1)$-th and the $(i+1)$-th spaceships get damaged. When the k-th spaceship is damaged, Thanos needs $t_k = {}^{l_k}/_2$ amount of time to repair it. Moreover, when the i-th spaceship gets destroyed beyond repair, he needs $T_i = l_i$ amount of time to reform the line of his spaceships, even if to this was the last remaining spaceship. Thanos and his army cannot attack if all the available/remaining spaceships are not restored and are not forming a line. You cannot attack when they are not attacking and you can attack a single spaceship at a time.

Write a program (either in `C`, `C++`, or `Java`) to find out the maximum amount of time you can buy for Tony - you may make him live a little longer. Use top-down dynamic programming (memoization). The input to your program needs to be stored in a file. Your program must read the file to process the input. You need to pass the input filename as a command-line argument. Sample input is provided in the file `Spaceships.txt`. You need to execute your program for that input file and upload the output while submitting the code.

Input file format: `<number of spaceships> <length of each spaceship as a space separated list>`

Output: `<time to live>`

Example 1:

Content of input file: `0`

Output: `0.0`

Example 2:

Content of input file: `1 9.5`

Output: `9.5`

Example 3:

Content of input file: `2 10 3`

Output: `18.0`

Example 4:

Content of input file: `3 8 7 6`

Output: `32.0`

Example 5:

Content of input file: `3 8 20 6`

Output: `54.0`

Marking scheme: File read: 15 marks; Base case: 15 marks; Recursion: 15 marks; DP with memoization: 30 marks; Correct answer for `Spaceship.txt`: 20 marks; Coding style, naming convention: 5 marks.

Disclaimer: All names, characters, and incidents portrayed in this question are fictitious. No identification with other fictional (living or deceased) or actual persons (living or deceased) is intended or should be inferred.