2 hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

COMP26120 Revision for Part C

May 2019

Time: ?

Answer all questions

The use of electronic calculators is permitted provided they are not programmable and do not store text.

Section C

Throughout this section you may assume the existence of standard data structures (e.g. lists, queues, stacks, trees) but to get full marks you must state the complexity of the operations you perform on your data structure(s).

5. It is your first day as Ant and Dec's new agent helping them set up their new Game Show. Solve all of the problems and you can have a nice sit down by the pool.

a) Your first job is to help Ant and Dec organise a charity fundraiser to advertise the show. They need to work out how much airtime to give to different celebrities. They have a list of the amount of time each celebrity is available for and the expected donation they will receive for every 10 minutes the celebrity is on air. For example:

Celebrity	Availability	Donations
Robbie Williams	30 minutes	£50 per 10 minutes
Ed Balls	300 minutes	£0.1 per 10 minutes
David Mitchel	10 minutes	£10 per 10 minutes
Pudsy the Dog	2 minutes	£500 per 10 minutes

You ask Ant and Dec how often they have to do something like this and they tell you that it's about once a week so you decide to design a general solution.

Let the length of the fundraiser be N minutes, let k be the number of celebrities on the list, and let a_i and d_i be the availability and donation rate for celebrity i. Design a general solution for deciding how much airtime to give each celebrity to maximise donations. You confirm with the producer that there is no minimum amount of time a celebrity can be on air e.g. they could be on air for just 1 second if needed.

Give the complexity of your solution in terms of N and k. (5 marks)

b) Next, Ant has proposed a new game for their show but Dec is uncertain if they will have time for it. The proposed game is as follows:

1. Ant hides an inflatable toy somewhere in the audience.
2. Dec splits the audience in half and gets them to cheer if the toy is in their half
3 Dec repeatedly splits the audience and repeats (2) until he finds the toy

You notice that this game is following an *algorithmic technique*. Identify the technique. Given that it takes 30 seconds to get the right number of audience members to cheer, how long will the game take if there are N people in the audience (evenly distributed). (3 marks)

c) This time Dec proposes a new game for their show. A contestant is faced with a floor made up of a grid of numbers. For example:

40	70	80	60	40
60	70	30	90	20
30	80	10	20	30
70	10	70	30	70
20	90	80	90	30

They must then walk from one corner (e.g. top left) to the opposite corner (e.g. bottom right) by stepping on squares that are to their right, below them, or diagonally below them to the right (e.g. towards the opposite corner only). They then win the total of the value of the tiles they step on e.g. the above path would win them £300.

Ant has remembered that all prize money comes out of their lunch budget and is worried that there won't be enough money left over for his favourite brand of sausage roll. Devise a general solution that, given a board, computes the maximum amount of money a contestant can win.

They will only have a short amount of time to prepare for each game so a brute-force solution will not be fast enough (and will only receive partial marks).

(6 marks)

d) The final game (proposed by their friend Cat Deeley) requires pitching teams of families or friends against each other for a number of mini-challenges. Given teams with m and n contestants respectively there will be $m \times n$ mini-challenges played. Each mini-challenge takes a fixed constant amount of time c but the format of the show requires the overall game to take a different amount of time each week. You propose dealing with this by varying the number of contestants.

Before each show you will be given a list of teams and their number of contestants. For example:

Team Name	Contestants
The A Team	4
McBusted	6
The Regers	3.5
Take that	~~5~~ ~~4~~ 3

You must find a pair of teams such that their mini-challenges can fit into a given time N. Given that the show is running once a day, you decide to design a general solution to the problem. Give your solution and its complexity, remembering to be explicit about the data structures you are using and the complexity of operations you perform on them.

(5 marks)

e) Finally, Ant and Dec ask you to maximise the fee they get paid for the show. Controversially, the production company have said that they will pay Ant £1k per minute he is on screen but they will by Dec £1.2k. They also stipulate that their joint screen time must be lower than 60 minutes but their individual screen time must be at least 20 minutes.

Cast this problem as a linear programming problem and solve it using the Simplex algorithm. State how many minutes of screentime each star should make and what their overall fee will be between them (they share everything). (8 marks)

END OF EXAMINATION