1A Lent Algorithms

Supervision 7: Amortized Analysis and Advanced Data Structures

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1 Refresher

1. Given an unweighted, undirected graph G and two vertices in it u and v. Describe an algorithm that finds the number of edge-disjoint paths from u to v and the paths themselves. How can you find the number of *vertex*-disjoint paths from u to v?

2. * Consider a round-robin tournament with n players. In the tournament each pair plays exactly twice (home game and away game) and there are no draws. We will say that a team has lost *mathematically* if it has no chance of winning, no matter what the outcomes of the remaining games is. Given the current table of the tournament (the pairs of teams that have already played and who won each game), determine the team that have lost mathematically.

   Construct a graph that involves the teams and the games and use flow.

2 Advanced Data Structures and Amortized Analysis

1. Questions 1-11 from the Lecturer's example sheet 7/8[1].

2. Recall the implementation of a queue using two stacks discussed in supervision 3[2]. Analyse it using the potential method.

3. Consider a counter n that starts at 0 and is incremented until some N. Luckily, modern computers support hardware operations to do each increment in constant time. Consider the "manual" method of incrementing a number in binary format: to increment a number, we replace all trailing 1's with 0, and replace the 0 before them with 1. For example, if $n = 19 = (10011)_2$, then $n + 1 = 20 = (10100)_2$.

   (a) How long does it take to increment a number n in the worst case?

   (b) How long does it take for the counter to reach N? Use amortized analysis (if it helps do the aggregate first).

[1] `http://www.cl.cam.ac.uk/teaching/1718/Algorithms/ex7.pdf`
[2] `http://www.cl.cam.ac.uk/~hs586/files/1a-alg-lent-2018/supervision3.pdf`