TDT4125 Algorithm Construction

Examination, May 29, 2020, 09:00–13:00

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Support material code A

Problems

Because of the corona pandemic, this is a *pass/fail* home exam with all aids allowed. Therefore, no emphasis is placed on distinguishing performance in it the upper parts of the grade scale, and the selection of task types is somewhat unusual. Consequently, the exam set should not be seen as representative of regular exams.

1 You have n advisors who advise you on a series of decisions. Before each decision, you must decide which of them you will listen to. After the decision you will find out which of the advisors gave you good and bad advice. Suppose one of the advisors always gives you good advice – but you don't know which one. How can you limit the number of times you follow bad advice? How many times Will you end up following bad advice, in the worst case?

Explain and elaborate. Link to relevant theory, possibly in different parts of the curriculum.

2 You have a weighted undirected graph and want to select a set of edges that is as heavy as possible. The only requirement you have is that none of the edges you choose share nodes. If you choose greedily, how good will your solution be?

Explain and elaborate. Link to relevant theory, possibly in different parts of the curriculum.

3 Assume that you have a method for finding valid solutions to linear programs. Discuss how you can use such a method to find an optimum. Why is your procedure correct?

Explain and elaborate. Link to relevant theory, possibly in different parts of the curriculum.

4 Assume that you have a linear program with some integer restrictions of type $x_j \in \{0, 1\}$. You change these to $0 \leqslant x_j \leqslant 1$. What can you say about the optimum for this new program? What can you say about the optimum if you round each such x_j to 1 or 0, randomly, with probabilities x_j and $1 - x_j$? What can you say about restrictions $(Ax)_i \leqslant b_i$? Can you get similar results for the target function *without* randomization? What about the restrictions?

Explain and elaborate. Link to relevant theory, possibly in different parts of the curriculum.

5 In preference elections, all voters rank all candidates. Several methods of determining such elections combine the rankings so one ends up with a so-called *tournament*, i.e., a complete, directed graph $G = (V, E)$: Between two nodes $u, v \in V$, $u \neq v$, exactly one of the edges (u, v) and (v, u) is in E. In order to be able to pick a winner, we want G to have the following property: For all $u, v, w \in V$, if $(u, v) \in E$ and $(v, w) \in E$, then we have $(u, w) \in E$. A common strategy for determining such elections is to reverse the direction of as few edges as possible to give the graph the described property. Discuss how to do this. What if you instead decide to eliminate as few candidates as possible to achieve the property?

Explain and elaborate. Link to relevant theory, possibly in different parts of the curriculum.