Approximation Algorithms
Summer term 2009

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Exercise Set 9

Exercise 1:
Prove: The algorithm of Kou, Markowsky, and Berman is a $2 - \frac{2}{t}$ factor approximation, where t is the number of terminals.

(4 Points)

Exercise 2:
Let $G = (V, E)$ be a graph with non-negative edge costs, and let $S \subset V$ and $R \subset V$ be disjoint vertex sets ("senders" and "receivers"). Consider the problem of finding a minimum cost subgraph of G that contains a path connecting each receiver to a sender.

(i) Prove: If $S \cup R = V$, then the problem is in P.

(ii) Give a 2-factor approximation algorithm for the case $S \cup R \neq V$ (which is NP-hard). *Hint: Modifiy the graph and compute a minimum Steiner tree.*

(2+3 Points)

Exercise 3:
Find an algorithm which solves the Steiner Tree Problem with 3 terminals in time $\mathcal{O}(n \log n + m)$. *Hint: If the terminals are v_1, v_2, and v_3, consider the shortest path P between v_1 and v_2 and let a be the distance of v_3 to P. Then find a vertex z which minimizes the sum of the distances to the terminals under the conditions* $\text{dist}(v_i, z) \leq \text{dist}(v_1, v_2)$ *for* $i \in \{1, 2\}$ *and* $\text{dist}(v_3, z) \leq a$. *The Steiner tree will be the union of the shortest paths from the terminals to z.*

(4 Points)

News:
The Mentorenprogramm at the Institute for Discrete Mathematics invites all students to join them at an excursion to the Post Tower. A talk at 4:15pm on Monday, June 22nd, will inform you about the applications of mathematics at the Deutsche Post. *Important:* A registration is necessary and you have to register until wednesday. Find more information at the mentor's message board at `or.uni-bonn.de/forum` (see "Ankündigungen").

(0 Points)

Please return the exercises until Tuesday, **June 23nd, at 2:15 pm**.