Albert-Ludwigs-Universität
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Summer Term 08

Energy Efficient Algorithms
Assignment 5

Hand in on Monday, July 14, 2008, during the lecture.

Exercise 1: Minimum energy broadcasting on the line. Suppose that $n = 8$ nodes are located on the real line as shown in Figure 1. Find an optimal schedule for a broadcast initiated by p_0 by executing the algorithm introduced in the lecture (that runs in $O(n^2)$ time). Here, the cost for a transmission of radius d is d^α with $\alpha = 2$. Specify the resulting schedule as well as the total energy consumption for the transmissions.

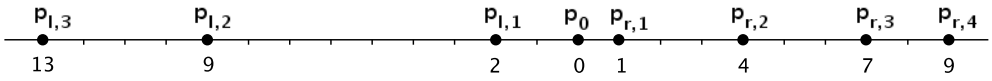

Figure 1: Nodes located on the real line together with their distances from p_0.

Remark: Consider the general case with n_1 nodes on the left hand side of p_0 and n_2 nodes on the right hand side. Suppose that $p_{l,1}$ is farther from p_0 than $p_{r,1}$ and that the initial transmission from p_0 to $p_{l,1}$ reaches $p_{r,k}$ as the rightmost node. If no transmission initiated on one side of p_0 is used to reach nodes on the other side, the minimum total cost is

$$\sum_{i=0}^{n_1-1} d(p_{l,i}, p_{l,i+1})^\alpha + \sum_{i=k}^{n_2-1} d(p_{r,i}, p_{r,i+1})^\alpha.$$

Exercise 2: The BIP algorithm. A file **network.txt** containing the listed node coordinates of a network of size 30 can be downloaded from the homepage of the lecture. The broadcast initiator is the first node in this list with coordinates $x = 33$ and $y = 41$. Implement the BIP algorithm discussed in the lecture in your favorite programming language, and apply this algorithm to this network. Visualize the computed broadcast tree. Choose $a = 2$, i.e, sending with radius d costs d^a energy. What is the energy cost of your broadcast tree? Further optimize the link structure with the following operation, called the *sweep-operation*:

Let T be the broadcast tree. Make a depth-first traversal on T. Let v be the current node in this traversal with sending radius d, and let T_v be the nodes in the subtree of T rooted in v. For each node $u \in T_v$, if u can be reached from v, i.e., if the distance from v to u is less of equal than d, then make u a child of v. Let p be the former parent of u. Since u is no longer a child of p, decrease the sending radius of p as much as possible such that all remaining children of p can be still reached from p. What is the cost of your broadcast tree after the sweep-operation?