Research Institute for Discrete Mathematics
Chip Design
Summer Term 2014

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Exercise Set 3

Exercise 3.1:

Prove: The Minimum Elmore Delay Steiner Tree Problem is NP-hard even for $|M| = 2$.

(4 points)

Exercise 3.2:

Given a root $s \in \mathbb{R}^2$ and a set of terminals $T \subseteq \mathbb{R}^2$, a rectilinear Steiner tree Y is said to be a rectilinear shortest path tree for s and T if the length of the s-t path in Y equals the l_1-distance of s and t for all $t \in T$. Let $smt(\{s\} \cup T)$ denote the length of a shortest rectilinear Steiner tree for $\{s\} \cup T$ and let $sp(s, T)$ denote the length of a shortest rectilinear shortest path tree for s and T. Let $f(n) := \max_{s \in \mathbb{R}^2, T \subseteq \mathbb{R}^2, |T|=n} \frac{sp(s,T)}{smt(\{s\} \cup T)}$ for $n \in \mathbb{N}$.

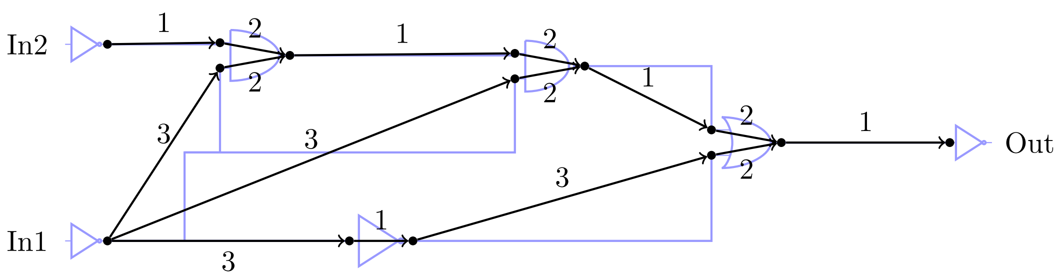
a) Prove: $f(n) = \Omega(\log(n))$.

b) Prove: $f(n) = \mathcal{O}(\log(n))$.

(4 + 4 points)

Exercise 3.3:

Consider the following piece of combinational logic and its netlist graph:



The edge labels specify the delays. We do not distinguish between rising and falling signals and do not consider slew. Maximum (late mode) and minimum (early mode) delays are equal. Assume that all the arrival times for the latest and earliest signal at the primary inputs ‘In1’ and ‘In2’ are 0 and the required arrival times at the primary output ‘Out’ are 10 (early mode) and 12 (late mode).

a) What are the earliest and latest arrival times of a signal at the primary output pin?

b) Compute the early and late slack at each pin.

(2 + 2 points)

Deadline: Wednesday, April 30, before the exercise class.

The websites for lecture and exercises are linked at

http://www.or.uni-bonn.de/lectures/ss14/ss14.html

In case of any questions feel free to contact me at scheifele@or.uni-bonn.de .