Research Institute for Discrete Mathematics
Chip Design
Summer term 2013

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Exercise Set 9

Exercise 9.1:
Formulate the Simple Global Routing Problem as an integer linear program with a polynomial number of variables and constraints.

(4 points)

Exercise 9.2:
Given an instance of the Simple Global Routing Problem and additionally a set $\mathcal{P}$ of timing-critical paths with delay bounds $D : \mathcal{P} \to \mathbb{R}_+$. Each path $P \in \mathcal{P}$ consists of a sequence $N_1, N_2, \dots, N_n$ of nets. Let $\mathcal{Y}_N$ be the set of Steiner trees for $N \in \mathcal{N}$. A delay function $d_N : \mathcal{Y}_N \to \mathbb{R}$ specifies the delay through the circuit driving N. The delay depends on the length of the Steiner tree $Y_N \in \mathcal{Y}_N$ and the additional spacing $s_N(e)$:

$$d_N(Y_N) := \alpha_N + \beta_N \cdot \sum_{e \in E(Y_N)} l(e) \left(w(N,e) + \frac{\zeta_{N,e}}{s_N(e)} \right)$$

with constants $\alpha_N, \beta_N, \zeta_{N,e}$.
We require that

$$\sum_{N \in P} d_N(Y_N) \leq D(P) \text{ for all } P \in \mathcal{P}.$$

Show that the fractional relaxation of the Simple Global Routing Problem with these additional spacing variables and delay constraints can be modeled as a Min-Max Resource Sharing Problem.

(4 points)

Exercise 9.3:
Let G be an acyclic, directed graph and let $s_1, s_2, t_1, t_2 \in V(G)$ be pairwise distinct vertices. We want to compute a s_1-t_1 path P_1 and a s_2-t_2 path P_2 in G such that P_1 and P_2 are vertex (resp. edge) disjoint or decide that such paths do not exist. Show:

(a) The vertex disjoint and the edge disjoint version are polynomially equivalent.

(b) The vertex disjoint version can be solved in $\mathcal{O}(|V(G)| \cdot |E(G)|)$ time.

(3+5 points)

Deadline: Thursday, July 4th, before the lecture.