Prof. Dr. Jens Vygen
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Exercise Set 11

Exercise 11.1:
Formulate the SIMPLE GLOBAL ROUTING PROBLEM as an integer linear program with a polynomial number of variables and constraints.

(5 points)

Exercise 11.2:
Show an instance of the SIMPLE GLOBAL ROUTING PROBLEM which admits a fractional solution, but for which there is no feasible integral solution. For this, you are not allowed to set $w(N, e) > u(e)$ for any net N and edge e.

(5 points)

Exercise 11.3:
Let G be a 3-dimensional grid graph as in the SIMPLE GLOBAL ROUTING problem. Consider a single net N, consisting of a source $r \in V(G)$ and k sinks $s_1, \ldots, s_k \in V(G)$ with weights $w_1, \ldots, w_k \geq 0$, where $k \geq 1$ is a fixed constant. Assume that we are given costs $c : E(G) \to \mathbb{R}_+$ on the edges, and delay per unit distance $d > 0$ and bifurcation cost $b > 0$, as in the formulation of the REPEATER TREE TOPOLOGY problem. Show that it is possible to compute in polynomial time a Steiner tree Y for N in G which minimizes the weighted sum of the edge cost and the sink delays, i.e. such that

$$\sum_{e \in E(Y)} c(e) + \sum_{i=1,\ldots,k} w_i \left(\sum_{e \in E\left(Y_{[r,s_i]}\right)} d\,\ell_1(e) + b\left(\left|E\left(Y_{[r,s_i]}\right)\right| - 1\right) \right)$$

is minimum.

(5 points)

Exercise 11.4:
Let the chip area be $[0, q] \times [0, 1]$ with an even $q \in \mathbb{N} \setminus \{0\}$. Let $\alpha, \beta \in \mathbb{R}_{>0}$, $\alpha < \beta$. Let $\mathcal{T}_\alpha$, respectively $\mathcal{T}_\beta$ be a set of ℓ_1-balls with unit radius, centered at all the points $(2k, 0)$, respectively $(2k+1, 1)$, for $k = 0, \ldots, q/2$. For a rectilinear segment s in the chip area, define

$$c(s) := \sum_{T \in \mathcal{T}_\alpha} \alpha\,\ell_1(s \cap T) + \sum_{T \in \mathcal{T}_\beta} \beta\,\ell_1(s \cap T).$$

For a path $P = (s_1, \ldots, s_n)$ set $c(P) := \sum_{i=1}^{n} c(s_i)$. Let G be the grid graph with vertical gridlines at $0, 1, \ldots, q$ and horizontal gridlines at $0, 1/2, 1$.

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Show that, for β sufficiently close to α, if we remove any horizontal edge with y-coordinate $1/2$ from G, G does not contains a c-shortest path from $(0, 1/2)$ to $(q, 1)$.

(5 points)

Deadline: July 14^{th}, before the lecture. The websites for lecture and exercises can be found at

`http://www.or.uni-bonn.de/lectures/ss16/ss16.html`

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