Prof. Dr. Stephan Held
Philipp Ochsendorf, M. Sc.

Exercise Set 8

Exercise 8.1. Show that the SINGLE ROW ALGORITHM can also be used to minimize linear bounding box netlength (instead of quadratic movement for the SINGLE ROW PLACEMENT PROBLEM WITH FIXED ORDERING).

(5 points)

Exercise 8.2. Consider the *spreading LP* for $d = 2$:

$$\begin{aligned}
\min \quad & \sum_{e \in E(G)} w(e)\, l(e) \\
\text{s.t.} \quad & \sum_{y \in X} l(\{x,y\}) \geq \frac{1}{4}\left(|X|-1\right)^{3/2} && x \in X \subseteq V(G) \\
& l(\{x,y\}) + l(\{y,z\}) \geq l(\{x,z\}) && x,y,z \in V(G) \\
& l(\{x,y\}) \geq 1 && x,y \in V(G),\ x \neq y \\
& l(\{x,x\}) = 0 && x \in V(G)
\end{aligned}$$

Show that the optimum of the spreading LP is a lower bound for the cost of any 2-dimensional arrangement.

(5 points)

Exercise 8.3. Let T be a finite, nonempty subset of $\mathbb{R}^2$. Show that CLIQUE can be computed in $O(|T| \log |T|)$ time where

$$\textsc{Clique}(T) := \frac{1}{|T|-1} \sum_{\{(x,y),(x',y')\} \subseteq T} \left(|x-x'| + |y-y'|\right).$$

(4 points)

Exercise 8.4. Consider quadratic netlength minimization in x-dimension based on the (quadratic) CLIQUE netmodel i.e.

$$\textsc{CliqueSQ}(N) := \sum_{\{p,q\} \subseteq N} \frac{w(N)}{|N|-1}\Big(x(p) + x(\gamma(p)) - x(q) - x(\gamma(q))\Big)^2$$

(a) Show that CLIQUESQ can be replaced equivalently by the quadratic STARSQ netmodel

$$\textsc{StarSQ}(N) := w'(N) \cdot \min\left\{ \sum_{p \in N} \left(x(p) + x(\gamma(p)) - c\right)^2 \,|\, c \in \mathbb{R} \right\}$$

for an appropriate weight function w'.

(b) For a fixed placement x and a single net N let $l, r \in N$ be defined as $l := \arg\min\{x(p) + x(\gamma(p)) \mid p \in N\}$ and $r := \arg\max\{x(p) + x(\gamma(p)) \mid p \in N\}$. We further define for $p, q \in N$

$$w_{pq}^{\mathrm{B2B}} := \begin{cases} 0 & \text{if } \{p, q\} \cap \{l, r\} = \emptyset, \\ \left|x(q) + x(\gamma(q)) - x(p) - x(\gamma(p))\right|^{-1} & \text{else.} \end{cases}$$

Show that the CliqueSQ netlength with weights w^{B2B} equals the (linear) bounding box netlength for placement x.

(3 + 3 points)

Deadline: June 27th, before the lecture. The websites for lecture and exercises can be found at

`http://www.or.uni-bonn.de/lectures/ss17/chipss17.html`

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