Prof. Dr. Stephan Held
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Exercise Set 6

Exercise 6.1. Consider the *spreading LP* for $d = 2$:

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

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

(5 points)

Exercise 6.2. Provide a polynomial time algorithm for the Standard Placement Problem restricted to instances with only one circuit.

(5 points)

Exercise 6.3. Consider the Standard Placement Problem on instances without blockages, where $h(C) \equiv 1 \equiv w(C)$ (unit size for $C \in \mathcal{C}$) as well as $w(N) \equiv 1$ (unit net weights for $N \in \mathcal{N}$).

Prove or disprove that this problem is NP-hard.

(5 points)

Exercise 6.4. The Gridded Placement Problem is an extension of the Standard Placement Problem with a grid $\Gamma = \Gamma_x \times \Gamma_y$ where $\Gamma_z := \{k \cdot \delta_z : k \in \mathbb{Z}\}$ with $\delta_z \in \mathbb{Z}$ for $z \in \{x, y\}$. In this variant, the lower left corner of each circuit is required to be in Γ.

Prove that the Gridded Placement Problem is NP-hard even if an optimum solution of the associated ungridded placement problem is known.

(5 points)

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

`https://www.or.uni-bonn.de/lectures/ss25/chipss25_ex.html`

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