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Exercise Set 8

Exercise 8.1. Consider the Placement Legalization Problem with $y_{\max} - y_{\min} = 1$. We are given an infeasible placement $\tilde{x} : \mathcal{C} \to \mathbb{R}$. Show that there are instances for which there is no optimum solution which is consistent with $\tilde{x}$, i.e. such that $x(C) < x(C') \Rightarrow \tilde{x}(C) \leq \tilde{x}(C')$.

(5 points)

Exercise 8.2. Consider the following variant of the Single Row Placement With Fixed Ordering problem, in which we minimize the bounding box net length:

> **Input:** A set $\mathcal{C} = \{C_1, \ldots, C_n\}$ of circuits, widths $w(C_i) \in \mathbb{R}_+$, an interval $[0, w(\square)]$, s.t. $\sum_{i=1}^{n} w(C_i) \leq w(\square)$. A netlist $(\mathcal{C}, P, \gamma, \mathcal{N})$ where the offset of a pin $p \in P$ satisfies $x(p) \in [0, w(\gamma(p))]$. Weights $\alpha : \mathcal{N} \to \mathbb{R}_+$.
>
> **Task:** Find a feasible placement given by a function $x : \mathcal{C} \to \mathbb{R}$ s.t. $0 \leq x(C_1)$, $x(C_i) + w(C_i) \leq x(C_{i+1})$ for $i = 1, \ldots, n-1$ and $x(C_n) + w(C_n) \leq w(\square)$, that minimizes
>
> $$\sum_{N \in \mathcal{N}} \alpha(N) \cdot \mathrm{BB}(N).$$

Here, $\mathrm{BB}(N)$ denotes the bounding box net length.

Show that there exist $f_i : [0, w(\square)] \to \mathbb{R}$, $i = 1, \ldots, n$, piecewise linear, continuous and convex, such that we can solve this problem by means of the Single Row Algorithm.

(5 points)

Exercise 8.3. Formulate the Simple Global Routing Problem as an integer linear program with a polynomial number of variables and constraints.

(5 points)

Exercise 8.4. Show that the Vertex-Disjoint Paths Problem is NP-complete even if G is a subgraph of a track graph G_T with two routing planes. Recall that in this case G_T is a graph $G_T = (V, E)$ for some $n_x, n_y \in \mathbb{N}$ with $V = \{1, \dots, n_x\} \times \{1, \dots, n_y\} \times \{1, 2\}$ and $E = \{\{(x, y, z), (x', y', z')\} : |x - x'|z + |y - y'|(3 - z) + |z - z'| = 1\}$.

Hint: Consider the proof of Theorem 5.2.

(5 points)

Deadline: Tuesday, June 4^{th} , before the lecture. The websites for lecture and exercises can be found at:

`http://www.or.uni-bonn.de/lectures/ss19/chipss19.html`

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