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Exercise Set 8

Exercise 8.1. Consider following specialized legalization problem. A feasible placement consists of integral placement coordinates $x, y : \mathcal{C} \to \mathbb{Z}^2$ (such that all circuits are located within the chip image), and all circuits have unit height and width. In addition, there is an (infeasible) input placement $\tilde{x}, \tilde{y} : \mathcal{C} \to \mathbb{R}^2$.

- Find a polynomial-time algorithm that finds a legal placement minimizing the linear or quadratic movement.
- Find a linear time algorithm that finds a legal placement minimizing the quadratic movement if the instance consists of a single row. Assume that the input is sorted.

(2+2 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 $\mathcal{C} = \{C_1, \dots, C_n\}$ of circuits, widths $w(C_i) \in \mathbb{R}_+$, an interval $[0, w(\Box)]$, s.t. $\sum_{i=1}^{n} w(C_i) \leq w(\Box)$. 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 $i = 1, \dots, n-1$ and $x(C_n) + w(C_n) \leq w(\Box)$, 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 $f_i : [0, w(\Box)] \to \mathbb{R}$, $i = 1, \dots, n$, piecewise linear, continuous and convex, such that we can solve this problem by means of the Single Row Algorithm.

(5 points)

Exercise 8.3. Consider an instance of the Multisection Problem with k regions and a feasible fractional assignment. Prove that there is an integral partition which violates capacity constraints by at most

$$\frac{k-1}{k} \max \{\text{size}(C) : C \in \mathcal{C}\}.$$

(5 points)

Exercise 8.4. Consider the Escape Routing Problem: We are given a complete 2-dimensional grid graph $G = (V, E)$ (i.e. $V = \{0, \ldots, k-1\} \times \{0, \ldots, k-1\}$ and $E = \{\{v, w\} \mid v, w \in V, \|v - w\| = 1\}$) and a set $P = \{p_1, \ldots, p_m\} \subseteq V$. The task is to compute vertex-disjoint paths $\{q_1, \ldots, q_m\}$ s.t. each q_i connects p_i with a point on the border $B = \{(x, y) \in V \mid \{x, y\} \cap \{0, k-1\} \neq \emptyset\}$.

Find a polynomial-time algorithm for the Escape Routing Problem or prove that the problem is NP-hard.

(5 points)

Deadline: June 14, before the lecture. The websites for lecture and exercises can be found at:

`http://www.or.uni-bonn.de/lectures/ss22/chipss22_ex.html`

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