Research Institute for Discrete Mathematics
Chip Design
Summer Term 2014

Prof. Dr. S. Hougardy
R. Scheifele, M. Sc.

Exercise Set 6

Exercise 6.1:

Let $G = (V, E)$ be a connected graph, $c : E \to \mathbb{R}_{\geq 0}$ be a cost function and $T \subseteq V$ be a set of terminals. Prove:

a) If $b_1 : V \times 2^T \to \mathbb{R}_{\geq 0}$ and $b_2 : V \times 2^T \to \mathbb{R}_{\geq 0}$ are feasible lower bounds, then $\max(b_1, b_2)$ is a feasible lower bound.

b) $b_j(v, I) := \max_{J \subseteq (I \cup \{v\}), |J| \leq j} \text{smt}(J), \quad v \in V, I \subseteq T$, is a feasible lower bound for any $j \geq 2$.

(1 + 4 points)

Exercise 6.2:

Given a chip area A and a set $\mathcal{C}$ of circuits. A *move bound* for a circuit C is a subset $A_C \subseteq A$ in which C must be placed entirely. Assume that the height and width of every circuit is 1 and that A and each move bound A_C, $C \in \mathcal{C}$, are axis-parallel rectangles with integral coordinates. Describe an algorithm with running time polynomial in $|\mathcal{C}|$ that decides whether there exists a feasible placement such that all move bound constraints are met.

(4 points)

Exercise 6.3:

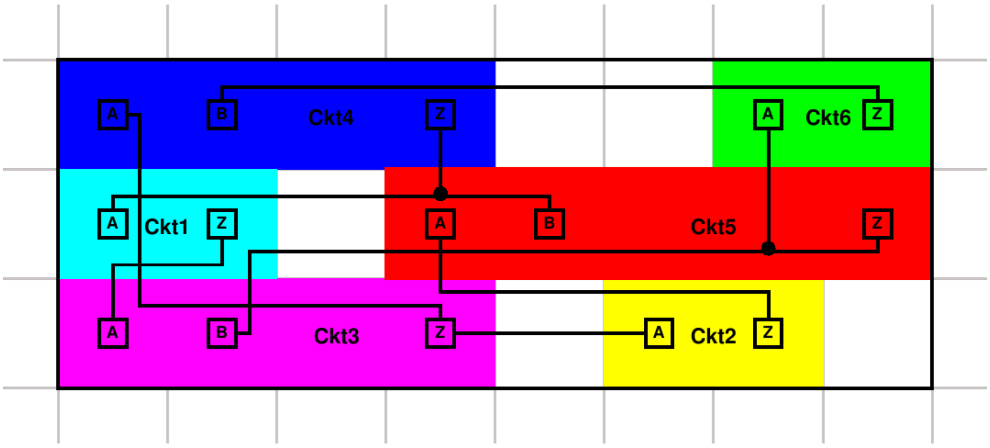
Consider the placement instance in the figure below. Each of the circuits Ckt1, Ckt2, Ckt3, Ckt4, Ckt5, and Ckt6 must be placed in one of the three circuit rows. Of course, their placed areas must also be within the chip area (black outline) and must not intersect each other. The orientation of the circuits must not be changed. The figure shows a feasible placement.

Pins (can be seen as point-shaped objects) are marked by small squares within their circuits. The centers of these squares are the pin locations. They are fixed relative to their circuit. Nets are described by Steiner trees connecting their pins. These Steiner trees are not pairwise disjoint; therefore Steiner points are drawn as filled circles. Two adjacent parallel grey lines have distance one.

The *Steiner tree net length* of a placement is defined as

$$\textsc{Steiner}(\mathcal{N}) := \sum_{N \in \mathcal{N}} \textsc{Steiner}(N)$$

where $\mathcal{N}$ is the set of nets in our instance. The placement in the figure has a Steiner net length of 32.



(a) Prove that there is no feasible placement with $\textsc{Steiner}(\mathcal{N}) < 9$. Can you find a better lower bound?

(b) Determine a feasible placement of minimum Steiner net length.

(If your placement is feasible and k units worse than the optimum, you will get $\max\{0, 5 - k\}$ points.)

(2 + 5 points)

Deadline: Thursday, May 22, before the lecture.
The websites for lecture and exercises are linked at

http://www.or.uni-bonn.de/lectures/ss14/ss14.html

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