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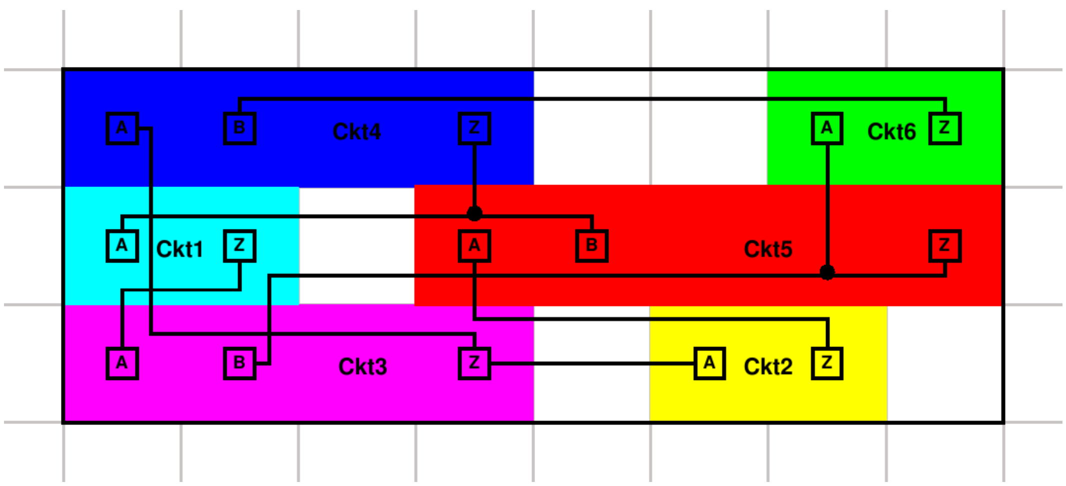
Exercises 5

1) 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 outlines 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 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.
Note that, for better readability, not all Steiner trees in the above figure are optimum. The placement in the figure has a Steiner tree 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? (2 points)

(b) Determine a feasible placement of minimum Steiner tree net length. (6 points)

(If your placement is feasible and k units worse than optimum, you will get $\min\{0, 6 - k\}$ points.)

2) Let A be the chip area and $\mathcal{C}$ a set of circuits with move bounds $A_C \subseteq A$ and $h(C) = w(C) = 1$ for all $C \in \mathcal{C}$. Assume that A and each move bound A_C, $C \in \mathcal{C}$, is an axis-parallel rectangle 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.
Hint: Consider the set

$$\left\{ \bigcap_{C \in \mathcal{C}'} A_C \cap \bigcap_{C \in \mathcal{C} \setminus \mathcal{C}'} (A \setminus A_C) \quad : \mathcal{C}' \subseteq \mathcal{C} \right\} \setminus \{\emptyset\}.$$

(4 points)

Deadline: May 18 before the lecture (12.15 pm).