Research Institute for Discrete Mathematics
Chip Design
Summer Term 2014

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

Exercise Set 9

Exercise 9.1:
Prove: Unless $P = NP$, there is no polynomial time n^α approximation algorithm for the QUADRATIC ASSIGNMENT PROBLEM for any $\alpha < 1$ even if $w(e) = 1$ for all $e \in E(G)$, c is zero, d is metric and G is a tree.

(4 points)

Exercise 9.2:
Let $G = (V, E)$ be an undirected graph with edge weights $w : E(G) \to \mathbb{R}_{\geq 0}$. Let $\mathcal{C} \subseteq V(G)$ and $f : V(G) \backslash \mathcal{C} \to \{1, \ldots, k\}$ be a placement function, where $k \in \mathbb{N}$. We are looking for positions $f : \mathcal{C} \to \{1, \ldots, k\}$ such that

$$\sum_{e=\{v,w\} \in E(G)} w(e) \cdot |f(v) - f(w)|$$

is minimum. f is not required to be injective.

Prove that this problem can be solved optimally by solving $k - 1$ minimum weight s-t cut problems in digraphs with $\mathcal{O}(|V(G)|)$ vertices and $\mathcal{O}(|E(G)|)$ edges.

Hint: Consider the digraphs G_j defined by $V(G_j) = \{s, t\} \cup \mathcal{C}$ and

$$\begin{aligned} E(G_j) = &\{\{s, v\} : \exists\, w \in V(G)\backslash\mathcal{C}, f(w) \leq j, \{v, w\} \in E(G)\} \cup \\ &\{\{v, w\} : v, w \in \mathcal{C}, \{v, w\} \in E(G)\} \cup \\ &\{\{v, t\} : \exists\, w \in V(G)\backslash\mathcal{C}, f(w) > j, \{v, w\} \in E(G)\} \end{aligned}$$

(4 points)

Deadline: Tuesday, June 17, 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 .