Chip Design
SS 2008

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Exercise 4

1. Assume there is an oracle which, neglecting the disjointness of the circuits, returns a placement of minimum total netlength for any input netlist containing only two-terminal nets.

   Show that such an oracle can be used to minimize the bounding box netlength of a general netlist (neglecting the disjointness of the circuits). (4 points)

2. (a) Show that, for quadratic netlength minimization, CLIQUE net models can be replaced equivalently by STAR net models by adjusting the netweights. (4 points)

   (b) Conclude that, for quadratic netlength minimization, it suffices to solve a linear equation system $Ax = b$, where A has $O(|P| + |C|)$ non-zero entries. (2 points)

3. Let $G = (V, E)$ be a simple graph with $V = \{1, \ldots, n\}$. The Laplacian matrix L_G of G is an $n\times n$-matrix, whose entries $l_{i,j}$, $1 \leq i, j \leq n$, are given by

$$l_{i,j} = \begin{cases} -1 & \text{if } i, j \in E, \\ |\delta(i)| & \text{if } i = j, and \\ 0 & \text{otherwise.} \end{cases}$$

   (a) Prove that L_G is positive semidefinite, that is, $x^T L_G x \geq 0$ for all $x \in \mathbb{R}^n$. (Hint: Rewrite $x^T L_G x$ as a sum of squared differences.) (3 points)

   (b) Let G be connected and let $\lambda_1 \leq \lambda_2 \leq \cdots \leq \lambda_n$ be the eigenvalues of L_g. Show that $\lambda_1 = 0$ and $\lambda_2 > 0$. (2 points)

   (c) Show that the multiplicity of 0 as an eigenvalue of L_G equals the number of connected components of G. (2 points)

The deadline for all problems is **Tuesday May 20 at 12:15**, before the lecture.