國立中央大學數學系

專題演講

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題目 ：Analytical Methods for Circuit Placement Optimization

時間：2013 年 12 月 24 日(星期二) 1:00 p.m. ~ 2:30 p.m.

地點： 中央大學鴻經館M 107室

摘要：

In this talk, we introduce circuit placement process in EDA (Electronic Design Automation) of large scale integrated circuits (LSI), and consider nonlinear optimization methods used in the field. The circuit placement works on a cell-level netlist, which can be defined as a graph $\mathcal{N} = (V, E)$, where a node $v \in V$ corresponds to a cell, and an edge $e \in E$ to a net that is a subset of V. The cells are logical gates such as AND, NAND, NOR, half adder, etc., and a net e is a set of the cells that are required to be interconnected. Let $V = \{1, 2, \ldots, n\}$ be a set of cells, and the coordinates of cell i be (x_i, y_i) $(i = 1, 2, \ldots, n)$, the circuit placement problem is formulated as to determine node locations $\boldsymbol{x} = (x_1, x_2, \ldots, x_n)^T \in \mathbb{R}^n$, $\boldsymbol{y} = (y_1, y_2, \ldots, y_n)^T \in \mathbb{R}^n$ so that all the cells are located within predefined rectangular area. As the objective function to be minimized, we use total half-perimeter wire length (HPWL) which is the sum of the half-perimeter wire length of net e denoted $\mathrm{HPWL}_e(\boldsymbol{x}, \boldsymbol{y})$ below over all nets in E.

$$\mathrm{HPWL}_e(\boldsymbol{x}, \boldsymbol{y}) = (\max\{x_i | i \in e\} - \min\{x_i | i \in e\}) + (\max\{y_i | i \in e\} - \min\{y_i | i \in e\}).$$

Since the objective function above is not differentiable, untill now, some kinds of approximate functions have been used. One way is to use quadratic objective functions as approximated wire length. The other is to approximate max and min functions by some kind of differentiable functions. As the quality of the final placement results is estimated by HPWL, other nonlinear optimization methods are expected to be used directly to minimize HPWL. For example, subgradient methods can be applied to the circuit placement because max function satisfies the Lipschitz condition $|\max(\boldsymbol{x}) - \max(\boldsymbol{y})| \leq \|\boldsymbol{x} - \boldsymbol{y}\|_2$ for all $\boldsymbol{x}, \boldsymbol{y} \in \mathbb{R}^n$, where $\max(\boldsymbol{x}) = \max\{x_i | i = 1, 2, \ldots, n\}$ for $\boldsymbol{x} = (x_1, x_2, \ldots, x_n)^T \in \mathbb{R}^n$.

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