California Institute of Technology
Department of Computer Science
Electronic Design Automation

CS137a, Winter 2004 Assignment #5 Monday, March 8

Due: Wednesday, March 17, 4:59pm.

Resources You are free to use any books, articles, notes, or papers as references. Provide citations in your writeup as appropriate.

Collaboration Please work independently on this assignment.

Writeup Writeup should be in an electronically readable format (HTML or PDF preferred). State any assumptions you need to make.

Problems

1. **[30–60 minutes]** Fill in details for a Simulated Annealing approach to homogeneous, resource-bound scheduling. Assume you have a static task graph and are given a number of identical resources. The runtime of each task is static and given to you as part of the scheduling problem. You are familiar with the general simulated annealing framework from class and reading.

   (a) Identify the "moves" which you will allow the annealer to make.

   (b) Give the cost function which the annealer will use to drive optimization. Explain each of the terms of the cost function. Make sure the cost function is relative "cheap" to evaluate (ideally $O(1)$); identify the complexity of evaluating the cost function.

   (c) Explain how state and costs are updated after each move.

   To fully specify the algorithm, you would also need to provide a cooling schedule or strategy. We are not asking that you provide that as part of your answer to this question.

2. **[60–90 minutes]** How would you solve dataflow-oriented bi-partitioning in order to minimize cycle time? In class we talked about partitioning techniques that minimized number of cut edges (bisection width). We noted that this did not, necessarily, address the issue of critical path length. In this problem, you want to minimize the number of times each path (or cycle) is cut. To make this concrete:

- minimize the cycle time for the graph (without adding registers – don't worry about retiming, that's an important, practical issue, but is not what this question is about).
- partition should be δ-balanced with $\delta \leq 5\%$.
- non-cut edges have delay 1, cut-edges have delay 100

Consider the following techniques discussed in class:

(a) KLFM partitioning

(b) network flow-based partitioning

(c) α-β search

(d) simulated annealing

Pick 3 techniques (at least two of which should be from the list above), and sketch how you would adapt the technique to solve this problem. This question is, potentially, open ended. The time guidance suggests you spend up to 30 minutes understanding the problem, then 20 minutes on each of the three techniques.

3. [**90–120 minutes**] Perform two-sided, one-dimensional place and route for routed channel width minimization. You have a set of connected cells and may place them along two rows sharing a single channel. You want to place and route them (2-metals for channel route) so as to minimize the channel width required. You will need to worry about vertical constraints. You may assume you have permutable cell inputs. Your placement should be moderately fast (avoid simulated annealing, avoid invoking a full router on ever placement "move").

   - Provide your algorithm for both placement and routing
   - Aside from solving the cases where this is exactly the problem you have to solve, how else might this algorithm be useful?