

Project

A Simple Simulated-Annealing Cell Placement Tool

Introduction

Develop a simple simulated annealing-based placer that minimizes the total wirelength. You will also study the effects of the cooling rate (see cooling parameters below) on the quality of the placement.

Assumptions

- HPWL (half-perimeter of the smallest bounding box containing all pins for a net) is used to estimate the wirelength of any net
- The core area is an 2D array of empty squares (sites)
- Each cell is a square and matches the site size.
- The site size is 1x1.
- No site is assigned to more than one cell.
- The distance between two cells is measured from the center of one cell to the center of the other.

The Input Netlist

The input to the placer is a netlist file with the following format

- The first line contains 4 values:
 - the number of cells to be placed.
 - the number of connections (nets) between the cells.
 - the number of rows (ny)
 - the number of columns/sites per row (nx)
- Each of the following lines represents a net and it contains the following:
 - The number of components attached to the net
 - The list of components attached to the net

An example of a netlist file content is shown below:

```
3 3 2 2
3 0 1 2
2 2 0
2 1 2
```

- Line 1: The number of components is 3 and the number of nets is 3. The placement grid is 2x2 (2 rows; each of 2 sites).
- Line 2: First net connects 3 components: 0, 1 and 2
- Line 3: Second net connects 2 components: 2 and 0
- Line 4: Third net connects 2 components: 1 and 2

The cooling schedule:

- Initial Temperature = $500 \times \text{Initial Cost}$
- Final Temperature = $5 \times 10^{-6} \times (\text{Initial Cost}) / (\text{Number of Nets})$
- Next Temperature = $0.95 \times \text{Current Temperature}$ ← 0.95 is the cooling rate
- Moves/Temperature = $10 \times (\text{Number of cells})$

The placer output

The placer displays (on the console) the final placement and the final wire length when it finishes. For example:

```
-- -- -- -- 01 08
09 -- 10 -- 02 03
-- 04 07 -- 05 --
06 -- -- 11 -- 12
```

Total wire length = 25

Where:

- -- : Empty site
- DD : The site has the component number DD

Notes:

- 1) Your implementation must support swapping with empty cells.
- 2) You need to select the data structures carefully to reduce the implementation time complexity. Running T3 design in less than 60 seconds is a good indicator.
- 3) Plot the temperature against the total wire length (TWL) for the 6 designs.
- 4) Plot the TWL vs. the cooling rate for the 6 designs; make sure that you use the same random seed for any given design. Use the cooling rates: 0.75, 0.8, 0.85, 0.9, and 0.95 (one graph/design)
- 5) Print the TWL after the initial random placement and after finishing the SA.
- 6) To make sense of how well is your implementation, print the grid in binary format after the initial random placement and after the SA. An Example for 3 rows by 5 columns grid is shown below, 0 means occupied cell and 1 means an empty cell:

```
01010
11010
00001
```

Grading:

- a) 15%: Parsing the netlist
- b) 15%: Initial Random Placement
- c) 30%: Correctness of the results (through test cases)
- d) 10%: Representing the placement on the console.
- e) 10%: Cooling rate vs. TWL graphs.
- f) 10%: Temperature vs. TWL graphs.
- g) 10%: The report (at least 5 pages discussing the algorithm, the implementation, the graphs and some conclusions)
- h) 10% (Bonus): Animate the placement progress graphically (Animated GIF is sufficient).
- i) 10% (Bonus): The fastest implementation (one group only).

Guidelines:

- Work in a group of three students.
- Use any programming language to implement your placer.
- Use GH for development.

Timeline:

- November 27: items 'a' to 'd', from the list above, are implemented and can be demonstrated; a few bugs are allowed. Failure to provide an acceptable demonstration will result in losing 25% of the grade.
- December 11: Final Demo. All deliverables must be ready before the interview.