Combinatorial Decision Making and Optimization

Project Report

VLSI Design

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1 SMT

1.1 Considerations on the Height

The problem was solved assuming that no gaps are allowed between the circuits, the plate height is thus obtained by taking the sum of the circuits' areas divided by the plate width.

To solve cases for which this does not apply the code could be modified by adding a for loop that tries to solve the problem with increasing heights, starting from the calculated height.

1.2 Variable Encoding

Each circuit can be represented as its lower-left corner coordinates c (c_x, cy) and a number identifying the circuit (n).

1.3 Constraints

For the following constraints dc (dc_x, dc_y) will be used to define each circuit own given dimension and dp (dp_x, dp_y) for the plane given dimension. The list of all circuits will be defined as C.

- **Inside**

  Each circuit's bottom-left corner needs to be in the grid so that all the circuit is contained in the plate.

  $$\forall c \in C : c_x \geq 0$$

  $$\forall c \in C : c_x + dc_x \leq dp_x$$

  The same should be done with the y coordinate, and all this constraints must be true.

- **Overlap**

  Each circuit cannot overlap with another circuit. This means that the distance between the two corners needs to be at least as big as the dimension of the first circuit.

  Given than circuit 1 x coordinate is bigger than circuit 2 x coordinate $(c1_x \geq c2_x)$ this constraints must be respected:

  $$\forall c1, c2 \in C \wedge c1 \neq c2 \wedge c1_x \geq c2_x : c1_x - c2_x \geq dc2_x$$

  For the opposite case $(c1_x < c2_x)$ the same reasoning can be applied. The same two case can be seen for the y coordinate of the circuits. It's enough that **at least one** this cases is true for the circuits to avoid overlapping.

- **Implied**

  The implied constraints were already given: the sum of the horizontal/vertical sides of the traversed circuits, can be at most the one of the plate.

$$\forall i \in rows : (\sum_{c \in C} dimension_{i,c}) \leq plate_{width},$$

$$dimension_{ic} = \begin{cases} d_x, & \text{if c in row i} \\ 0, & \text{otherwise} \end{cases}$$

The same needs to be done for the columns considering y coordinates and the circuit height.

1.4 Rotation

To allow the model the possibility of rotation we can add a list of boolean variables that is the same length as the number of circuits and keeps track of whether the circuit is rotated or not. Given this list, it's easy to find the actual width and height of each circuit and using those in the constraints.

1.5 Final Considerations

The implied constraints seem to generally worsen the solving time (although in some specif case they do help), so they were removed from the code.

The model was able to solve 37/40 instances with the time constraint of 300 seconds. Many of which can be solved in less than 60 seconds.