Research Institute for Discrete Mathematics
Chip Design
Summer Term 2014

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Exercise Set 1

Exercise 1.1:

Let $n \in \mathbb{N}$ such that $\log_2(n) \in \mathbb{N}$ and let $plus : \{0,1\}^{2n} \to \{0,1\}^{n+1}$ be the addition function of two binary n-bit integers. Consider the following problem:

Input: A_i, $B_i \in \{0,1\}$ for $i = 0, 1, \ldots, n-1$ representing $A = \sum_{i=0}^{n-1} 2^i \cdot A_i$ and $B = \sum_{i=0}^{n-1} 2^i \cdot B_i$.

Task: Compute the binary representation of $A + B$.

Construct two netlists (one for condition a) and one for condition b)) realizing the function $plus$ using a library containing only *AND*s, *OR*s and *XOR*s such that

a) The number of used circuits is at most $5n$.

b) The number of circuit edges on each path of the netlist graph is at most $n + \log_2(n)$.

For both netlists derive formulas for the number of used circuits and maximum number of circuit edges on any path in the netlist graph.

(6 points)

Exercise 1.2:

Prove or disprove: For every netlist with technology mapping there is a logically equivalent one that only contains a) *NOR*s b) *XOR*s c) *NAND*s.

(6 points)

Exercise 1.3:

Let N be a finite set of pins, and for each $p \in N$ let $\mathcal{S}(p)$ be a set of axis-parallel rectangles. We want to compute the bounding box net length of N, i.e. the minimum perimeter of any axis-parallel rectangle R such that for every $p \in N$ there exists $S \in \mathcal{S}(p)$ with $S \cap R \neq \emptyset$ (in closed border interpretation). Let $n := \sum_{p \in N} |\mathcal{S}(p)|$. Show that the bounding net length of N can be computed in $\mathcal{O}(n^3)$ time.

Hint: Enumerate possible coordinates for the lower left corner of R.

(4 points)

Deadline: Thursday, April 17, before the lecture.
The websites for lecture and exercises are linked at

http://www.or.uni-bonn.de/lectures/ss14/ss14.html

In case of any questions feel free to contact me at scheifele@or.uni-bonn.de .