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Exercise Set 6

Exercise 6.1:
Show that the Standard Placement Problem can be solved optimally in time

$$O\left(\frac{((n+s)!)^2}{2^s}\cdot(n+k)\cdot(m+n^2+k\log k)\cdot\log(n+k)\right),$$

where $n=|\mathcal{C}|$, $s=|\mathcal{S}|$, $k=|\mathcal{N}|$, $m=|P|$. Here, $\mathcal{C}$ is the set of circuits, $\mathcal{N}$ the netlist, P the set of pins and $\mathcal{S}$ a set of disjoint blockages.

(4 points)

Exercise 6.2:
Given rectangles $C_1,\dots,C_n$ with widths $w_1,\dots,w_n$ and heights $h_1,\dots,h_n$, formulate an integer linear program that checks whether they can be packed (without overlaps) within a rectangle $[x_{\min},x_{\max}]\times[y_{\min},y_{\max}]$, allowing rotations by multiples of 90°.

(3 points)

Exercise 6.3: **Programming exercise**
Implement an algorithm which computes a rectangular chip image of minimum area in which a feasible placement exists for a given set of n rectangles (without rotations), *by means of sequence pairs*. The theoretical running time must be $O((n!)^2\cdot n\log n)$.

n
w_1 h_1
w_2 h_2
$\dots$
w_n h_n

(a) Input file format.

W H
x_1 y_1
x_2 y_2
$\dots$
x_n x_n

(b) Output format.

Figure 1

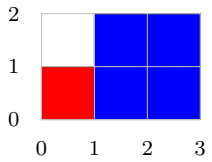
Input: your program will take one argument, the path to a file as in Figure 1a where $n\in\mathbb{N}_{>0}$ is the number of rectangles to be placed, and the remaining n lines define the width $w_i\in\mathbb{N}_{>0}$ and the height $h_i\in\mathbb{N}_{>0}$ of the i-th rectangle. The values w_i and h_i fit into a 32-bit unsigned integer.

```
2
1  1
2  2
```

(a) Input file.

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

(b) Output.



(c) Resulting placement.

Figure 2: An example of an instance with two squares with edge length 1 and 2, and one possible output.

Output: the output consists of $2n + 2$ nonnegative integers, which your program will write to the standard output in the form specified by Figure 1b, where W and H are, respectively, the width and the height of the computed chip area $[0, W] \times [0, H]$, and the remaining n lines encode the coordinates $(x_i, y_i) \in [0, W - w_i] \times [0, H - h_i]$ of the lower left corner of the i-th rectangle.

The program must be written in C or C++ (you are allowed to use up to C++11) and must compile and run on Linux. To achieve the maximum score, your program must not leak any memory and must be well documented. It must compile with either Clang $\geq$ 3.4.2 or Gcc $\geq$ 4.8.3, with `-Wall -Wpedantic -Werror`, and it cannot link to any other library. You can use any tool available in the standard library.

The deadline for the programming exercise is June 19th, 12:00. Deliver your source code by email.

(15 points)

Deadline: June 9th, before the lecture. The websites for lecture and exercises can be found at

`http://www.or.uni-bonn.de/lectures/ss16/ss16.html`

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