Prof. Dr. Jens Vygen
Martin Drees, M. Sc.

Programming Exercise 2

Exercise P.1. Implement an algorithm based on the *sequence pairs* idea for the following problem: Find a rectangular chip image of minimum area in which a disjoint placement exists for a given set of n rectangles. Rotating rectangles is not allowed.

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 P.1

Your program will take one argument: the path to a file as in Figure P.1a. Each number in the input file is a positive integer that can be represented by 32-bit. The first line of the input file encodes the number of rectangles n to be placed. Each of the remaining n lines defines width w_i and height h_i of the i-th rectangle.

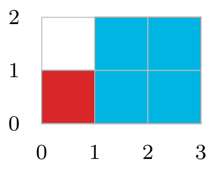
The output consists of $2n+2$ nonnegative integers, which your program will write to the standard output in the form specified by Figure P.1b. Here W and H denote the width and height of the computed chip area $[0,W]\times[0,H]$. The remaining n lines encode the coordinates $(x_i, y_i) \in [0, W-w_i]\times[0,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

```
2
1 1
2 2
```

(a) Input file.

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

(b) Output.



(c) Resulting placement.

Figure P.2: Example instance with two squares with edge length 1 and 2, and one possible output.

A concrete example instance is described in Figure P.2.

The program must be written in `C` or `C++` and must compile and run on Linux. You are allowed to use any any ISO `C` or `C++` standard including `C++20`. You can use any tool available in the standard library. Your program must compile with either Clang (any version $\geq$ 3.4.2) or Gcc (version $\geq$ 4.8.3) with `-Wall -Wextra -Wpedantic -Werror` and cannot link to any external library except the standard library.

The program has to achieve the theoretical running time of $\mathcal{O}((n!)^2 \cdot n^2)$. To achieve the maximum score, your program must not leak any memory and must be well documented. Bonus points will be rewarded for beautiful implementations and effective speedup techniques.

You can find test instances and a starting point for your program including a parser at:

`https://gitlab.com/ChipDesignProgramming/sequence-pairs`

You can submit an initial solution until May 30 to get some feedback on your program.

(24 + 8* points)

Deadline: June 6, before the lecture, via email to drees@or.uni-bonn.de. The websites for the lecture with all exercises can be found at:

`http://www.or.uni-bonn.de/lectures/ss23/chipss23_ex.html`