MSc in Computer Science
2021/22 - Autumn Semester

Constraint Programming

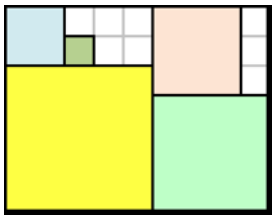
Project I – Packing Squares into Rectangles

Rectangle (square) packing problems involve packing all squares with sizes 1 × 1 to n × n into the minimum area enclosing rectangle (respectively, square). Rectangle packing is a variant of an important problem in a variety of real-world settings. For example, in electronic design automation, the packing of blocks into a circuit layout is essentially a rectangle packing problem. Rectangle packing problems are also motivated by applications in scheduling [1].

1. Specify in **Choco** a class **pack(int n, int maxW, int maxH)** that packs a set on all n squares with sizes from 1 × 1 to n × n into a rectangle of dimensions **maxW** and **maxH**. It should return a **2** × **n** matrix of integers where indicating the origins of the rectangles. If there is no solution the matrix is null (filled with zeros).

   Example: The call **pack(5, 9, 7)** returns an array corresponding to a possible packing of the 5 squares into the 9×7 rectangle.

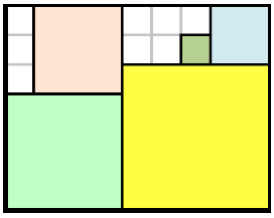
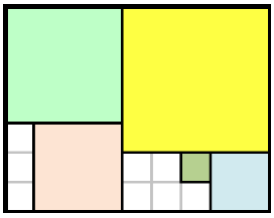
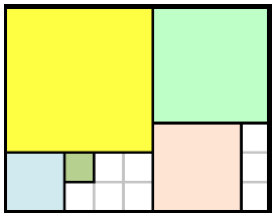
```
{  {3, 1, 6, 6, 1},
   {6, 6, 5, 1, 1} }
```



   To speed up execution of your function, consider the following issues:

   a) Global Constraints;
   b) Redundancy;
   c) Symmetry breaking
   d) Heuristics.

   Note: For symmetry breaking notice that the following solutions are symmetric to that shown above:

2. Use the above function to obtain the smallest rectangle into which a set of n squares with sizes from 1 × 1 to n × n can be packed. Try your implementation with different values of n.

3. Write a small report, describing the results we have achieved with the different options, as well as the technique used to obtain the rectangles with smallest area.

The report and the code should be sent by email to the lecturer (**pb@fct.unl.pt**) no later than Sunday, 14th November, at 23:59. Please use subject **Project_PR_1_by_XXXXX+YYYYY** (where XXXXX and YYYYY are the numbers of the students - max 2 per group).

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[1] H. Simonis and B. O'Sullivan. Search Strategies for Rectangle Packing. In *Procs of 14th international conference on Principles and Practice of Constraint Programming* (CP '08), Peter J. Stuckey (Ed.), Springer-Verlag, 52-66, September 2008.