Packing Containers in 2D

15-48 EC thesis proposal

For:	Master Students that know how to program and are interested. If you've ever done a course in heuristics, it is a pre.
Load:	15 - 48 EC, depending on blocks (see below)
Period (approx.):	From September 2021 onward
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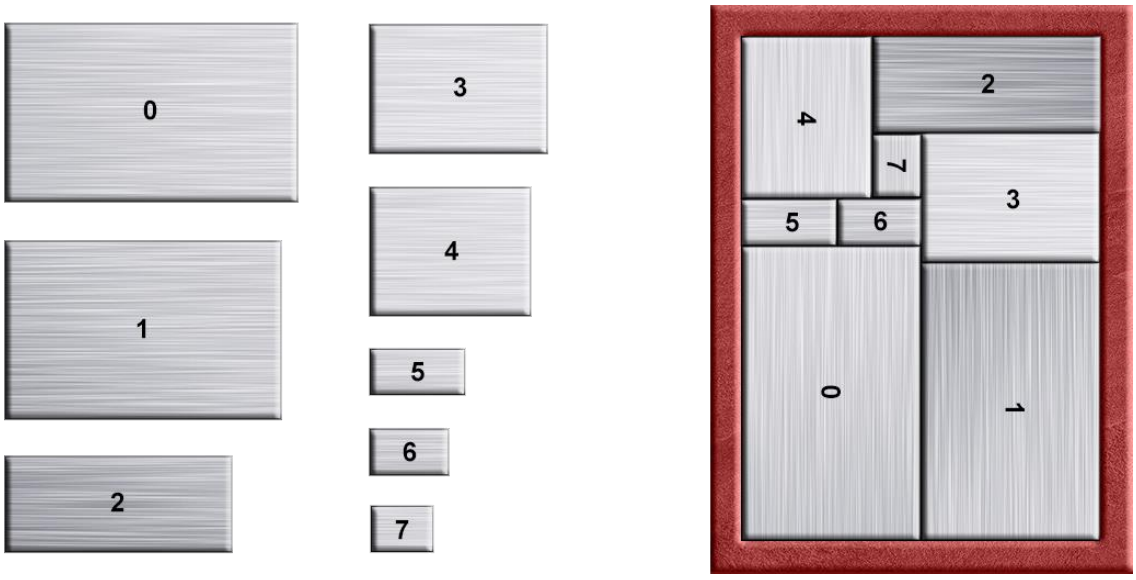

A typical PRPP-instance. This one has a solution, that is certainly not always the case

About the project

A Perfect Rectangle Packing Problem instance is a puzzle in which rectangular tiles must be placed inside a rectangular frame of equal size. So if it has a solution, it is a perfect fit. These problems are extremely complicated; a milestone was reached in 2016 when a famous unsolved instance of 34 tiles was solved by a multi-core several month runtime operation [1].

Recently, a very interesting pattern was found for these problems: there is a dependency from the number and the side length of the tiles to the chance of a puzzle being solvable [2]. This dependency is a very strict "phase transition", and it scales quadratically.

Block #1
In Braam's investigation, no fewer than 36,600 puzzles were solved and made publicly available. As soon as one solution was found, the algorithm was halted. Investigate ways of finding *all* solutions for each puzzle. This could be important, as the *number* of solutions could be related to the solvability itself. This could be a very tough start. Start with the smaller puzzles. Distributed computing power might help, but then we'll have to reassess the work load, as this block is 'only' 15-18EC's worth.

Block #2
Random restarts sometimes prove really valuable in solving these kinds of decision problems [3]. See if this works for these puzzles, and make graphs like in Figure 2 of Gomes & Selman's paper[3]. They must be different for different puzzles? But how?

Block #3
What are the consequences of the pruning options in the solver's algorithm, where it comes to runtime? Design an experimental setup to test this. The paper by UvA-student Joperi Sleegers might help [4].

Block #4
Let's try to find patterns in all the solutions. Use any means necessary.

How to start
First, read this paper [1]. Then, if you're still interested (or in doubt), contact me.

[1] https://bit.ly/3xM2QfT

[2] Braam & Van den Berg (2021) How to make (un)solvable Rectangle Puzzles
Contact me for a manuscript; at the time of writing, it is still under revision.

[3] Gomes, Carla, and Bart Selman. "On the fine structure of large search spaces." Proceedings 11th International Conference on Tools with Artificial Intelligence. IEEE, 1999.

[4] https://arxiv.org/abs/2107.00314