Master
Constraint Programming

Université de Nantes

Feuille de travaux dirigés n° 1
Constraint Programming

Exercice 1.1

If we list all the natural numbers below 10 that are multiples of 3 or 5, we get 3, 5, 6and 9. The sum of these multiples is 23. Propose a CSP to find the sum of all the multiplesof 3 or 5 below 1000.

Exercice 1.2

Consider a 111 by 111 binary matrix. The goal is to put 11 ones in each row in such a way that each column has 11 ones, and each pair of rows must have exactly 1 one in the same column. Propose a CSP to solve this problem.

Exercice 1.3

These problems are said to have many practical applications including sensor placements for x-ray crystallography and radio astronomy. A Golomb ruler may be defined as a set of m integers $0 = a_1 < a_2 < \ldots < a_m$ such that the $m.(m-1)/2$ differences $a_j - a_i, 1 \leq i < j \leq m$ are distinct. Such a ruler is said to contain m marks and is of length a_m. The objective is to find optimal (minimum length) or near optimal rulers. Note that a symmetry can be removed by adding the constraint that $a_2 - a_1 < a_m - a_{m-1}$, the first difference is less than the last.
There is no requirement that a Golomb ruler measures all distances up to its length - the only requirement is that each distance is only measured in one way. However, if a ruler does measure all distances, it is classified as a perfect Golomb ruler. For example, $0, 1, 3, 6$ is not a Golomb ruler while $0, 1, 4, 6$ is one.
There exist several interesting generalizations of the problem which have received attention like modular Golomb rulers (differences are all distinct mod a given base), disjoint Golomb rulers, Golomb rectangles (the 2-dimensional generalization of Golomb rulers), and difference triangle sets (sets of rulers with no common difference).
For a related problem, please see Costas Arrays.