# Solving diversity problems

Starting date : Any time from January to May 2025

Duration: 2 to 6 months (can be followed by a PhD)

#### Place :

Université de Lille - CRIStAL (UMR CNRS 9189), Villeneuve d'Ascq 59655, France

#### Supervisors :

Julien Baste (Associate professor), CRIStAL : julien.baste@univ-lille.fr Marie-Émilie Voge (Associate professor), CRIStAL : marie-emilie.voge@univ-lille.fr

## Context

When studying classical optimization problems, several approaches exist. The main one consists in finding a unique solution, and another one consists in enumerating all of them. In this internship, we plan to work on the so called *diversity problems* where the goal is to find a fixed number of solutions guaranteed to be pairwise distant with regard to a given metric.

Intuitively, this approach allows to take into account real context. Indeed, real world problems are often simplified during the modelization process. For example, subjective constraints, such as preferences or aesthetic, may be removed. Offering a diverse set of solutions allows a decision maker to reintroduce these forgotten constraints.

These problems have applications in a large number of fields like multiobjective optimization, operational research, or artificial intelligence and can be used for example in disease detection.

### Tasks

Finding a single solution of 2-SAT is known to be polynomial, but the number of solutions can be exponential in the size of the input. In this internship, we want to handle DIVERSE 2-SAT, where the input is a formula  $\phi$ , and two integers k and d and the goal is to find k solutions that satisfy  $\phi$  where solutions are pairwise at distance d for the Hamming distance.

In this internship, the selected student is expected to :

- Read and explain the basic bibliography on the topic.
- Look for an algorithm solving DIVERSE 2-SAT in polynomial time or prove that such an algorithm does not exist.
- Determine how the provided algorithm or reduction can be extended to other problems.
- If the problem is determined to be NP-hard, the student is expected to search for algorithms in the context of parameterized complexity.
- The obtained results should be written down at the end of the internship. If the results are good enough, a scientific publication can be expected.

## Application

It is expected from a candidate to have some experience with complexity.

If you are interested in this internship proposition, please send us your CV and transcripts to julien.baste@univ-lille.fr and marie-emilie.voge@univ-lille.fr.