Offre de Stage

— **Titre :** Decision rules and stability in two-stage robust optimization

— **Unité de recherche :** Institut de Mathematiques de Bordeaux (IMB), Centre Inria de l'Universite de Bordeaux

— **Localisation :** Talence (Bordeaux)

— **Thème :** Robust optimization

— **Mots clefs :** robust optimization, decision rules, stability, decomposition methods

— **Les noms, prénoms et courriels des encadrants**

Co-encadrant Ayşe Nur Arslan, ayse-nur.arslan@inria.fr

Co-encadrant Boris Detienne, boris.detienne@u-bordeaux.fr

— **Profil recherché :** Second year masters' student in Operations Research or related fields

Required skills :

Mixed-integer linear programming

C++ or Python/Julia

Knowledge in one of the following fields is appreciated :

Robust optimization

Decomposition methods in MILP

Stabilization techniques

— The internship may lead to a thesis offer within the context of the project DROI (Decision Rules for Optimization under Uncertainty) that received ANR funding in 2022.

Contexte scientifique

In this internship, we will be interested in optimization under uncertainty using the robust optimization paradigm. In robust optimization, it is assumed that the uncertain parameters lie within a compact, often convex, set known as the uncertainty set. The constraints are then imposed for every realization of uncertainty within this set while the objective function is evaluated for the worst-case realization within the set. When some of the variables of the problem can adjust to the realization of uncertainty, we speak of *adjustable robust optimization* or *robust optimization with recourse*. When the adjustable variables are continuous we speak of *continuous recourse*, otherwise we speak of *mixed-integer recourse*.

Recently, there has been many methodological developments in both exact and approximate solution of adjustable robust optimization problems. For instance, for continuous recourse, [6] propose Benders' decomposition-like algorithms, whereas [7] propose constraint-and-column generation. On the other hand, [4] propose monolithic formulations and [5] propose a branch-and-bound algorithm, for the approximate solution of the problem, in the binary and mixed-integer recourse cases, respectively. The premise of these latter approaches is to

choose K recourse policies to be implemented before the realization of uncertainty and to implement the best among them after the realization of uncertainty. There are also many decision rules such as affine [2], multi-polar [1], and binary decision [3] rules.

Objectifs

In this internship, we will focus on the solution of two-stage robust optimization problems with continuous or discrete recourse. Both exact solution algorithms and approximate solution via decision rules will be studied. The purpose of the internship is two-fold : studying and improving the numerical behavior of known decomposition methods (possibly using stabilization techniques), and studying new classes of decision rules, and developing solution algorithms if necessary. In order to achieve both of these objectives we will use a combination of integer programming, combinatorial optimization and non-linear programming techniques. An important part of the internship will be dedicated to implementing and numerically testing various solution algorithms.

Some of the applications we will consider may include robust network design (in the context of supply chains or energy networks) and disaster management.

Références

[1] W. Ben-Ameur, A. Ouorou, G. Wang, and M. Żotkiewicz. Multipolar robust optimization. *EURO Journal on Computational Optimization*, 6(4) :395–434, 2018.

[2] A. Ben-Tal, A. Goryashko, E. Guslitzer, and A. Nemirovski. Adjustable robust solutions of uncertain linear programs. *Mathematical programming*, 99(2) :351–376, 2004.

[3] D. Bertsimas and A. Georghiou. Binary decision rules for multistage adaptive mixed-integer optimization. *Mathematical Programming*, 167(2) :395–433, 2018.

[4] G. A. Hanasusanto, D. Kuhn, and W. Wiesemann. K-adaptability in two-stage robust binary programming. *Operations Research*, 63(4) :877–891, 2015.

[5] A. Subramanyam, C. E. Gounaris, and W. Wiesemann. K-adaptability in two-stage mixed-integer robust optimization. *Mathematical Programming Computation*, pages 1–32, 2019.

[6] A. Thiele, T. Terry, and M. Epelman. Robust linear optimization with recourse. *Rapport technique*, pages 4–37, 2009.

[7] B. Zeng and L. Zhao. Solving two-stage robust optimization problems using a column-and-constraint generation method. *Operations Research Letters*, 41(5) :457–461, 2013.