Call for Submissions: Special Issue on Optimization at the Second Level (Open Journal of Mathematical Optimization)

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The polynomial hierarchy is widely used for classifying optimization problems according to theoretical worst-case solution time. Level zero consists of problems solvable in polynomial time, while level one consists of the well-known class NP, containing (the decision versions of) mixed integer linear optimization problems, among others. The lesser-known second level is denoted by Σ_2^P and contains a variety of problems that either have multiple time/decision stages or have optimality conditions for one parametric problem embedded inside another. More abstractly, such problems can be viewed as those that have natural formulations with one existential and one universal quantifier. For instance, a typical problem in robust optimization asks whether there EXISTS some production plan that performs reasonably well under ALL possible price scenarios for electricity in the coming two years. A typical problem in bilevel optimization asks whether there EXISTS a way of setting taxes so that ALL courses of action by citizens acting purely in their own self interest lead to an outcome that is societally beneficial (e.g., generates reasonable tax revenue). A typical problem in Stackelberg games asks whether there EXISTS a starting move for the first player that wins the game against ALL possible counter-moves of the second player.

Problems of this type are often complete for the class Σ_2^P and hence are most likely not contained in the class NP. Even if this does not exclude efficient algorithms for special cases, which exist in particular in robust optimization, this means that such problems can be even harder than NP-complete in general, a situation that is typical in bilevel optimization and can also arise in robust optimization. In particular, two-stage robust optimization problems, specifically those with decision-dependent uncertainty, are closely related to bilevel optimization and are often intractable as well. While efforts to generalize the theory and algorithms from the better-studied case of NP-complete optimization problems have yielded many new insights concerning problems in Σ_2^P, the latter class has received far less attention than classes lower in the polynomial hierarchy. To develop a deeper understanding, there is a need for

a larger community to come together to develop new techniques, new tricks, new insights, new algorithms, and new theory to tackle the problems in this uniquely challenging area.

With this in mind, this special issue is focused on addressing the theoretical and computational aspects of problems at the second level of the polynomial hierarchy, particularly bilevel and robust optimization, but also problems arising in multistage stochastic/robust optimization and others. We particularly invite papers exploring the deep connections between problems in different, theoretically equivalent, classes of problem. This includes but is not limited to papers which:

- Investigate connections between robust and bilevel optimization (and maybe other areas), both from a theoretical and a computational perspective.
- Offer new theoretical insight into the structure of bilevel or robust optimization problems or devise theoretically based computational techniques.
- Classify bilevel or robust optimization problem structures regarding to their computational complexity or available solution techniques.

Submission deadline: June 30th, 2023

Submissions must follow the general OJMO guidelines, which can be found at the following link:

https://ojmo.centre-mersenne.org/page/submit-a-paper_en

When submitting the paper, choose the section "Special Issue on Optimization at the Second Level".