Minisymposium 1 - Discrete Optimization

Symmetry Reduction in Graph Coloring via Orbitopes

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It is a well-known phenomenon that symmetries in integer programming (IP) formulations makes them extremely hard to solve. The reason is that, on the one hand, the corresponding LP relaxations become poor and, on the other hand, the branch-and-bound tree is unnecessarily large, because equivalent solutions are found again and again. This situation also occurs for a natural IP formulation for *graph coloring*, which has a variable for each pair of a node in the graph and a potential color.
We have recently introduced so-called partitioning *orbitopes*, which are the convex hulls of 0/1 matrices with exactly one 1 in each row, whose columns are lexicographically sorted. The goal is to remove symmetry by isolating a lexicographically maximal representative in each orbit of the full symmetric group acting on the columns of the matrices. We derived a complete linear description of these polytopes. In this talk, we investigate the integer hulls of the intersections of orbitopes with the polytopes associated with the mentioned graph coloring formulation. The goal is to remove symmetry as much as possible. It turns out that even describing the dimensions of the resulting polytopes seems to be quite complicated (and so is the investigation of the facial structures). Nevertheless, we will discuss several classes of valid inequalities and present computational results based on them.
Joint work with Yuri Faenza and Volker Kaibel.