Integer Programming Formulations and Exact Algorithms for Hard Combinatorial Optimization Problems on Graphs

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The course presents several Integer programming (IP) formulations for combinatorial optimization problems on graphs. A special attention is devoted to IP models with an exponential number of variables and/or constraints and the relative exact algorithms, based on Column Generation and Constraint Separations. The course presents the basic concepts and main ideas of the effective exact methods based on branch-and-price and branch-and-cut techniques. These families of algorithms are often the state-of-the-art ones for several classes of optimization problems on graphs, like for example the vertex coloring problem or the graph partitioning problem. In a second part of the course, several Stackelberg-game problems on graphs are presented as well as the exact algorithms designed to compute optimal solutions. This part is focused on bilevel optimization and how it can be used to effectively tackle optimization problems on graphs. In a nutshell, the course is intended to present some of the most effective exact algorithms which exploit the combinatorial structure of the optimization problem on graphs and networks.