A STUDY OF ALGORITHMS FOR SOLVING INTEGER AND SEMI-INTEGER LINEAR PROGRAMMING PROBLEMS

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Integer and semi-integer linear programming problems (ILP and SILP) occupy an important place in modern optimization theory and are widely applied in production planning, logistics, transport problems, resource management and financial analysis. Unlike classical linear programming problems, where variables can take on arbitrary real values, in ILP an integer constraint is imposed on all or some of the variables, which significantly complicates the process of finding the optimal solution.

The aim of this work is to investigate the efficiency of modern algorithms for solving LP and LP-CIL problems, as well as to analyses their computational complexity and practical suitability for problems of various dimensions. The main focus is on approaches such as the branch-and-bound method, the branch-and-cut method, as well as the use of relaxations and heuristic algorithms.

The branch-and-bound method is one of the basic tools for solving integer optimisation problems. Its essence lies in the step-by-step partitioning of the feasible solution region into sub-problems, followed by an evaluation of the objective function's bounds. This allows for the elimination of unpromising options and a reduction in the computational load. An extension of this approach is the branch-and-cut method, which combines the branching procedure with the addition of linear constraints (cuts) that exclude non-integer solutions.

The paper also examines the application of relaxation methods, in particular linear relaxation, which allows an estimate of the optimal solution to be obtained and is used as an auxiliary tool in hybrid algorithms. Particular attention is paid to heuristic and meta-heuristic approaches, which ensure the finding of approximate solutions within a limited time, which is important for high-dimensional problems.

A comparison of the algorithms showed that exact methods guarantee the finding of the optimal solution, but their efficiency depends significantly on the structure of the problem and the number of variables. In turn, heuristic approaches allow for a significant reduction in computation time, although they do not guarantee the optimality of the result.

The results obtained can be used to select appropriate methods for solving practical optimization problems, as well as for developing hybrid algorithms that combine the accuracy of classical methods with the speed of heuristics. Thus, research into LP and SLP algorithms contributes to improving the efficiency of decision-making in complex control and planning systems.

References:

1. John E. Mitchell. *Integer Programming: Branch-and-Cut Algorithms*. Encyclopedia of Optimization, 2024.

2. Clautiaux F. *Last fifty years of integer linear programming: A focus on recent advances*. European Journal of Operational Research, 2025.

3. Scavuzzo L., Aardal K., Lodi A. та ін. *Machine learning augmented branch-and-bound for mixed integer linear programming*. Mathematical Programming, 2024.