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Summary of the dissertation: Algorithms for scheduling jobs with indeterminate release dates on unrelated machines

The fundamental aim of this dissertation is the development and study of algorithms for solving the job scheduling problems with indeterminate release dates on unrelated machines. The notion of „indeterminateness" may arise from the fact that a job's release date depends on the decisions, or it is due to the lack of knowledge of its exact value. In the first case, the reference is an integrated problem of machine location and job scheduling (Scheduling and Location, in short ScheLoc), where job's release dates are related to the time required to move each job to selectable machine locations. The considered imprecision of release dates is represented by well-defined uncertainty intervals, and the quality of scheduling is based on a regret function, leading to robust optimization problem. In consequence, the two types of optimization problems are taken into account. Firstly, a deterministic problem with the makespan criterion and precisely defined release dates of jobs is studied. Next, a non-deterministic (robust) problem with the minmax regret criterion for the makespan and interval (uncertain) release dates is investigated.

The deterministic scheduling problem is formulated under the assumption that the release dates are machine-dependent. The five methods for assessing the makespan value are developed and special cases, which can be solved optimally or in pseudopolynomial time, are identified. The algorithms for solving the underlying scheduling problem use a greedy decision-making strategy with long-term planning for the same quality decisions, a semi-random search (an algorithm based on Simulated Annealing metaheuristic) and a decomposition with exhaustive search. The statistical tests showed that a greedy algorithm guarantees statistically the lowest makespan value in comparison with the other methods.

The two cases of the robust optimization problem, in which the uncertainty intervals of release dates are job-dependent or machine-dependent, are distinguished. The difference in the interpretation of the maximum regret criterion for both cases is proved analytically. It is important to limit the number of scenarios in order to efficiently assess the minmax regret criterion value. It is shown that an extreme scenario and an intermediate scenario can simultaneously represent the worst-case scenario. Algorithms for solving the non-deterministic

problems use a greedy decision-making strategy, a decomposition of the robust criterion, a semi-random search (an algorithm based on Tabu Search metaheuristic) or a reformulation to the deterministic case. The statistical showed that the greedy algorithm guarantees statistically the lowest value of estimated maximum regret value for both robust optimization problems.

The results of research on scheduling problems are used to solve the ScheLoc problem with the makespan criterion and unrelated machines. For this purpose, a genetic algorithm and a metaheuristic-based algorithm (Simulated Annealing) are adapted. The impact of a two-stage optimization (called the sequential approach) on the makespan criterion is investigated by comparing it with the results of a joint optimization (called the holistic approach or the systemic approach). In the two-stage optimization, m-median and m-center problems are used to select the machine locations. A distinctive feature of this dissertation is the use of algorithms developed for the non-deterministic scheduling problems to solve the deterministic ScheLoc problem. It is shown that there exist instances of the ScheLoc problem that can be solved more efficiently assuming interval release dates of jobs.

The final section of this dissertation discusses application areas of the developed algorithms. It is shown how to apply the algorithms developed for the non-deterministic scheduling problems to production planning of Printed Circuit Boards (PCBs) with resource allocation. In addition, a theoretical example of scheduling scientific simulation studies is also discussed in detail

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