Hardness analysis and a new approach for the shift minimisation personnel task scheduling problem

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When considering personnel scheduling problems, there exist different levels of granularity. Personnel rostering can be considered coarsely granulated since it requires the assignment of large blocks in time, e.g. tours or shifts, to employees. In some contexts, a more finely granulated type of assignment is required such that a more detailed employee roster can be constructed. This is often the case in production facilities where not only shifts need to be assigned to personnel, but also tasks should be planned within each working shift. The result is that each employee knows *when* to work, and also *which tasks* to perform when working.

We study the problem of assigning tasks with fixed start and end times, to a set of employees whose shifts have already been assigned and who are furthermore restricted by qualification requirements. This problem was first introduced by Krishnamoorthy and Ernst [1] as the personnel task scheduling problem. The present study discusses the problem of minimising the number of active employees, i.e. employees who are performing at least one task, while still assigning all tasks. In the literature, this problem is denoted as the shift minimisation personnel task scheduling problem (SMPTSP) [2] . In practice, planners often try to minimise the same objective by assigning work such that all tasks can be performed with as few employees as possible in order to reduce operational personnel costs.

We present a two-phase hybrid heuristic approach which improves the current state-of-the-art [3] by solving all benchmark instances from the literature to optimality in very limited computation time. First, an initial solution is generated using a constructive heuristic. The initial solution is then improved in the second phase with a heuristic algorithm that employs a general purpose MIP solver for iteratively solving a restricted variant of the original model.

In the second part of this study, we investigate the influence of two properties of the SMPTSP on algorithmic performance: the average task length and the average number of tasks each employee can perform (the *multi-skilling level*). We examine their effect on the performance of both heuristic approaches and an

exact general purpose solver.

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References

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