THESIS INFORMATION

Title**: Some approaches for solving the personal scheduling problem**

Major: Computer Science

Major Code: 62.48.01.01

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1. ABSTRACT

The objective of personal scheduling aims to assign the jobs into available time windows so that jobs can be handled in the most effective way. Current personal task management applications such as Microsoft To-Do, Google Tasks, Apple Reminders, Evernote, nTask, Todoist, ... only provide a visual environment that helps us to manually organize jobs, and we often struggle because of that. Another issue is that sometimes these jobs require a lot of processing time, so it is difficult to determine and assign these jobs into suitable available time windows. However, unlike machines, personal jobs can often be split into a lot of parts so that they can be flexibly assigned in different available time windows. It is possible that the jobs are split into sub-jobs with ``too small size", the scheduling result is not as effective in many practical situations as expected since these jobs are too fragmented, and it should be spent more time on resuming the sub-jobs. It is necessary, consequently, to consider the constraint that “the jobs cannot be split less than a certain threshold” for a more efficient result, and this constraint is often not addressed in literature scheduling problems. Therefore, this thesis focuses on methodology and several approaches for solving the personal scheduling problem with two constraints that are the jobs that can be split but not less than a certain threshold and jobs are only assigned in available time windows.

With only one of these two constraints, the problem can easily determine the optimal solution. For example, if we consider the constraint of "the jobs that can be split but not less than a certain threshold", then the optimal solution is achieved by splitting all jobs equal to this specified threshold and then assigning these sub-jobs into the time axis. Otherwise, when only considering the constraint of "the jobs can be split and assigned in available time windows", the optimal solution is achieved by splitting all jobs into units of time is 1, and then assigning these sub-jobs into available time windows. However, if both constraints are considered at the same time, this problem becomes a strongly *NP*-hard problem.

This personal scheduling problem can be applied to one person (*personal scheduling problem*) or multiple people (*teamwork scheduling problem*). For each specific scheduling problem, the thesis has presented almost necessary approaches related, including (1) specification of the problem through problem statements, presentation of notations used in the problem, as well as giving illustrative examples to be able to understand the problem, ..., (2) approaches for solving the problem include analyzing the difficulty of the problem, considering some special cases, giving some properties in the structure of an optimal solution, proposing the exact method based on MILP model and approximate methods such as heuristic, metaheuristic, matheuristic, ..., and (3) the experimental results to evaluate the proposed methods on both input datasets which are small samples and large samples, from which to propose an effective method for selection with different input dataset types.

2. MAIN CONTRIBUTIONS

The main contributions of the thesis include:

C1. Considering and solving the unresolved issues of the personal scheduling problem (PSP) from previous studies.

C2. Extending research to solve specific personal scheduling problems with some constraints that are often used in practice such as each job has a different setup-time (PSP+setup-time), each job has a deadline for completion (PSP+deadline), and the personal scheduling problem for multiple people with different time windows (TWSP).

C3. Proposing a general scheme of 7 approaches to solve a class of personal scheduling problems including: (1) analyzing the difficulty of the problem, (2) considering some special cases, (3) giving some properties of the optimal solution, (4) determining the bounds of the problem, (5) building a MILP model, (6) using the exact method with MILP solver to determine the optimal solution for the problem, (7) using approximation methods as heuristic/metaheuristic/matheuristic to determine possible solutions to the problem.

C4. On the basis of considering the problem of individual job scheduling as a problem where time is a special resource that needs to be allocated for jobs, proposing some specific heuristics that inherit classical algorithms, and some metaheuristics commonly used in industry, thereby determining possible solutions with good quality within an acceptable runtime (less than 10 minutes).

C5. Proposing a matheuristics approach by combining a (meta)heuristic algorithm with an exact method using MILP solver to determine the best possible quality solution.

3. QUESTION ISSUES TO CONTINUE THE RESEARCH

From the research and contributions presented in this thesis to the personal scheduling problem, some issues can be considered and studied in the future, namely:

- Study other characteristics of the problem to apply other modeling methods, especially techniques in finding optimal solutions in the search space.
- Research and apply advanced techniques to determine the lower bound *LB* such as lagrangian relaxation, column generation, ... with the desire to propose a better lower bound *LB*.
- Implement more metaheuristics belonging to the swarm optimization algorithms such as particle swarm optimization, ant colonies optimization, bee colony, ...

- Research and apply other algorithms such as approximation algorithms for scheduling problems of strongly NP-hard class (polynomial-time approximation scheme) can measure the gap with theoretical optimal solutions such as PTAS, EPTAS , FPTAS, QPTAS, ..., or randomized algorithms such as Las Vegas algorithm, Monte Carlo algorithm, ...
- Change the strategy of dividing the input jobs of the matheuristic E4SSJ, or consider combining it with a machine learning method (called learnheuristic), ... to be able to determine an even better solution.
- Further survey the classification of input data to suggest specific effective algorithms for each one with different characteristics.

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