Invitation

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DOCTOR OF BUSINESS ECONOMICS

by Jingyu Luo

TOWARDS AUTOMATED DESIGN: PRIORITY RULES FOR RESOURCE-CONSTRAINED PROJECT SCHEDULING

Supervisor:
Prof. Dr. Mario Vanhoucke

Thursday, 2 May 2024 at 14h00
In the Faculty Board Room, Campus Tweekerken, Tweekerkenstraat 2, 9000 Ghent
Please confirm your attendance no later than 18 April by email to
Jingyu.Luo@ugent.be

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Abstract

The resource-constrained project scheduling problem (RCPSP) is about planning a series of precedence-related activities in a project while also considering constraints on the resources needed for these activities' completion. It is a complex problem that has attracted a lot of research attention. One common solution approach is using simple and fast priority rule-based heuristics to decide the order of activities. However, priority rules are problem specific. Therefore, no single rule consistently outperforms others across all scenarios, and project managers often have to test different rules to find the optimal one, which can be inefficient.

To improve this process, there is interest in developing a more standardized way to design new, better priority rules. Designing these rules is traditionally slow and limited by what experts know, leading to an interest in automating the process. This automation, known as hyper-heuristics, is being explored in various areas but is still quite new in project scheduling. The research presented in this dissertation aims to bridge the identified gap in the literature. It includes five chapters, with Chapter 1 offering an overview of project scheduling problems and the automated design of priority rules. The subsequent three chapters delve into distinct research avenues. Finally, Chapter 5 discusses the conclusions drawn and directions for future research. Further explanations are given below for Chapters 2 to 4.

Chapter 2 presents a method called genetic programming hyper-heuristics (GPHH) to generate new priority rules for the RCPSP, incorporating a technique for eliminating duplicates to enhance efficiency. This technique reduces the time required for training without losing effectiveness. The newly (GP-)designed rules are tested on various datasets and perform better than traditional rules in most cases, especially in large projects. Furthermore, a new method based on CHAID regression analysis is introduced, improving performance by accurately predicting the most effective combination of rules.

Chapter 3 explores using a supervised learning method to design priority rules, a different approach from the more common unsupervised methods like GPHH. It evaluates nine regression algorithms, improving the top three with ensemble techniques. These enhanced models perform better than traditional and GP-designed rules in many cases. The effectiveness of these new heuristics is verified on large project datasets, showing their wide applicability.

Chapter 4 tackles the issue of GPHH's high computational demand by introducing four surrogate models tailored to the RCPSP. These models match or exceed the original's performance in less time and are effective across various scenarios. The efficacy of one of the best surrogate models is further validated across various population sizes, showing its ability to achieve performance comparable to those of the original model after an extensive exploration of search spaces. An analysis of the surrogate models' precision and the compactness of the rules they generate indicates the surrogate models' ability to maintain high accuracy and generate more concise rules than the original RCPSP model, confirming their efficiency and effectiveness across different scenarios.

Curriculum vitae

Jingyu Luo (born in Liuzhou, Guangxi, China) holds a Master of Engineering degree in Control Science and Engineering (Shenyang Architecture and Civil Engineering Institute, Liaoning, China) and a Bachelor of Engineering degree in Electrical Engineering and Automation (Shenyang Architecture and Civil Engineering Institute, Liaoning, China). Jingyu joined the Department of Business Informatics and Operations Management at Ghent University in October 2017. During his Ph.D., Jingyu presented the results of his research at several conferences, such as the 18th International Workshop on Project Management and Scheduling (Ghent, online, 2022), the INFORMS Annual Meeting (Anaheim, online, 2021), the 31st European Conference on Operational Research (Athens, online, 2021), and the 30th European Conference on Operational Research (Dublin, 2019). Chapter 2 of Jingyu's dissertation is published in the international peer-reviewed journal *Expert Systems with Applications*, while Chapter 4 is published in the international peer-reviewed journal *Swarm and Evolutionary Computation*. Besides the work in his dissertation, Jingyu also contributed to a co-authored article published in *Expert Systems with Applications*.