FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

UNIVERSITEIT GENT

Invitation

You are cordially invited to the public defense to obtain the academic degree of

DOCTOR OF BUSINESS ECONOMICS

by Fangfang Cao

Approaches for improving robustness in project scheduling with uncertain durations: proactive and reactive perspectives

Supervisors:
Prof. dr. Mario Vanhoucke - Prof. dr. Zhengwen He

Friday, 11 October 2024 at 10h00
Live stream via Zoom.
Please confirm your attendance no later than 23 September by email to fangfang.cao@ugent.be
You will receive a link via email to attend the online meeting.

EXAMINATION BOARD

Prof. dr. Mirjam Knockaert
Chair - Ghent University

Prof. dr. Mario Vanhoucke
Supervisor - Ghent University, Vlerick Business School, University College London

Prof. dr. Zhengwen He
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Abstract

The doctoral dissertation consists of five chapters in which three mains chapters are involved with the focus of improving the robustness of project scheduling with duration uncertainty using proactive and reactive methods. Projects inevitably face uncertainties during their execution such as resource unavailability, tardy deliveries of material and a changed work scope, resulting in time and cost overruns and catastrophic failures. The proactive approach generates predictive baseline schedules designed to be robust by incorporating safety time to absorb anticipated disruptions prior to the start of the project. The reactive procedure is then invoked when a schedule breakage occurs during project execution, allowing for adjustments to maintain project on schedule or to prevent significant deviations.

Chapter 2 introduces a novel approach for sizing the activity buffers by clustering similar activities and allocating the buffers using a unique attribute in each cluster. Since an optimal clustering both in terms of the number of clusters and the assignment of activities to these clusters is needed. Secondly, an optimal selection of attributes for each cluster is crucial as well. Both questions cannot be investigated independently and only an integrated solution will result in optimal buffer sizes. An adapted multi-factorial evolutionary algorithm (aMFEA) is thus developed to solve multiple buffer allocation problems simultaneously. The results show the added value of the evolutionary components of the aMFEA and show that the proposed approach is superior to existing benchmarking procedures.

Chapter 3 continues the research from Chapter 2 and explores the impact of clustering on the performance of BAP. Four classes of clustering algorithms are proposed and tested, depending on statistical measures, activity preferences, criticality metrics and subparts of the project network. The goal is to determine the ideal groups of activities for creating buffers and placing them within the project network. The clusters are then inputted to the multi-population multi-factorial evolutionary algorithm (MPMFEA) for solving the single BAP and multiple BAPs at the one framework. The results validate the effectiveness of the proposed MPMFEA for solving the BAP, especially in combination with the network clustering method.

Chapter 4 intensifies the integration of proactive and reactive scheduling by using information about completed activities to improve the buffering of future similar activities identified in proactive scheduling. We propose to dynamically recluster and rebuffer activities to monitor the actual buffer consumption and predict future buffer consumption (i.e reactive) based on the buffered schedules from BAP (i.e. proactive). When the updated time buffers are deemed inadequate, we react by investing extra resources in order to expedite activities. A two-stage procedure is developed to resolve this problem with a multi-modal multi-objective genetic algorithm using time buffers and a Variable Neighbourhood Search heuristic using resource investments. The results show that the reclustering and rebuffering strategies prove effective and the additional resource investments enhance both the time and cost efficiency.

Curriculum vitae

Fangfang Cao (born in China) completed her Master of Management Science and Engineering at Xi'an Jiaotong University (XJTU) in 2015. She earned her Bachelor's degree in Information Management and Information Systems from Shanxi University of Finance and Economics in 2013. After completing her master's, she worked as a Senior Product Manager in an Information Technology company specializing in the power industry until 2019. In September 2019, Fangfang began her doctoral research at the Department of Operations Management & Industrial Engineering at XJTU. In November 2021, she started her joint PhD at Ghent University in the Department of Business Informatics and Operations Management. Chapters 2 and 3 of her dissertation are currently under revision in high-quality journals. Fangfang has presented her work at several conferences, including the Annual Meeting of the Operations Research Society of China (Zhengzhou, China, 2024) and the 3rd Intelligent Manufacturing Systems Engineering Conference (Xi'an, China, 2020).