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 Rojin Nekoueian

## Solution improvements for scheduling projects with alternative subgraphs

Supervisor:
Prof. dr. Mario Vanhoucke

**Tuesday, 10 September 2024 at 15h00**
In the Faculty Board Room, Campus Tweekerken, Tweekerkenstraat 2, 9000 Ghent
Please confirm your attendance no later than 25 August by email to rojin.nekoueian@ugent.be

**EXAMINATION BOARD**

Prof. dr. Maggie Geuens
Chair - Ghent University

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

Prof. dr. José Coelho
Ghent University, Universidade Aberta

Prof. dr. Veronique Limère
Ghent University

Prof. dr. Louis-Philippe Kerkhove
Ghent University, Crunch Analytics

Prof. dr. Tom Servranckx
Ghent University

Prof. dr. Erfan Asgari
Excelia Business School, France

Dr. Jakob Snauwaert
OMP company, Belgium

## Abstract

This doctoral dissertation comprises six chapters focused on project scheduling within project management, particularly under resource constraints and precedence relations. Effective project scheduling is crucial for organisational success, especially in a rapidly evolving business environment. The problem addressed in this dissertation is an extension of the resource-constrained project scheduling problem where activities should be scheduled considering constrained resources and precedence relations. In this problem, the project network structure is assumed to be fixed, which doesn't adequately reflect modern project complexities. Therefore, researchers have added flexibility to project structure by introducing the resource-constrained project scheduling problem with alternative subgraphs, where project work packages can be implemented in multiple alternative ways. This dissertation addresses the resource-constrained project scheduling problem with alternative subgraphs with the objective of project duration minimisation by integrating solutions for selection and scheduling subproblems.

Chapter 2 focuses on developing fast and relatively good solutions for the problem of this dissertation by employing unique priority rules for each subproblem and ultimately devising constructive heuristics. Additionally, the chapter examines how the selection of appropriate priority rules can impact the project duration. The results show that using distinct priority rules significantly reduces project duration, offering valuable insights for project managers in optimising decisions based on project complexity.

Chapter 3 introduces a dynamic learning-based genetic algorithm to enhance the efficiency of solution approaches for the resource-constrained project scheduling problem with alternative subgraphs. The genetic algorithm of this chapter uses constructive heuristics and priority rules to create high-quality initial solutions. The best genetic algorithm framework is identified through experimental design and learning-based local searches, with various restart schemes included to further enhance performance. Based on the results and experiments, the newly developed dynamic genetic algorithm outperforms other solution methodologies proposed for the problem.

Chapter 4 builds upon Chapters 2 and 3, presenting a novel genetic algorithm that combines various learning-based genetic algorithms to explore different areas of the solution space. This chapter evaluates existing and new performance measures across a range of the solutions of the problem. The combined genetic algorithm framework is tuned by analysing the number of schedules needed to be generated by each genetic algorithm. Lastly, a new threshold-based stopping criterion is introduced that incorporates multiple threshold-based criteria.

Chapter 5 extends the problem with cost minimisation objective introducing various cost components and cumulative resources. A new mixed-integer mathematical model, validated using Gurobi, is proposed along with adapted heuristics as the solution approach. The methodology is tested on both an artificial dataset and empirical case studies, demonstrating practical relevance. The conclusion is that solution approaches based on time and resources are competitive for low-complexity projects considering time and cost objectives, while time-based approaches perform best for all projects considering time minimisation.

## Curriculum vitae

Rojin Nekoueian (born in Tehran, Iran) finished her Master of Science as the top-ranked student among master's students in Industrial Engineering – Project Management at Amirkabir University of Technology in 2020 and obtained a Bachelor of Science in Industrial Engineering at Amirkabir University of Technology in 2017. She started as a doctoral researcher at Ghent University in September 2020 at the Department of Business Informatics and Operations Management. Chapter 2 of her dissertation has been published in Computers and Industrial Engineering (CAIE), and Chapters 3 and 5 are under revision in high-quality journals. Rojin presented her work at several international conferences: the INFORMS Annual Meeting (Anaheim, online, 2021), the 31st and 32nd European Conference on Operational Research (Athens – hybrid, 2021 and Espoo, 2022) and the 18th and 19th International Conference on Project Management and Scheduling (Ghent – online, 2022 and Bern – 2024).