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 Miao Li

Multi-league sports scheduling: design, mathematical models and algorithms

Supervisor:
Prof. dr. Dries Goossens

Monday, 10 June 2024 at 15h30
In the Faculty Board Room, Campus Tweekerken, Tweekerkenstraat 2, 9000 Ghent
Please confirm your attendance no later than 27 May by email to Miao.Li@ugent.be

EXAMINATION BOARD

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Abstract

Most sports associations organize a multitude of leagues, which cannot be scheduled independently from each other. In professional sports, the leagues are connected by teams sharing the same police zone or stadium. In practice, scheduling typically follows a hierarchical structure, starting with the top-tier league, which subsequently imposes constraints on scheduling lower-tier leagues. In amateur and youth sports, clubs typically have several teams categorized by age and strength levels. However, all teams from the same club share the same infrastructure. This can lead to capacity problems when clubs need to host more matches on a particular point in time than their available playing fields can support. This PhD dissertation investigates the simultaneous determination of schedules from multiple leagues with such interdependencies.

Study 1 introduces the multi-league sports scheduling problem, in which we consider round robin leagues with different sizes. Our focus lies on schedules that use a minimal number of matchdays, where for each league we are given a feasible set of home-away patterns (HAP) to be assigned to the teams. A HAP determines when the team assigned to it plays home and when away. We also optimize the competition organizer's decision on the starting time of each league. The objective is to minimize venue capacity violations since the number of simultaneous home games that clubs can organize for their teams is limited by the capacity of their venue. Computational results demonstrate that clubs do not need to invest in more terrains given careful planning of the leagues and their starting rounds.

Study 2 further explores the multi-league sports scheduling problem by considering more general and realistic settings: leagues can be interrupted by rest periods, teams have a larger set of HAPs to choose from, and teams from the same league need not necessarily play in the same matchday. The objective is still to minimize venue capacity violations. This study reveals that the potential of this added flexibility to contribute to a reduction in capacity violations.

Study 3 integrates the sports team grouping problem, where leagues need to be composed, with the previously introduced multi-league sports scheduling problem, where a time-constrained round robin schedule is determined for each league. The former deals with minimizing the total travel distance faced by the teams, while the latter focuses on minimizing the venue capacity violations faced by the clubs. While in practice, these problems are typically handled sequentially (solving the grouping problem first), we show this comes at a cost provided that leagues have different sizes or are played on different matchdays. We develop a heuristic to reveal the trade-off between these two objectives, and allow the practitioner to make an informed choice.

Study 4 proposes a multi-league scheduling approach using a single incomplete round robin to organize sports competitions. While the classic approach is to split up teams over leagues, and then having each league play a round robin tournament, in this case we have all teams playing in a single round robin tournament, however, without the constraint that each team competes against every other team (an equal number of times). We first select a HAP for each team, and then construct the opponent schedule. This approach leads to challenging issues related to minimizing the venue capacity of the clubs and minimizing the total travel of the teams, while respecting fairness constraints. Experimental outcomes show that our approach can be highly effective compared to the classic approach, allowing a significant decrease in travel distance and/or capacity violations.

Curriculum vitae

Miao Li (born in China) holds a Master of Management degree in Management Science and Engineering (2019, Shanghai University, China). During her master, she has co-authored papers that have been published in the top-ranked journals in the field such as *Computers and Operations Research*, *Transportation Research Part D: Transport and Environment*, and *Computers and Industrial Engineering*. She joined the Department of Business Informatics and Operations Management at Ghent University in September 2019. During her PhD, Miao presented the results of her research at several conferences including: the 31st European Conference on Operational Research (2021, online), the Norwegian Operations Research Society Annual Conference (2021, Bergen), the 2nd EUROYoung Workshop (2022, Porto), the 32nd European Conference on Operational Research (2022, Espoo), the 9th MathSport international conference (2022, Reading), the 13th International Conference on the Practice and Theory of Automated Timetabling (2022, Leuven), and the 36th conference of the Belgian Operational Research Society (2022, Ghent). Study 1 of her dissertation have been published in *European Journal of Operational Research*, study 3 and 4 are currently under revision in renowned international journals.