Springer Proceedings in Mathematics & Statistics

Volume 411

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Editors

Operational Research

IO 2021—Analytics for a Better World. XXI Congress of APDIO, Figueira da Foz, Portugal, November 7–8, 2021

Springer

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ISSN 2194-1009 ISSN 2194-1017 (electronic)
Springer Proceedings in Mathematics & Statistics
ISBN 978-3-031-20787-7 ISBN 978-3-031-20788-4 (eBook)
https://doi.org/10.1007/978-3-031-20788-4

Mathematics Subject Classification: 90Bxx, 65XX, 91Axx, 49-XX, 90XX

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The XXI Congress of APDIO, the Portuguese Operational Research Society, took place on 7 and 8 November 2021, with more than 120 registered participants and around 80 papers submitted. This congress took place at a very particular historical moment. After the first waves of the COVID-19 pandemic, which had immobilized humanity, cancelling all gatherings, society was equipped with the first effective weapons against the pandemic, in particular vaccines, and the world was beginning to reopen. Science, in all its facets, had been massively called upon for this on a scale that humanity had never before experienced. It was in this context of hope that the APDIO congress took place, also celebrating the significant contribution of this discipline in fighting the pandemic. Thus, "Analytics for a Better World" was chosen as the congress theme.

The plenary talks were fully aligned with the congress theme. Manuel Matos spoke about uncertainty in decision processes. We know that uncertainty is the rule rather than the exception, but it has a special impact when human lives are at stake, in humanitarian logistics applications, or in disaster management. And this was the theme of the talk by Sérgio Guedes Silva, who leads the supply chain management team of the World Food Program (WFP), and who spoke about "The power of analytics in a Humanitarian Context". An equally sensitive mission was the one taken on by Vice Admiral Gouveia e Melo, who led the task-force in Portugal that managed the vaccination process against COVID-19. For the benefit of Portugal, the success of his work was overwhelming. Therefore, we wanted to hear from the Vice-Admiral the main challenges faced, and the lessons learnt in this process. The pandemic had unexpected impacts on various sectors of the economy, but logistics is one of the activities that is still most affected by the disruption suffered. Supply chain management is Pedro Amorim's area of work, and it was from this application that he reflected on how we can leverage the practical relevance of our research.

The works selected for this book have also, in different ways, contributed to a better world.

As shown in "A Biased Random-Key Genetic Algorithm for the Home Care Routing and Scheduling Problem: Exploring the Algorithm's Configuration Process", by Aguiar et al, one approach to reducing the expenses of the health system

is to shift some of the undifferentiated care provision to social systems. Such is the case of home care, provided by social organizations which support the elderly and convalescent patients, contributing to reducing the demand for hospital care. But, and not less relevant, home care allows for more personalized treatment of these patients.

Forest fires cause incalculable damage to fauna and flora and lead to the death of people and financial damage in general. To avoid wildfire catastrophes is fundamental to detect fire ignitions in the early stages, which can be achieved by monitoring ignitions through sensors. "An Integer Programming Approach for Sensor Location in a Forest Fire Monitoring System", by Azevedo et al, deals with the decision of where to locate such sensors to maximize the coverage provided by them, taking into account different types of sensors, fire hazards, and technological and budget constraints.

The healthcare structure and quality of life of the population can be impacted by the efficiency of global pharmaceutical supply chains, through the price and the availability of medication. A bi-objective capacity allocation model that aims to generate cost-efficient and fair solutions is presented in "Capacity Allocation Incorporating Market Equity Concerns: A Pharmaceutical Supply Chain Case Study" by Bessa et al, minimising unfairness with a metric that accounts for drug shortages and maximising the economic value generated. Results suggest that a significant amount of unfairness can be tackled with little impact on economic targets.

The paper "The Shortest Path in Signed Graphs", by Costa et al, looks at shortest path problems in a signed graph. The shortest path in a signed graph can be used to understand how successive relations, even if distant, aaffect the dynamics of the network. Initially introduced to represent feelings among people belonging to the same social group, signed graphs were later used to model other systems, such as biological networks, international relations networks, risk management networks, i.e, systems a polarized environment is present and there is the willingness to consider it explicitly.

Having efficient manufacturing processes requires accurate failure detection to reduce equipment downtime. "The Break Point: A Machine Learning Approach to Web Breaks in Paper Mills", by Dias et al, presents a machine learning approach for predicting web breaks in tissue paper machines. Web breaks prediction plays a key role in ensuring product quality and sustainable use of energy, water, and other resources.

A real case addressing the optimization of fire brigades' rescue time is presented by Lima et al. "A Resectorization of Fire Brigades in the North of Portugal". Through a practical application of a Non-dominated Sorting Genetic Algorithm (NSGA-II) that performs the distribution of fire brigades into geographic areas, the authors propose a solution method to minimise the rescue time response in the case of forest fires, assuming the geographic and population characteristics of the areas and the fire brigades' capacity.

Firms can determine optimal operating policies based on agility and flexibility principles. In the work of Magalhães et al. "A Holistic Framework for Increasing

Agility in a Production Process", the authors address the complexities of real-world manufacturing systems by proposing a generic framework for increasing the agility of the production processes. Existing interdependencies between portfolio management, product complexity, equipment efficiency, and production planning decision-making are mapped into a set of methods that can enable flexibility.

To achieve high production efficiency, adequate additive manufacturing scheduling methodologies are important. In "Nesting and Scheduling for Additive Manufacturing: An Approach Considering Order Due Dates" by Nascimento et al, a constraint programming formulation is presented to solve a problem of simultaneously nesting irregular-shaped parts and scheduling additive manufacturing machines, balancing the fulfilment of order due dates with the usage of the machines' capacity.

The work proposed by Öztürk et al., "Developing a System for Sectorization: An Overview" also tackles the sectorization challenge by proposing a decision support system capable of solving various sectorization problems. These include real-life decision-making situations, such as school or health districting, logistic planning, maintenance operations or transportation. Several solution methods can be used depending on the structure of the problem to be solved.

In transporting hazardous materials or in cash collection it is important to find K dissimilar paths, that can work as alternatives or backups to one another in case of a failure in the network, while also minimizing the total cost. In "New Models for Finding *K* Short and Dissimilar Paths" by Pascoal et al., this bi-objective problem is modelled with integer linear programming and solved with ϵ-constraint method.

Healthcare services have critical delivery time windows, and consequently require maximum route optimisation. Pereira et al. in the chapter "Time Windows Vehicle Routing Problem to On-Time Transportation of Biological Products on Healthcare Centres", analysed and determined a set of vehicle routes to perform on-time transportation of biological products from seven local healthcare centres to a central hospital. Using a Vehicle Routing Problem with Pickups and Time Windows (VRPPTW) model, it was possible to improve the healthcare units' solution without further investments or reallocation of available resources

An effective communication could impact the incidence of an infectious disease, leading to new habits of the population, and at the same time, to improve the awareness of health centers' staff. In the chapter "The Role of Communication on the Spread of Dengue: An Optimal Control Simulation", the authors through a compartmental model related to vector-borne dengue disease carried out simulations, using distinct levels of communication by the authorities, aiming to show that an efficient channel of communication could save money to the Health System and could considerably decrease the number of infected individuals.

Optimizing the blood supply chain network is of uttermost importance for the rational use of a scarce and valuable resource: blood products. In "Towards an Optimized and Socio-Economic Blood Supply Chain Network", by Torrado et al, the design of a blood supply chain network is considered to support blood supply and

demand and the geographical distribution for donors/patients according to the location of the healthcare facilities. In the design process, not only are costs minimized, but social aspects are also taken into consideration.

Road transportation is still a critical sector in terms of carbon dioxide emissions. To address this challenge Vaz et al., "A DEA Approach to Evaluate the Performance of the Electric Mobility Deployment in European Countries", describe a DEA approach to evaluate the electric mobility of the European countries, aiming at improving practices toward better road transport sustainability. Results indicate that most countries have the potential to improve road transport, for instance, by following the best practices adopted by the Netherlands or Sweden.

The economic point of view of retailers and manufacturers is addressed in "The Art of the Deal: Machine Learning Based Trade Promotion Evaluation" by Viana & Oliveira. A decision support system was developed to aid in the promotional planning process of olive oil and vegetable oil, to evaluate trade promotions from the point of view of the manufacturer, ensuring manufacturer margins. The simulation is powered by multiple gradient boosting machine models that estimate sales from the limited and unpolished data available.

This is a very thorough and rich set of examples where Operational Research applies analytics tools for a better world, demonstrating the vitality of the Operational Research community in Portugal.

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