Received: 25 June 2020 | Accepted: 27 June 2020 | Published on: 21 July 2020
DOI: 10.1002/net.21971

PREFACE

WILEY

Preface to the special issue on optimization in vehicle routing and logistics

This special issue of *Networks* is dedicated to the seventh conference of the EURO Working Group on Vehicle Routing and Logistics Optimization (VeRoLog 2019) held in Seville, Spain, on June 2 to 6, 2019. The event brought together the large community of researchers and practitioners interested in vehicle routing optimization and its relationship with logistics. Specifically, the meeting saw the participation of more than 200 people from five continents. As in previous VeRoLog conferences, the scientific program was rich and included two plenary talks about designing routes for vehicles and drivers and the importance of routing at Amazon.com, two tutorials related to the efficient implementation in this field and variants, formulations and exact methods for multi-trip vehicle routing problems, and two brainstorming sessions organized by companies active in vehicle routing optimization. Furthermore, 173 high-quality methodological contributions, relevant real-world applications, and case studies from industry and the service sector were presented in 35 parallel sessions. The special issue collects an important selection of these contributions covering various aspects of the research on vehicle routing and its applications.

Cabrera et al. propose an exact method based on a recursive depth-first search procedure, known as the *pulse algorithm*, to solve the constrained shortest path problem. This problem consists of finding a minimum-cost sequence of arcs on a directed network that satisfies knapsack-type constraints on the resource consumption over the arcs. One of the key contributions of the proposal lies in a bidirectional search strategy leveraging on parallelism for the solution. In addition, the pulse-based heuristic quickly finds near-optimal solutions and shows great potential for column generation schemes. The authors present computational experiments over large real-road networks.

Triki et al. focus on an extension of the winner determination problem (WDP) which integrates the auction-based transportation procurement process with the decisions related to the production scheduling. The original problem arises when a manufacturer has to clear a combinatorial auction in order to decide whether to satisfy his transportation needs by using the owned fleet or to procure them through the auction. This new variant includes an additional decision level by integrating the WDP with production scheduling in order to gain efficiency and achieve savings in the logistics system. The authors propose a mathematical formulation and develop two heuristic approaches for solving the integrated problem. To validate this novel model, they report extensive computational experiments and sensitivity analysis, to assess the performance of the heuristics and to show the effect of integration on the total cost.

Schermer et al. study the traveling salesman problem with drone (TSP-D). This problem minimizes the delivery time required to serve a set of customers using a truck that is equipped with a single drone. They provide two compact mixed integer linear programming formulations which may solve instances with up to 10 customers within a few seconds. Also, they introduce a third formulation for the TSP-D with an exponential number of constraints which can be incorporated in a branch-and-cut algorithm capable of solving several instances with up to 20 customers within 1 hour of computing. Computational results provide an in-depth comparison of the effectiveness of the proposed formulations solving three different sets of benchmark instances. Moreover, they reveal further details on the operational characteristics of a drone-assisted delivery system.

Löffler et al. hybridize a large neighborhood search and granular tabu search to solve the electric vehicle-routing problem with time windows and single recharge (EVRPTWS), considering the possibility of both full and partial recharge. The heuristic works on routes represented as customer sequences. Recharge operations are implicitly considered by optimally determining their position along the route, the recharging station to visit, and the amount to be recharged. The paper also discusses how the proposed approach can be extended to handle nonlinear recharging times, different recharging times per station, and time-dependent waiting times at stations. The algorithm is shown to be able to provide optimal or near-optimal solutions for instances with up to 100 customers within reasonable runtimes using EVRPTWS instances from the literature. In addition, the computational experiments reveal a considerable reduction of routing cost when allowing partial recharges and this is more evident when the instance size increases. Also, they find that partial recharges tend to be more beneficial compared to full recharges if many customers have time-window requirements and if the customer time windows are narrow.

Lin and Kwan consider the problem of avoiding unnecessary merging and demerging of flows in train operations, known as train unit assignment/scheduling problem or shunting problem. The authors present a novel heuristic branching method to be used within an ILP solver for removing unnecessary merging/demerging flows without the use of fixed-charge constraints. They use the concept of "flow potentials" to select arcs which are heuristically removed, as well as "flow connection bigraphs" and "flow connection groups." The computational testing on real-world instances shows that the heuristic approach can significantly enhance the full fixed-charge model by warm-starting and the usefulness of the proposed methods.

Sampaio et al. investigate the potential benefits of using transfers in urban freight delivery systems through the use of a crowdsourced system where drivers express their availability to perform delivery tasks for a given period of time. The optimization is performed by a centralized platform which determines the schedules for the drivers with the requests to serve. The considered problem is framed as a multi-depot pickup and delivery problem with time windows and transfers, and the authors propose an adaptive large neighborhood search algorithm that effectively identifies beneficial transfer opportunities and synchronizes driver operations. Computational experiments indicate that introducing transfer options can significantly reduce system-wide travel distance as well as the number of drivers required to serve.

Furthermore, three papers related to the VeRoLog Solver Challenge 2019 organized by ORTEC are included in this special issue. The problem of the VeRoLog Solver Challenge 2019 combines distribution and subsequent installation of equipment, such as vending machines. The machines must be delivered within a customer-dependent delivery window and must be installed by a technician as soon as possible after the delivery. The planning horizon consists of a period of five consecutive days. There are different types of machines, each having its own size. The instance includes machine requests from customers which have to be satisfied. A request consists of a number of machines of a given type, and a delivery window within which these machines have to be delivered. Each delivery window consists of a number of consecutive days within the planning horizon. Furthermore, if a customer needs more than one type of machine, separate requests are issued. Hard constraints are imposed on the machine delivery and machine installation. In a solution all requested machines must be delivered and installed within the planning horizon and the total cost must be minimized. There are costs per unit of distance traveled by the delivery truck, for using a truck for a day, and for using a truck at all during the planning horizon. Furthermore, there are costs per unit of distance traveled by a technician, for using a technician for a day, and for using a technician at all during the planning horizon. Finally, there are costs for every full day a machine is idle, specified for each kind of machine. Many teams participated in this challenge from which eight winners were selected to present their results at the conference. Their proposals were tested not only on small instances but also on large scale instances from realistic service scenarios provided by ORTEC. The first prize went to Benjamin Graf, the second winner was Martin Josef Geiger, and the third best team was composed of Caroline Jagtenberg, Andrea Raith, Michael Sundvick, Kevin Shen, Oliver Maclaren, and Andrew Mason.

Graf describes the algorithm which won the VeRoLog Solver Challenge 2019 by proposing a combination of two methodologies: an adaptative large neighborhood search and variable neighborhood descent applying a decomposition approach to efficiently generate competitive solutions under restricted computational resources. The interplay of the heuristics, the decomposition, and the way the search space is explored has been orchestrated by an adaptive layer that explicitly considers the instance to be solved, the time limit, and the performance of the computing environment. In a computational study, it is shown that the method is efficient and effective, especially under tight time restrictions.

Jagtenberg et al. were awarded the third place in the challenge. They describe a method based on a matheuristic approach, in which the overall problem is heuristically decomposed into components that can then be solved by formulating them as set partitioning problems. To solve such set partitioning problems, they introduce a novel method, called "columnwise neighbourhood search," which allows one to explore a large neighborhood of the current solution in an exact manner. They obtain good quality solutions to the subproblems by iteratively applying mixed integer programming methods. Then, a local search "fusion" heuristic is used to further improve the solution to the overall problem. Furthermore, they perform an interesting analysis of the problem instances for which the approach was particularly successful and identified the main limits of the proposed method.

Kheiri et al. were selected as one of the finalists of the VeRoLog Solver Challenge 2019. They modeled the challenge problem as a rich VRP integrating a VRP with time windows, and a service technician routing and scheduling problem for delivering various equipment based on customers' requests, and the subsequent installation by a number of technicians. The main objective is to reduce the overall costs of hired resources, and the total transportation costs of trucks/technicians. They developed a mathematical model for this problem and a novel hyper-heuristic algorithm to solve the problem based on a population of solutions. Experimental results on two datasets of small and real-world size instances reveal the success of the hyper-heuristic approach in finding optimal solutions in a shorter computational time, when compared to the proposed exact model.

We thank the authors for submitting their papers and the referees for their reviews. On behalf of the Organizing Committee of VeRoLog 2019, we also thank all the participants of this meeting, the sponsors, and the people who helped to organize this conference. Special thanks to Dr B. L. Golden for the opportunity to publish this special issue of *Networks*.

ORCID

Jesús Sánchez-Oro https://orcid.org/0000-0003-1702-4941

Ana D. López-Sánchez[1]
Jesús Sánchez-Oro[2]
Daniele Vigo[3]

[1]Department of Economics, Quantitative Methods and Economic History, Pablo de Olavide University, Sevilla, Spain
[2]Department of Computer Science, Rey Juan Carlos University, Madrid, Spain [3]Dipartimento di Ingegneria dell'Energia Elettrica e dell'Informazione "Guglielmo Marconi", Università di Bologna, Bologna, Italy