Preface to the special issue on Variable Neighborhood Search

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Abstract This special issue of *Optimization Letters* presents selected, peer-reviewed, papers that were accepted for presentation in the two recent International Conferences on Variable Neighborhood Search. The "ICVNS 2018" was held in Sithonia, Halkidiki, Greece, during October 4-7, 2018 and the "ICVNS 2019" was held in Rabat, Morocco, during October 3-5, 2019.

The Variable Neighborhood Search (VNS) metaheuristic is based on systematic changes in the neighborhood structure within a search. It has been successfully applied for the solution of various combinatorial and global optimization problems. The aim of this special issue of *Optimization Letters* is to present recent advances in the Variable Neighborhood Search methodology and also real-world applications in this area.

We would like to express our sincere thanks to all contributors and reviewers for their submissions and the excellent reports, respectively. Also, as guest editors

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we would like to gratefully acknowledge the Editor-in-Chiefs of ENDM, Prof. Pavlo Krokhmal and Prof. Oleg A. Prokopyev for their continuous support to the series of the VNS international conferences. We hope that the readers will find innovative ideas for future research directions in the papers of this special issue.

Each submission was rigorously peer reviewed by at least two referees, according to the editorial policy of *Optimization Letters*. Based on a rigorous reviewing process, twenty articles were finally accepted for publication in this joint special issue that cover different topics such as matheuristics and VNS, parallel VNS, multi-objective VNS, as well as preventive maintenance planning and location - routing optimization using VNS. The first six articles in the first part of the special issue were submitted after the ICVNS 2018 meeting and the remaining fourteen articles in the second part of the special issue were submitted after the ICVNS 2019 meeting. The short description of the accepted manuscripts follows.

1 Cluster: ICVNS 2018

The issue begins with the paper "On solving the order processing in picking workstations" authored by A. Ouzidan, M. Sevaux, A. L. Olteanu, E. G. Pardo, and A. Duarte. The authors present a present a General Variable Neighborhood Search (GVNS) algorithm for a real-world supply chain problem of order processing in picking workstations which outperforms other state-of-the-art methods in the literature. The second paper considers 0-1 generalized quadratic multiple knapsack problems and it is titled "A matheuristic for the 0-1 generalized quadratic multiple knapsack problem". Y. Adouani, B. Jarboui, and M. Masmoudi introduce a new matheuristic combining VNS with Integer Programing (IP) to solve large sized instances.

T. H. Nogueira, H. L. Ramalhinho, C. R. de Carvalho, and M. G. Ravetti, in the paper "A hybrid VNS-Lagrangean heuristic framework applied on single machine scheduling problem with sequence-dependent setup times, release dates and due dates", deal with a single machine scheduling problem with setup times, release, and due dates to minimize total tardiness. The authors have developed a hybrid VNS-Lagrangean heuristic framework and also present competitive results when compared with previous related works. The fourth paper shows how the VNS is able to provide an initial set of columns for a column generation algorithm. E. T. Bogue, H. S. Ferreira, T. F. Noronha, and C. Prins in their paper titled "A column generation and a post optimization VNS heuristic for the vehicle routing problem with multiple time windows" show the benefits of this integration and also propose a post optimization procedure based on the same VNS approach which improves the upper bounds obtained by one of the best heuristics for this problem.

In the paper by J. C. N. Silva, I. M. Coelho, U. S. Souza, L. S. Ochi, and V. N. Coelho titled "Finding the Maximum Multi Improvement on neighborhood exploration", the aim is to find the optimal combination of moves in a multi improvement neighborhood exploration. The sixth article titled "A modified variable neighborhood search algorithm for manufacturer selection and order acceptance in distributed virtual manufacturing network" considers a collaborative optimization problem with order acceptance, manufacturing and outsourcing selection, and production scheduling. M. Kong, J. Zhou, J. Pei, X. Liu, and P. M. Pardalos present

a Reduced Variable Neighborhood Search (RVNS) algorithm combined with multiple random mutations neighborhood structures for the solution of this problem.

2 Cluster: ICVNS 2019

S. Ibrahim and B. Jarboui in the seventh article titled "A General Variable Neighborhood Search approach based on a p-median model for cellular manufacturing problems" study the cell formation problem. The authors successfully applied a combination of the GVNS algorithm and the estimation of distribution algorithm and managed to efficiently solve large-sized cell formation problems. The eighth article by M. J. Brusco and D. Steinley is titled "A variable neighborhood search heuristic for nonnegative matrix factorization with application to microarray data". The authors propose a new VNS metaheuristic for nonnegative matrix factorization and also present favorable comparative computational experiments using two microarray datasets.

The ninth article is titled "A parallel variable neighborhood search for solving covering salesman problem" and co-authored by X. Zang, L. Jiang, M. Ratli, and B. Ding. The authors reformulate the Covering Salesman Problem (CSP) as a Bilevel CSP (BCSP) and develop two parallel VNS methodologies for the solution of the BCSP. The paper by S. Elleuch, B. Jarboui, N. Mladenović, and J. Pei titled "Variable neighborhood programming for symbolic regression", proposes a basic variable neighborhood programming method for solving automatic programming problems. The authors show advantages in terms of speed of convergence and also computational stability.

P. Karakostas, A. Sifaleras, and M. C. Georgiadis in the paper "Variable neighborhood search-based solution methods for the pollution location-inventory-routing problem" present a novel efficient VNS solution approach for a complex $\mathcal{NP}$-hard combinatorial optimization problem, which combines location, inventory, and routing decisions and considers both economic and environmental issues. The paper by S. Elleuch, B. Jarboui, and N. Mladenović is titled "Preventive maintenance planning of railway infrastructure by reduced variable neighborhood programming" and aims to present a decision support system for forecasting the deterioration of track geometry using an RVNS approach.

The thirteenth article authored by M. Abderrahim, A. Bekrar, D. Trentesaux, N. Aissani, and K. Bouamrane is titled "Bi-local search based variable neighborhood search for job-shop scheduling problem with transport constraints". This paper studies a job shop scheduling problem with transport constraints and presents a mathematical programming formulation and a VNS solution approach. In the paper by M. Ratli, D. Urošević, A. A. El Cadi, J. Brimberg, N. Mladenović, and R. Todosijević "An efficient heuristic for a hub location routing problem", the hub location routing problem is introduced. The authors present a GVNS methodology for the solution of this complicated problem which outperforms other state-of-the-art approaches.

J. Sánchez-Oro, A. D. López-Sánchez, and J. M. Colmenar consider the bi-objective obnoxious p-median problem (Bi-OpM). Their work titled "A multi-objective parallel variable neighborhood search for the bi-objective obnoxious p-median problem" generalizes VNS in order to efficiently solve the Bi-OpM. The sixteenth article by L. Jiang, X. Zang, J. Dong, C. Liang, and N. Mladenović is

titled "A variable neighborhood search for the last-mile delivery problem during major infectious disease outbreak". The authors propose a VNS algorithm for the solution of delivery problems arising in the last-mile delivery during major infectious disease outbreak.

The next paper by A. L. Souza, M. Bernardo, P. H. Penna, J. Pannek, and M. J. Souza aims to solve a real problem faced by a patient transportation request system in Brazil. The authors propose a GVNS solution method in their paper titled "Bi-objective optimization model for the heterogeneous dynamic dial-a-ride problem with no rejects". Also, L. Jiang, X. Zang, J. Dong, and C. Liang in the paper titled "A covering traveling salesman problem with profit in the last mile delivery", consider an actual situation faced by a courier in the last mile delivery. The authors propose a VNS method and evaluate its performance using modified instances from the TSPLIB collection.

V. N. Coelho and R. H. Koochaksaraei in the paper titled "Non-dominated solutions for time series learning and forecasting" show how forecasting models with different, and even opposite, characteristics can be obtained from sets of non-dominated solutions, using multi-objective variable neighborhood descent inspired techniques. This special issue closes with the contribution from N. Mladenović, J. Pei, P. M. Pardalos, and D. Urosević, "Less Is More Approach in Optimization - A Road to Artificial Intelligence". The authors illustrate the main idea of Less is More Approach (LIMA) by using as fewer as possible ingredients to provide the best possible outcome in hard optimization problems.