Journal of Heuristics (2020) 26:335–338
https://doi.org/10.1007/s10732-020-09442-0

GUEST EDITORIAL

Special issue on recent innovations in variable neighborhood search

Abraham Duarte[1] · **Eduardo G. Pardo**[1]

Published online: 22 February 2020

Variable neighborhood search (VNS) is a so-called single-solution based metaheuristic. The main idea behind VNS is the use of systematic changes in the neighborhood structure of the single solution that is transformed during the search of an optimum. The technique includes additional strategies that help the search escape from the basins of attraction known as local optima.

The extensions proposed over the last two decades have moved VNS from a relatively simple metaheuristic to a general optimization framework that includes various methods and design choices. Mladenović and Hansen (1997) introduced what is now known as the basic variable neighborhood search. The current literature includes such variants as the reduced VNS, the variable neighborhood descent, and the general VNS. VNS has been applied in a variety of settings, including multi-objective optimization problems (Duarte et al. 2015), max–min/min–max hard optimization problems (Pardo et al. 2013). In addition, the VNS structure has been exploited in efficient parallel implementations (Duarte et al. 2016).

Several comprehensive reviews of VNS implementations and advances in the methodology serve as an indicator of the high level of interest in this optimization technique (Hansen and Mladenović 2001, 2003, 2018; Hansen et al. 2008, 2017). Additional evidence of interest is provided by the special issues that research journals have been devoted to VNS (Melián and Mladenović 2007; Moreno-Vega and Melián 2008; Mladenovic et al. 2014; Carrizosa et al. 2015). Finally, we point out that the international conference on variable neighborhood search has been already celebrated seven times (Sifaleras et al. 2012, 2019; Jarboui et al. 2014; Pardo and Sifaleras 2017; Coelho et al. 2018).

Due to its effectiveness and simplicity (given that some designs are almost parameter-free), VNS has been successfully applied to many hard optimization problems in business and engineering. This special issue presents several examples of

✉ Eduardo G. Pardo
eduardo.pardo@urjc.es

Abraham Duarte
abraham.duarte@urjc.es

[1] Department of Computer Sciences, Universidad Rey Juan Carlos, 28933 Móstoles, Madrid, Spain

implementation innovations of VNS that are applied to traditional and novel optimization problems, as described below.

The selective traveling salesman problem with draft limits by Shahin Gelareh, Bernard Gendron, Saïd Hanafi, Rahimeh Neamatian Monemi, and Raca Todosijević

This article tackles a variant of the Travelling Salesman Problem (TSP) that includes draft limits. In this variant, the objective is to find a maximum profit tour that respects draft limit constraints at the visited nodes. This problem is motivated by a real-world application in maritime transportation. The authors first propose a Mixed Integer Linear Programming formulation for the problem. This model finds exact solutions to small-sized instances, and these results are used as benchmarks for their general variable neighborhood search (GVNS). The GVNS includes eleven different neighborhood structures that are efficiently explored with the use of fast feasibility checking procedures.

A variable neighborhood search simheuristic for project portfolio selection under uncertainty by Javier Panadero, Jana Doering, Renatas Kizys, Angel A. Juan, and Angels Fito

The Project Portfolio Selection Problem consists in choosing the best portfolio of projects in order to maximize the expected net present value of the investment. The difficulty of the problem increases with the number of projects and the presence of constraints found in real settings. The authors present a simulation–optimization algorithm that integrates variable neighborhood search and a Monte Carlo simulation in order to account for the inherit uncertainty of this problem. This type of algorithms, known as simheuristics, extend metaheuristics by coupling simulation techniques to assess the performance of promising solutions.

The parking allocation problem for connected vehicles by Marko Mladenović, Thierry Delot, Gilbert Laporte, and Christophe Wilbaut

The parking allocation problem for connected vehicles is a dynamic variant of the Generalized Assignment Problem, where the objective is to maximize the profit of assigning tasks to a group of available agents. The problem is to find an optimal assignment of a fleet of cars (connected by GPS) to available parking slots in a parking lot. The assignment is based on the estimated arrival time to the parking lot provided by the GPS information. The authors propose a 0–1 programming model for the static variant of the problem at a particular moment in time and a variable neighborhood search to tackle large-sized instances. Synthetic problem instances serve as the platform for testing the performance of the proposed solution methods.

A biased-randomized variable neighborhood search for sustainable multi-depot vehicle routing problems by Lorena Reyes-Rubiano, Laura Calvet, Angel A. Juan, Javier Faulin, and Lluc Bové

A variant of the multi-depot vehicle routing problem that considers economic, environmental, and social dimensions is tackled in this article. The authors propose a metaheuristic-based approach that integrates biased-randomization strategies within a variable neighborhood search framework. The authors formulate a mathematical programming model of the problem and compare the solutions found with both

approaches. Furthermore, a comprehensive analysis of the trade-off among different sustainability indicators is provided.

A general variable neighborhood search for solving the multi-objective open vehicle routing problem by Jesús Sánchez-Oro, Ana D. López-Sánchez, and J. Manuel Colmenar

This paper considers a multi-objective optimization problem called the open vehicle routing problem. It is a variant of the classical vehicle routing problem where vehicles are not required to return to the depot after completing their service and where more than one objective function is optimized. The objectives to be optimized consist of minimizing the total number of routes, minimizing the total travel cost, and minimizing the longest route. The authors propose a general variable neighborhood search and compare it with the well-known multi-objective genetic algorithm NSGA-II.

We would like to thank the authors of the articles for enhancing the quality of this special issue with their latest and most innovative findings. We would also like to thank the inestimable help of the reviewers. Finally, we would like to acknowledge the Journal of Heuristics and its Editor In Chief for giving us the opportunity to guest edit this special issue. We hope that the articles that we have selected contribute to enrich the VNS literature.

References

Carrizosa, E., Hansen, P., Moreno-Pérez, J.A.: Variable neighborhood search. J. Glob. Optim. **63**(3) (2015). https://link.springer.com/journal/10898/63/3

Coelho, V.N., Santos, H.G., Coelho, I.M., Penna, P.H.V., Oliveira, T.A., Souza, M.J.F., Sifaleras, A.: In: 5th International Conference on Variable Neighborhood Search (ICVNS'17). Electronic Notes in Discrete Mathematics, vol. 66, pp. 1–5 (2018)

Duarte, A., Pantrigo, J.J., Pardo, E.G., Sánchez-Oro, J.: Parallel variable neighbourhood search strategies for the cutwidth minimization problem. IMA J. Manag. Math. **27**(1), 55–73 (2016)

Duarte, A., Pantrigo, J.J., Pardo, E.G., Mladenović, N.: Multi-objective variable neighborhood search: an application to combinatorial optimization problems. J. Glob. Optim. **63**(3), 515–536 (2015)

Hansen, P., Mladenović, N.: Variable neighborhood search: principles and applications. Eur. J. Oper. Res. **130**(3), 449–467 (2001)

Hansen, P., Mladenović, N.: Variable neighborhood search. In: Glover, F., Kochenberger, G.A. (eds.) Handbook of Metaheuristics. International Series in Operations Research and Management Science, vol. 57. Springer, Boston, MA (2003)

Hansen, P., Mladenović, N., Moreno-Pérez, J.A.: Variable neighborhood search. Eur. J. Oper. Res. **191**(3), 593–595 (2008)

Hansen, N., Mladenović, P., Todosijević, R., Hanafi, S.: Variable neighborhood search: basics and variants. EURO J. Comput. Optim. **5**(3), 423–454 (2017)

Hansen, P., Mladenović, N.: Variable neighborhood search. In: Martí, R., Pardalos, P., Resende, M. (eds.) Handbook of Heuristics. Springer, Cham (2018)

Jarboui, B., Sifaleras, A., Rebai, A.: In: 3rd International Conference on Variable Neighborhood Search (VNS'14). Electronic Notes in Discrete Mathematics, vol. 47, pp 1–4 (2014)

Melián, B., Mladenović, N.: Editorial. IMA J Manag. Math. **18**(2), 99–100 (2007)

Mladenović, N., Hansen, P.: Variable neighborhood search. Comput. Oper. Res. **24**(11), 1097–1100 (1997)

Mladenovic, N., Salhi, S., Hnafi, S., Brimberg, J.: Recent advances in variable neighborhood search. Comput. Oper. Res. **52**(B), 147–148 (2014)

Moreno-Vega, J.M., Melián, B.: Introduction to the special issue on variable neighborhood search. J. Heuristics **14**(5), 403–404 (2008)

Pardo, E.G., Mladenović, N., Pantrigo, J.J., Duarte, A.: Variable formulation search for the cutwidth minimization problem. Appl. Soft Comput. **13**(5), 2242–2252 (2013)

Pardo, E.G., Sifaleras, A.: In: 4th International Conference on Variable Neighborhood Search (ICVNS'16). Electronic Notes in Discrete Mathematics, vol. 58, pp 1–5 (2017)
Sifaleras, A., Urošević, D., Mladenović, N.: In: EURO Mini Conference (MEC XXVIII) on Variable Neighborhood Search. Electronic Notes in Discrete Mathematics, vol. 39, pp. 1–4 (2012)
Sifaleras, A., Salhi, S., Brimberg, J.: In: 6th International Conference, ICVNS 2018. Lecture Notes in Computer Science. Variable Neighborhood Search, 11328 (2019)