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### Note from the Editor

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## Note from the Editor

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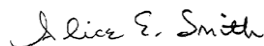
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We continue to announce the winners of *INFORMS Journal on Computing (IJOC)* Test of Time Paper Award to cover the backlog of awards since the journal's inception. The energetic and able committee chaired by John Chinneck with members Bill Cook, Bruce Golden, Pascal Van Hentenryck, and David Woodruff have selected the awardee, covering the period 1999–2003. What follows is the citation from the award committee and then a reflection on the paper and this award by the authors.

I want to thank the committee for their superb efforts and am very pleased to share this recognition of the impactful heritage of our journal.

All my best,



The Test of Time Award for papers published in the *INFORMS Journal on Computing* in the years 1999–2003 is awarded to the following:

### The Granular Tabu Search and Its Application to the Vehicle-Routing Problem

Paolo Toth and Daniele Vigo

*INFORMS Journal on Computing* 15(4):333–346 Fall 2003  
<https://doi.org/10.1287/ijoc.15.4.333.24890>

### Test of Time Award Citation 1999–2003

Heuristics for vehicle routing have been around since the 1960s. In the 1990s, tabu search emerged as one of the best metaheuristic approaches for solving a broad array of vehicle-routing problem variants. Toth and Vigo proposed a granular tabu search approach that enabled users to obtain excellent vehicle-routing solutions within reasonably short computing times. The concept was easy to adapt to other important optimization problems.

The key idea behind granular tabu search was to a priori remove from the network those long arcs, which were unlikely to be contained in an optimal solution. The restricted neighborhoods without these long arcs were called granular. The authors show how to select the arcs to remove, and they perform extensive computational tests. This paper has been cited more than 600 times according to Google Scholar.

### Comments on This *IJOC* Test of Time Paper Award from the Authors, Paolo Toth and Daniele Vigo

We are extremely happy and honored to receive the Test of the Time award for our paper on the Granular Tabu Search by *IJOC* which was and is the main outlet for computationally oriented optimization and was thus a natural choice for us.

We started working at the ideas behind the granular neighborhoods in the late nineties inspired by the tremendous results obtained by the metaheuristic approaches in the solution of combinatorial problems and in particular of vehicle routing problems (VRPs) which were at the heart of our interest at that time. That was a very exciting moment in which the metaheuristics, and in particular Tabu Search proposed by Fred Glover (Glover 1989) in *ORSA Journal on Computing* (the forerunner of *IJOC*). With the seminal works of Eric Taillard (Taillard 1993) and Gendreau, Hertz and Laporte (Gendreau et al. 1994), Tabu Search proved to be able to find near optimal solutions for the existing benchmark instances of VRP. However, this came at the cost of considerably long computing times and low scalability with respect to instance size because the complete exploration of the neighborhoods in most cases requires quadratic cardinality.

Our motivation was therefore improving the computational efficiency of the local search engine at the basis of Tabu Search and other heuristics to make it possible to obtain good solutions within a reasonable computing time. The ground on which we built our intuition was

an extensive analysis of the benchmark instances data and of the characteristics of the solutions and of the improving moves during a local search step. Such analysis highlighted that, as expected, most of the arcs forming high-quality solutions were short with respect to the average arc length in the underlying graph and that the moves which insert such short arcs in the solution were much more likely to be the improving ones. Therefore, it was quite natural to introduce a sparsification of the graph in which long arcs were removed and to concentrate the search on moves which insert at least one short arc, thus filtering the neighborhood and reducing the effort of a local search iteration from quadratic to linear.

The idea behind granular neighborhoods was, thus, pretty simple, and we later realized it was already proposed by Glover and Laguna in their excellent book (Glover and Laguna 1997) in which they called it “candidate lists.” However, the simple and general filtering criterion and the efficient implementation of the search we proposed turned out to be particularly effective. Our preliminary experiments showed that with sparsification factors which preserve just a small fraction of the moves of the complete neighborhood a Tabu Search could still obtain state-of-the-art results. Furthermore, we did not observe a monotonous correlation between the number of arcs kept in the granular neighborhoods and the final solution quality, showing that the filtering also produces a beneficial bias in the search evolution. We then started developing a complete implementation of a Tabu Search where the acceleration provided by the granular neighborhoods boosted the search and allowed us to obtain solutions comparable or better than those found by the best existing methods in computing times which were one or two orders of magnitude smaller.

The implementation work and the revision of the manuscript, following the clever suggestions by colleagues and anonymous reviewers, absorbed us for about four years and the paper was eventually published in 2003. The ideas put forward in the paper received quite soon the attention of the large and active community working on heuristics for routing problems, also thanks to the recognition of their potential impact made by Gendreau, Laporte and Potvin in their fundamental chapter on modern VRP heuristics (Gendreau et al. 2002) where they pointed to our Granular Tabu Search as the forerunner of a new generation of metaheuristics combining effectiveness and computational efficiency. In the following years, granular neighborhoods and their evolution were systematically employed within local-search components of new algorithms for routing problems as well as in industrial implementations incorporated into logistics optimization software.

Along the years our research activities concentrated on different projects, such as the editing of the two

editions of the books on VRP, but we kept working on granular-based approaches by extending their use toward other variants of VRP (Escobar-Velasquez et al. 2014a, 2014b), Schneider et al. 2017) or by combining them with other search acceleration techniques (Accorsi and Vigo 2021).

In receiving this award, we wish to thank the large community of researchers and practitioners who stimulated with their ideas and enthusiasm the development of effective solution methods for routing problems. Without the joint effort of an entire community which through extensive experimental and continuous streamlining of the algorithmic techniques and components such as the granular neighborhoods, the achievements obtained in this field in the last decades would have never been possible. We also wish to thank Mauro Dell’Amico, who suggested to us such a fortunate name for our creature.

About the *INFORMS Journal on Computing* Test of Time Award:

- *Number of awards*: One per calendar year.
- *Goal*: Recognition of a published *IJOC* paper that has proven impactful over a length of time. Considerations can be citations per year, downloads per year, influence of sparking new areas of research, practical implications, significance of findings, and so forth.
- *Criteria*: All those papers published in the time window are considered. A paper can only be recognized with this award once. The time window is defined as a rolling window of 5 years starting 15 years ago.
- *Deadline*: None. Papers are considered on an annual basis.
- *Selection*: Small committee appointed by the editor-in-chief.
- *Recognition*: Certificate of Test of Time Award and recognition in the journal (paper, authors, affiliations, citation) and relevant listservs.
- *Procedure*: The set of papers published in *IJOC* during the time window with their citations per year (since publishing) will be sent to the committee members for their deliberation. A winner is selected by the committee, and the editor-in-chief is notified.

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