Comments on "Albayrak, M., & Allahverdy N. (2011). Development a new mutation operator to solve the Traveling Salesman Problem by aid of Genetic Algorithms. Expert Systems with Applications, 38(3), 1313-1320": A Proposal of Good Practice

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Abstract

This short note presents a discussion arisen after reading "Development a new mutation operator to solve the Traveling Salesman Problem by aid of Genetic Algorithms", by Murat Albayrak and Novruz Allahverdi, (2011). Expert System with Applications (38)(pp. 1313-1320). The discussed paper presents a new greedy mutation operator to solve the well-known Traveling Salesman Problem. To prove the quality of their new operator, the authors compare different versions of a classical genetic algorithm, each of one with a different mutation operator. The experimentation shown by the authors can generate some controversy. In this short note, we explain the origin of this controversy and we bring a solution to prevent it in future publications.

Keywords: Traveling Salesman Problem, Good Practice, Genetic Algorithms, Combinatorial Optimization, Routing Problems

1. Discussion

Nowadays, combinatorial optimization is a widely studied field in artificial intelligence and operations research. Problems such as Traveling Salesman Problem (TSP) (Lawler et al. (1985)) or Capacitated Vehicle Routing Problem (CVRP) (Laporte (1992)) have a great interest thanks to their real world applicability and their simple formulation. Being NP-Hard, these problems have a great scientific interest, and many studies are focused on their resolution, using a wide variety of algorithms (Bae & Rathinam (2012); Osaba & Díaz (2012); Nagata & Soler (2012); Mattos Ribeiro & Laporte (2012); Ngueveu et al. (2010)).

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The discussed paper (Albayrak & Allahverdi (2011)) presents a new greedy mutation operator, called Greedy Sub Tour Mutation (GSTM), to solve the TSP. To prove the quality of the proposed operator, the authors carry out an experimentation phase in which some genetic algorithms (GA) are compared, each one with a different mutation operator. The benchmark used for the tests is the TSPLIB (Reinelt (1991)), and the mutation operators used are Exchange Mutation (EXC), Displacement Mutation (DIPS), Inversion Mutation (INV), Insertion Mutation (INS), Simple Inversion Mutation (SIM), Scramble Mutation (SCM) and Greedy Swap Mutation (GSM), all of them cited in (Albayrak & Allahverdi (2011)).

Although in the literature there are a lot of benchmarks and other resources to test the quality of new techniques, the comparison between heuristics and meta-heuristics is complex. Many factors must be taken into account, and this fact creates a lot of controversy and can lead to much confusion and bad practices.

In the particular case of the discussed paper, even though the authors make several good practices when they compare the different versions of the GA (such as the utilization of benchmark instances or the use of the same parameters for all techniques), they do some practices that may generate controversy. In this short note, we explain the reasons of this controversy and we introduce a proposal to prevent it in the future.

1.1. Compare operators of the same kind

The first controversy concerns the mutation operators used. In the context of genetic algorithms mutation operators can be classified into two families: the operators performing changes in the individuals of the population regardless of problem-specific information, and those who use problem-specific information to "optimize" during the mutation process. The first are known as neutral operators and the latter as greedy or heuristic operators.

The mutation process conducted by neutral and heuristic operators is different. For this reason, the comparison of techniques using different types of mutation operators does not seem very fair. This is so, because it is very possible that greedy operators achieve better results as they use problem specific information. Focusing on the discussed article, the authors compare their GSTM with 7 different mutation operators, 6 of them are neutral (EXC, DIPS, INV, INS, SIM and SCM) and only one greedy (GSM).

In relation to the said above, the comparison with the first 6 GA versions provides no relevant information, as it is assumed that the greedy operator gets better results. For this reason, to perform a reliable comparison, we encourage the authors to compare their GSTM with other greedy or heurisitc mutation operators existing in the literature, such as the *non-secuential 4-change* (Freisleben & Merz (1996)). Thus, it would ensure that GSTM provides some improvement over the existing operators

1.2. Demonstrating the optimization ability

Another important issue when developing new operators, is the proper showing of their efficiency and optimization capacity. To achieve this, the most appropriate way is to use techniques with neutral functions, so that the optimization capacity of the new operator does not been "tarnished".

In the case of the discussed paper, to test the quality of GSTM, the authors use a genetic algorithm that uses greedy functions to initialize the population (nearest neighborhood) and perform crossovers (DPX). This means that individuals of the population are locally optimized in various parts of the algorithm, so that it is not possible to specify which is the optimization capacity of the new operator.

For this reason, we encourage authors of the paper to perform new tests using a GA which initializes the population randomly, and with a neutral crossover operator (such as Order Crossover, proposed by Davis (1985)). Alternatively, even though is not the main objective of the work, we suggest the authors to perform again the tests, including also an evolutionary algorithm, only based on mutations. We propose this, since as mentioned in the study conducted by Osaba et al. (2013), for routing problems is more appropriate the use of this kind of evolutionary algorithms. Following any of these suggestions, it could be demonstrated with more accuracy the capacity optimization of the proposed GSTM.

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