Improved Biogeography-Based Optimization for the Selective Vehicle Routing Problem in a Collaborative Environment

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Metaheuristics, Routing, Transportation.

Abstract

We investigate the Selective Vehicle Routing Problem in a Collaborative Environment (SVRP-CE) where several companies, called partners, contribute with their resources, i.e. vehicles, depots and list of customers, in order to minimize the total routing and compensation costs. More precisely, each customer could be not served as long as a penalty called a compensation for non-delivery is paid. For this challenging NP-hard problem, we propose a new enhanced Biogeography-Based Optimization algorithm. We conducted extensive computational experiments on benchmark instances from the literature. The results show the very well performance of the proposed approach.

Problem Presentation

The SVRP-CE was recently addressed by Defryn et al. (2016). They generalized the basic selective vehicle routing problem where both the number of available vehicles and the maximum distance travelled by each vehicle are limited. In a collaboration context, companies/partners join forces and decide to put in common their trucks/vehicles, depots and list of customers in a global distribution scheme. By allowing that a customer is served by any of the partners, it is likely that more efficient routes could be constructed. Going further in looking for potential cost saving, Defryn et al. (2016) proposed a well-engineered budget allocation method in order to derive appropriate "compensation for non-delivery" or penalty, if a customer is not served. Thus, The SVRP-CE requires finding the customers to be selected as well as their corresponding delivery vehicle routes, such that the total transportation and unvisited customers' penalties costs are minimized.

It is noteworthy that Defryn et al. (2016) proposed a randomized, multi-start variable neighborhood metaheuristic to solve this problem. More recently, Rekik et al. (2017) addressed a green version of the SVRP-CE and derived new linear programming models that solve to optimality small-sized instances.

Solving Approach

Introduced by Simon (2008), the Biogeography-Based Optimization (BBO) is an evolutionary procedure inspired by the species' emigration and immigration tendency. This population based metaheuristic is strongly influenced by the equilibrium theory of island geography. It is based on the balance between the immigration of new species into an island and the emigration of established species. In this work, we tailor the BBO using appropriate solution presentation and elaborated parameters in order to fit the specificity of the SVRP-CE.

Computational Results

The C++ language is used to implement the proposed algorithm. All experiments were carried out on a personal computer with a core i7-7500U CPU at 2.70 GHz and 8 GBs of RAM. In order to assess the empirical performance of the tailored approach, computational results are reported using test-bed for 13 sets of 30 instances each. They are instances of Defryn et al. (2016) that have 3 partners and 45 customers. Thereby, we found that our new BBO approach performs very well by obtaining very good final solutions in 1.08 seconds as an average CPU time.

References

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