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DECISION SUPPORT FOR FACILITY LOCATION – A RAMP APPROACH

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Abstract:
The current state of the global economy and the financial market fierceness require today's organizations to be more competitive than ever, hence the reduction of operational costs and the increasing of efficiency of the organizational and business processes are key aspects to any sustainable organization. With respect to that, choosing where to locate a facility is, undoubtedly, one of the greatest challenges that a decision maker could face, as it is usually a decision with long-term impact on the organization. For that reason, it is no surprise that the field of location models theory has attracted great attention from the scientific community over the last decades. In fact, location policy is considered, for a long time now, one of the more profitable areas of application to analysis systems (Krarup & Pruzan, 1983).

The problem of choosing the location of one or more facilities in order that they are the closest possible to a set of clients is known in the literature as the P-Median problem. More formally, the PMedian problem (Hakimi, 1964) aims at choosing the set of p facilities (medians), from a set of candidate ones, so that the sum of the distances of each costumer to the closest respective median is minimized. The P-Median problem has a wide utility both on public and private sectors. On public sectors, where the main goal is to offer efficient services with the minimum cost, P-Median can be applied, for instance, to locate an hospital or an ambulance depot in order to be close to the maximum number of users, minimizing system's response time. On their turn, private sectors, seek mainly to achieve a wider market share and maximize incomes. In this case, an example of application of the PMedian problem could be the location of warehouses to serve a set of stores. The closest the warehouse is to the largest amount of stores, the cheaper will be the process of serving them. Examples of other practical applications of the P-Median problem on real-world scenarios are the choice of location of schools (Honey, Rushton, Lononis, Dalziel, Armstrong, & Densham, 1991) or a bank (Willer, 1990), the selection of facilities for a university's admission examination (Correa, Steiner, Freitas, & Carnieri, 2001) and locating telephone switching centers (Hakimi, 1964).

Solving the P-Median problem through the use of exact methods implies high computational resources hence, being a well studied problem, a reasonable amount of heuristic approaches have already been proposed (Mladenović, Brimberg, Hansen, & Moreno-Pérez, 2007). In this work, we propose a new approach to solve the P-Median problem, based on Relaxation Adaptive Memory Programming (RAMP). RAMP, a metaheuristic recently proposed by Rego (Rego, 2005) that aims to efficiently explore the relation between dual and primal spaces of a problem. The proposed algorithms, Dual RAMP and PD-RAMP, correspond to RAMP's different sophistication levels. Dual RAMP, the simplest one, focuses on the dual space while solving the P-Median problem, using a Lagrangian Relaxation. Primal solutions are improved using a Swap Based Local Search (Werneck & Resende, 2003). On the other hand, PD-RAMP algorithm intensifies the search on problem's primal space by the addition of an evolutionary method to the existing Dual RAMP, in this case, the Scatter Search method (Martí, Laguna, & Glover, 2006).

The proposed RAMP algorithms were able to achieve high quality results on classic sets of instances of the P-Median problem, varying on the number of total locations and the number of medians to locate. Comparing the results obtained by the two algorithms, Dual RAMP obtains good solutions in reduced computational times and PD-RAMP, being more sophisticated, is more time consuming, but attains better solutions. These results prove that our RAMP approach to the P-Median problem is extremely effective, which shows its potential application to real word scenarios as a successful decision support tool.

Keywords: location problems, RAMP, P-Median, Metaheuristics, information technology