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The Multi-Period Vehicle Routing Problem with Consistent Service Constraints

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Distribution has been an important feature of industrial and economic life for many years, but it is in the relatively recent past that it has been identified as a major function in its own right. The academic and the business world have recognised the importance of distribution and logistics, leading to the adoption of a more scientific approach towards the subject [1]. This approach has focused on the whole concept of logistics, as well as its individual functions. One of the major operational issues lying at the heart of distribution management is the Vehicle Routing Problem (VRP).

The Consistent Vehicle Routing Problem (ConVRP) is a combinatorial optimization problem, recently introduced by Groër et al [2]. It involves the design of a set of optimal routes to service a set of customers with predefined demands and frequencies of visit over multiple days, using a homogeneous fleet of vehicles. The routes must start and end at a central depot. During each day customers must be visited exactly once by one vehicle and frequent customers must receive consistent service throughout the planning period. Thus, the maximum difference between the earliest and latest service times by the same vehicle over multiple days must not exceed a specified time limit and their visiting sequence must be the same. The objective is to minimize the total distance travelled while satisfying operational constraints, such as vehicle capacities, route duration, visit requirements and consistent service. An example of a possible daily solution to the problem is illustrated below.

Example of a daily solution to the problem

In general terms, ConVRP can be used to model a variety of real-life applications, e.g. parcel deliveries, collection and courier services, retail and wholesale deliveries, cleaning services and so on. This customer-focused application indicates the shift in companies' interest in creating stable bonds with their clients and their orientation towards customer-relationship management.

ConVRP belongs to the class of NP-hard discrete combinatorial optimization problems, as it is a generalization of the very well-known Vehicle Routing Problem (VRP). Discrete combinatorial optimization problems of high computational complexity appear in a multitude of real-world applications, such as assignment, scheduling, network design and many other fields of utmost economic, industrial and scientific importance. Taking into account that these problems in practice are usually large-scale, the significance and the challenge of producing optimum or near optimum solutions in reasonable computational times is obvious.

The use of intelligent algorithms and their strategic guidance in the solutions space is a very promising research area. To this end, hybrid algorithms are introduced and intelligent frameworks, in which exact algorithms are combined with metaheuristic algorithms and vice versa, are developed. The development of hybrid optimization algorithms is a new and emerging line of research, since it departs from traditional trivial collaborative combinations. By collaboration we mean that the algorithms exchange information among independent procedures executed sequentially, intertwined or in parallel. Intuitively however, one would expect more advanced integrative combinations of exact and metaheuristic algorithms to result in even stronger algorithms. By integration we mean that one technique is a subordinate embedded component of another technique. Thus, there is a distinguished master algorithm, which can be either an exact or a metaheuristic algorithm, and at least one integrated slave. Towards this end, it is also very interesting to apply "the spirit of metaheuristic frameworks" when designing exact algorithms.

References

[1] Rushton A., Croucher P. & Baker P., *The handbook of Logistics and Distribution Management*, Kogan Page Ltd, UK (2006).

[2] Groër C., Golden B.L. & Wasil E., The Consistent Vehicle Routing Problem, *Manufacturing & Service Operations Management*, (to appear).