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Vehicle Routing and Scheduling Problems with Product Returns

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Managing the flows of spent or returned products has become imperative for modern companies seeking to explore and integrate reverse logistics as a viable business activity. Many new formulations and models have been proposed to design new combined pickup-delivery systems in order to deal with closed loop supply chains and improve productivity and utilization of vehicle fleet. Among them, the most studied are the so-called Vehicle Routing Problem with Backhauls and Time Windows (VRPCBTW) (Gelinas et al., 1995) and the Vehicle Routing Problem with Mixed Backhauls and Time Windows (VRPMBTW) (Kontoravdis and Bard, 1995).

Particularly, given a homogeneous fleet of depot-returning capacitated vehicles the goal of both VRPCBTW and VRPMBTW is to design a set of vehicle routes to satisfy the delivery and collection requirements of a set of geographically scattered linehaul and backhaul customers. Each customer has a known demand for delivery or collection, and it must be serviced within a predefined time window that models the earliest and the latest times during the day that service can take place. As such, vehicles must remain at the customer locations during the service, while there is a waiting time if a vehicle arrives before the customer's earliest time window. Finally, each customer must be visited only once by exactly one vehicle, while the load of a vehicle must not exceed vehicle's maximum capacity at any time along its route. The primary objective is to minimize the number of vehicles required to service all customers, while the secondary objective is to minimize the distance traveled. VRPCBTW follows a sequence restriction routing (linehauls first - backhauls after) and ensures efficient unloading, eliminating additional rearrangements of carrying products during service. On the other hand, VRPMBTW follows a mixed service increasing the possible synergies of combining deliveries and returns within each route. The aforementioned problems appear NP-hard complexity since they are natural generalizations of the well-known combinatorial optimization Vehicle Routing Problem (VRP). Consequently, significant computational effort is required for determining optimum or near optimum solutions even for medium size instances.

Studying the recent literature, several modified construction and improvement heuristic approaches proposed as well as metaheuristic algorithms such as ACO algorithm, GRASP, etc. However, it is obvious that sophisticated hybrid algorithms incorporating artificial and computational intelligence are still in an early stage. Hybrid algorithms and innovative operations based on problem features and objectives could be proven advantageous and highly competitive producing high quality solutions within reasonable computational time. Hence, the development of successful superior frameworks that incorporate adaptive learning mechanisms (e.g. adaptive memory structures) and promising metaheuristic strategies (e.g. Path Relinking) could be a step further.

References

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