New hybrid heuristics for a location-routing problem

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As pointed out by Nagy and Salhi in their recent survey [1], many variants of the location routing problem (LRP) are addressed in the literature. Generally speaking the LRP consists of determining locations for depots from which customers are served on routes with the objective of minimizing the overall cost. In this talk we consider the capacitated location-routing problem (CLRP) which is defined as follows. Let G = (X, E) be an undirected graph where X is the vertex set and E the edge set. $X = V \cup W$ is composed of m vertices in V associated with potential location sites and of n vertices in W associated with customers. A cost matrix is defined on E and a fixed opening cost is associated with each vertex of V. Each customer i must be served a demand d_i from a depot. The total demand served from one depot must not exceed the depot capacity $\overline{Q}$. To deliver the demand, a fleet of vehicles is available and with each vehicle is associated a maximal capacity Q. A solution of the CLRP is a set of location sites for the depots and a collection of routes where: (i) each customer is visited only once; (ii) the total demand for each route is at most Q; and (iii) the total demand delivered from each depot is at most $\overline{Q}$. The CLRP aims to determine a minimal total cost solution. The total cost is the sum of the opening costs and of the routing costs.

In this talk we consider the following decomposition of the CLRP. Let us first consider that the depot locations are fixed. Then the CLRP reduces to the Multi-Depot Vehicle Routing Problem (MDVRP). On the other side if customers are a priori clustered into groups with total demands less than Q, the CLRP is the Capacitated Plant Location Problem (CPLP). Thus a generic algorithmic scheme can be devised in which MDVRPs and CPLPs are solved alternatively. Their solutions provide respectively sets of customers associated with routes and sets of opened depots which can be used in the solution of the counterpart problem. In our approach CPLPs are solved using an exact algorithm while good solutions for MDVRPs are obtained thanks to a tabu search heuristic. Based on this general scheme different hybrid heuristics are described and compared on a classical test bed. Computational results obtained by the best heuristic compare favorably with the heuristics previously described in the literature [2].

[1] G. Nagy and S. Salhi (2007), Location-routing : Issues, models and methods, *European Journal of Operational Research* 177, 649-672.

[2] C. Prins, C. Prodhon, A. Ruiz, P., R. Wolfler Calvo (2007), Solving the Capacitated Location-Routing Problem by a Cooperative Lagrangean Relaxation-Granular Tabu Search Heuristic, *Transportation Science* 41, 470-483.