TITLE OF THE TALK

Non-Hamiltonian Formulations for the Single Vehicle Routing Problem with Deliveries and Selective Pickups

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ABSTRACT

In one-to-many-to-one single vehicle routing problems, a single capacitated vehicle based at a central depot is required to perform some deliveries of a first commodity to a set of customers, and some pickups of a second commodity that has to be brought back to the depot. This class of problems is well studied in the literature because models several issues arising in reverse logistics.

The most representative problem of this class is probably the *single vehicle routing problem with deliveries and selective pickups* (SDSP). In the SDSP, each customer requires a delivery (linehaul customer), a pickup (backhaul customer), or both (combined-demand customer). While all delivery demands must be performed, pickup demands are optional and generate a certain revenue if performed. Moreover, the vehicle is allowed to visit either once or twice any combined-demand customer. The objective is to minimize the total cost, which is given by the total transportation cost minus the revenues generated by performing the pickup demands.

The fist mention to the problem is probably in [1], and since then a good research effort has been devoted to its solution. As far as we know, all mathematical formulations proposed in the literature attempt to produce a Hamiltonian tour by working on a modified network, which is obtained by splitting each combined-demand customer into two single-demand customers, a linehaul one and a backhaul one. This can result in a significant loss in performance, because the size of the network can be even doubled. Consequently, existing algorithms solved to proven optimality only instances with up to 22 combined-demand customers (see [2] and [3]), or 68 single-demand customers (see [4]).

In this work we focus instead on the original SDSP network and present new formulations that can yield non-Hamiltonian tours. Through the use of Benders decomposition and additional valid inequalities separated in a branch-and-cut framework, we are able to outmatch previous results in the literature, obtaining the optimal solution for all instances with up to 110 combined-demand customers.

REFERENCES

[1] B.L. Golden and A.A. Assad. OR forum – perspectives on vehicle routing: Exciting new developments. *Operations Research*, 34: 803–810, 1986.

[2] H. Süral and J.H. Bookbinder. The single-vehicle routing problem with unrestricted backhauls. *Networks*, 41: 127–136, 2003.

[3] I. Gribkovskaia, G. Laporte, and A. Shyshou. The single vehicle routing problem with deliveries and selective pickups. *Computers & Operations Research*, 35: 2908–2924, 2008.

[4] G. Gutiérrez-Jarpa, V. Marianov, and C. Obreque. A single vehicle routing problem with fixed delivery and optional collections. *IIE Transactions*, 41: 1067–1079, 2009.