A Bilevel Model with a Solution Algorithm for the Network Design and Pricing Problem

Christine Tawfik*
QuantOM, HEC Management School, University of Liege (ULg),
christine.tawfik@uliege.be

Sabine Limbourg
QuantOM, HEC Management School, University of Liege (ULg),
sabine.limbourg@uliege.be

Abstract This work is devoted to jointly examining the intertwined tactical problems of designing freight carrying services and determining their associated prices. We put forward a bilevel model, where a leader is portrayed at the upper level, as a freight transport operator seeking to maximize his profits by setting the services' tariffs and selecting their subsequent operating frequencies, dealing with continuous and discrete variables respectively. At the lower level, the shippers (followers), faced with itineraries composed of the leader's services and an available competition's alternative, react in a costs' minimization fashion. We discuss a heuristic approach to solve the proposed model, addressing its main points of difficulty: the network design and the lower-level optimality. The algorithm is based on the idea of starting with an initial service network that is able to accommodate all the market's demands, then iteratively decrease the frequencies of those services that do not considerably contribute to the leader's revenues. Each iteration is divided in two steps: generating the flows that are compatible with the updated services' frequencies while maximizing the leader's profits, then solving for the services' tariffs that guarantee the flows' optimality for the lower level. Promising results are obtained on real-life data showing the ability of the algorithm of reaching solutions within a small gap from the best reached by CPLEX in a significantly less amount of time.