Internalizing Negative Externalities in the Vehicle Routing Problem

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Abstract

Road freight transportation includes various internal and external costs that need to be accounted for in the construction of efficient routing plans. Typically, the resulting optimization problem is formulated as Vehicle Routing Problem (VRP) in any of its variants. While the traditional focus of the VRP was the minimization of internal routing costs such as travel distance or duration, numerous approaches to include external factors related to environmental routing aspects have been recently discussed in the literature. However, internal and external routing costs are often treated as competing objectives. Instead, this work considers the internalization of external costs within the economic structure of the logistic company. Thus, not only the traditional approach of distance based internal costs of routing is considered but also the external costs are included in the objective function: that is, minimization of the full costs. Two protocols of internalizing are further analyzed and discussed: green taxes and green tolls. Numerical experiments with a biased-randomization savings algorithm show benefits of combining internal and external costs in delivery route planning. Consequently, the behavior of companies when internalizing external costs significantly changes. That means that they plan a different route in order to minimize their full costs, allowing for a noticeable reduction on emissions.