The Static and Stochastic Vehicle Routing Problem with Time Windows and both random Customers and Reveal Times

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Abstract

Unlike its deterministic counterpart, static and stochastic vehicle routing problems (SS-VRP) aim at modeling and solving real life operational problems whilst considering uncertainty on the data. We introduce a new two-stage stochastic combinatorial optimization problem, the SS-VRPTW-CR. Like the SS-VRP introduced by Bertsimas in [1], given a fleet of capacitated vehicles we are interested in optimal first stage routes to handle a set of customer demands, each having a known probability to be present. In addition to capacity constraints, customers are also constrained by time windows, just as in [2]. Our contribution is the following. Up to our knowledge, all SS-VRP variants make a strong assumption on the time at which a stochastic customer reveals its presence (e.g. when a vehicle arrives at the corresponding location). In the SS-VRPTW-CR however, the moment when a customer reveals its presence is stochastic as well. The later property clearly positions this new SS-VRP variant in a more realistic context, and provides new tools for online combinatorial optimization approaches to dynamic and stochastic VRP's. Finally, by assigning each vehicle a sequence of waiting locations, the objective minimizes the expected number of customers that cannot be satisfied in time. We provide closed-form expressions for computing the objective function under two different recourse strategies. We propose a stochastic integer formulation and a extended branch and cut algorithm that solves the problem to optimality.

References

[1] Bertsimas, D.J., *A vehicle routing problem with stochastic demand*, Operations Research, 40(3), 574-585, 1992.

[2] Lei, Laporte, Guo, *The capacitated vehicle routing problem with stochastic demands and time windows*, Computers & Operations Research, 38(12), 1775-1783, 2011.