Research Title:

Dynamic routing to achieve efficient and fair distribution

Primary Investigator:

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We address the problem of allocating resources of limited supply to several agents whose demand is uncertain and revealed only upon arriving at them. The challenge is to determine the allocation amount to a given site upon arriving at it when the demand of the subsequent sites along the route is unknown. The goal is to maximize both effectiveness, measured by the total number of units distributed, and the fairness (equity) among the agents. This objective arises in many applications of urban logistic settings such as food distribution to agencies or a massive vaccine campaign after a sudden outbreak.

We analyze the problem by first formulating it as efficient linear programming that represents all possible realizations in a compact way. The solution of the above LP can be used to examine the performance of a heuristic solution for small instances. We then developed structural properties and a heuristic solution method based on them for larger instances of the problem. The heuristic procedure has demonstrated very good performance on relatively small instances for which we were able to obtain the optimal solution. Further analysis and experiments are required, as well as further fine-tuning of the heuristic procedure. In practice, most likely the allocation decisions are controlled via simple rules of thumb, and in this work, we suggest implementing optimization-based decisions.

In a complementary study, we focus on routing decisions when the source of uncertainty comes from the supply side. Future research will combine the outcomes of the two studies into an overall solution procedure when both supply and demand are uncertain.