

Multiple clients in ad-hoc shared ride planning

Matthias Braun

Institute for Geoinformatics, University of Münster, Germany

Stephan Winter

Department of Geomatics, The University of Melbourne, Australia

Problem and motivation

Shared ride systems aim to assign clients, e.g., pedestrians with a travel demand, to hosts such as private cars, taxis or mass transport that could potentially serve for rides. Ad-hoc shared ride services enable the assignment in an ad-hoc manner, i.e., instantly and without pre-registration [1, 2].

This work introduces multiple clients in ad-hoc shared ride planning. Multiple clients lead to competition among clients for hosts and among hosts for clients. The fundamental problem is the assignment of free capacity supply to travel demand while optimizing some objective value of the global network. The capacity assignment problem has been identified as the multi-commodity flow problem known in operations research, which is known to be NP-hard in dynamic networks [3].

Research questions and hypothesis

A basic research question is the definition of a global optimum for clients. In a multiple client system the total trip costs of all clients with respect to the clients' cost functions have to be considered.

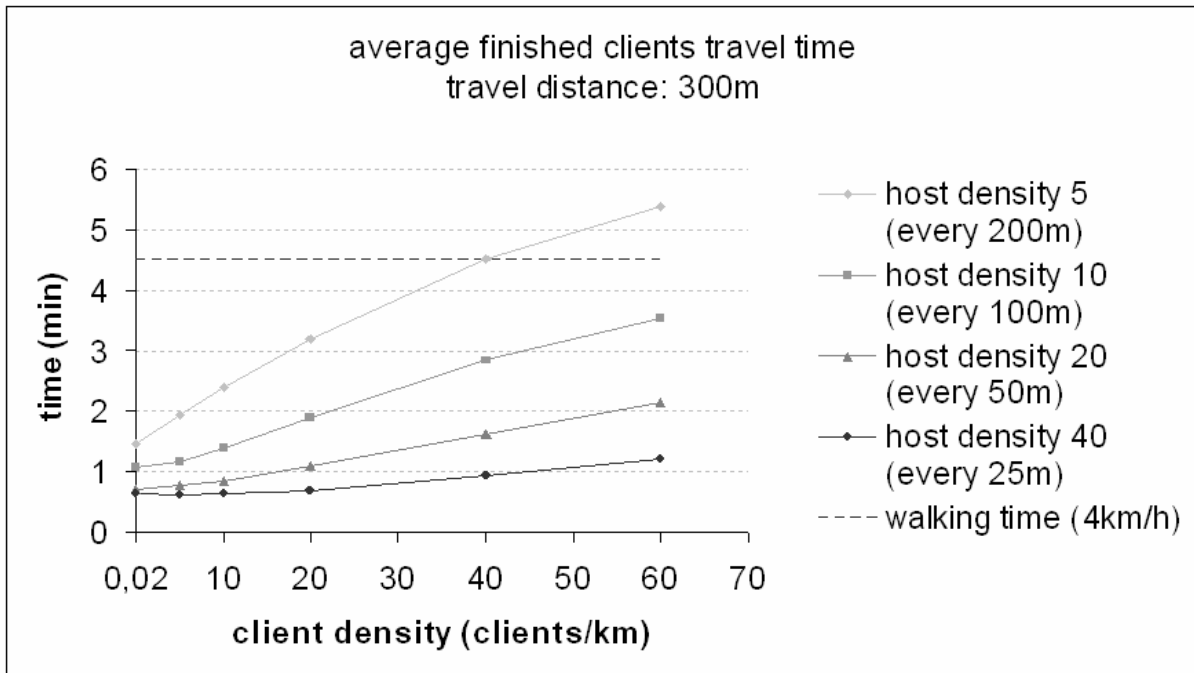
The second question is to find a solution for the capacity assignment problem in this dynamic network that is computable in polynomial time. One host can receive multiple requests from clients for the same seat. If the host's seat capacity is not sufficient to serve all clients, they have to decide about the offers to make for which client. A negotiation process has to be formalized that takes this aspect into account. Therefore, the hypothesis of this work is: By solving the capacity assignment problem *locally*, agents are able to make effective decisions. That is, agents use local knowledge resulting in trips close to the optimal total trip costs. The communication effort is significantly less than for collecting complete transportation knowledge.

Approach

First, the global optimum for clients will be defined as the total clients' trip costs, which are to be minimized. Second, for solving the capacity assignment problem we develop a polynomial time approximation scheme. It spatially decomposes the complex problem into many local ones that can be solved efficiently. The heuristics has been formalized in a negotiation process between multiple hosts and clients. A simulation system for large-scale traffic simulations has been implemented that uses a real street network, realistic agent densities and physically realistic simulation parameters. With the simulation system all necessary experiments have been carried out to investigate the properties of the proposed heuristics, and to test the hypothesis.

Results and relevance

In the simulation experiments, clients' travel costs were defined by their travel times over 300m distances. Host and client densities were varied and the host capacity was fixed to one seat per host. The client density of 0.02 represents a single client experiment.



The results show that effective capacity assignment in ad-hoc shared ride systems is possible based on local environments only. Trip quality is perceived as excellent compared to a single client system. The trip quality increases only linear with a slope below 0.1 in all experiments. Shared ride travel time is below walking time even in the worst case involving 60 clients/km and a host density above 10 hosts/km. The heuristics is simple and computationally efficient. Further, the approach is efficient with regard to communication effort. It uses only mid-range communication, i.e., less than 100m communication range. Therefore, the approach is fully scalable.

References

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