

Agent Behavior in Peer-to-peer Shared Ride Trip Planning

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INTRODUCTION

Movement of people in a city forms a complex system, which includes street networks, traffic infrastructures (e.g. traffic lights, signs) as well as the actions of intelligent pedestrians and vehicles. Since increasing traffic has become a common problem all over the world recently, a peer-to-peer shared ride trip planning system is designed as a solution. With transportation client and host agents representing pedestrians and vehicles, this solution accomplishes a trip for clients by ad-hoc negotiation with available hosts around.

Hosts are distinct from each other in speeds, capacities, and both clients and hosts have typical behaviors, which affect the negotiation process and travelled trip as a result. For example, a rushed client would prefer those hosts, who can come in short time, move with a higher speed and head straightly toward the destination without detour, such as taxis. On the other hand, taxis can be highly in demand in the morning busy time, and catching passing by trams can be an alternative: they are slower but more available. In order to further examine how clients and hosts negotiate with each other and make better decision in a peer-to-peer shared-ride trip planning system, this paper investigates the different behavior of agents with a computer simulation, and the consequence on the trip planning processes.

HYPOTHESIS

Agents, i.e. clients and hosts, in peer-to-peer shared-ride trip planning systems have knowledge of their environment. They can collect and transmit information from/to their neighbors. Frequently agents have choices. They have their preferences and various optimization criteria, such as money or time, and are able to make current optimal decisions based on their knowledge. Previous research (Winter and Nittel 2006) tests different communi-

cation strategies (unconstrained, short-range and mid-range) in large transportation networks with homogeneous hosts, and finds out that mid-range strategy is both efficient (leading to less communication messages) and effective (leading to less travel time). The hypothesis of this paper is that involving different behaviors of agents, the trips will change significantly, but mid-range communication strategy is still both efficient and effective compared to other communication strategies.

METHODOLOGY

In order to reflect better the properties of a realistic transportation system, three typical kinds of hosts are identified in a computer simulation. They are public transports, taxis, and private cars. The main different attributes of them are shown in Table 1. Public transport generally can be available for a few clients to share, but must follow the predefined routes under timetable. Clients are only allowed to get on and off at stops. Taxis can arrive at an appointment intersection anywhere as soon as possible, willingly make a detour for the clients, but likely charge more and are limited by capacity. Private cars have predefined route and may less likely make a detour for the clients, whereas they can pick up clients at any intersection along their trips too.

Tab. 1: Typical host attributes

	capacity	speed	route	detour	others
public transport	10	2	predefined	FALSE	timetable
taxi	1	1	changeable	TRUE	nil
private car	1	1	predefined	FALSE	nil

This simulation is designed as an object-oriented architecture using JAVA. In this architecture, clients and hosts are the actors in the negotiation processes. They are developed from an abstract object, *agent*, which owns common attributes, such as ID, speed and capacity, as well as common methods, e.g. *move*. Clients and hosts are moving in a grid environment including (a) an internal clock incrementing with each negotiation cycle, (b) edges which agents travel along, and (c) intersections where hosts can stop. Every negotiation cycle starts with requests from clients for a shared ride. The requests are broadcasted to their neighbors. Hosts are responsible for matching the requested route with their own, determining how to contribute to the clients' trip and send client an offer. Clients choose the optimal offer and book it. The quality of the negotiation is assessed by (a) the average number of communication messages, which should be low and (b) the average travel time (optimizing time in a first instance).

RESULTS

The simulation can be deployed to test various compositions of host agents, various densities of host agents, and various designs of public transport networks. All these factors influence the simulation results (average trip times, average number of messages). However, these results are consistently supporting our hypothesis. As an example, we report here about simulations with one client and a constant number of hosts in a 21×21 grid world, 72. Note that this is a comparatively low host density, such that communication connectivity in most negotiation processes is low. In this world, the client has ten segments to travel, prefers quickest trips, sticks to her chosen route and can not move by herself. Buses operate on a bus line that overlaps for six segments of the client's trip plan, and has stops at every other segment; hence stopping four times on the client's route. Buses come along a bus stop every second time unit. Other hosts move randomly. Mid-range communication is employed in negotiation processes.

Now consider Figure 1: For the chosen parameters, the simulations show that under these conditions:

- (1) Taxis, if available, have the priority of being booked. They minimize the average message number and travel time because of heading directly from departure to destination.
- (2) Public transport vehicles are lesser occupied because of the constraint of fixed route and timetable (in our design, their route only partly overlaps with the client's route). They are still preferred to cars for their higher speed.
- (3) The introduction of multiple kinds of hosts evidently improves the efficiency and effectiveness of trip planning compared to previous results of homogeneous hosts (Winter and Nittel 2006) that are reflected in Figure 1 by the experiment with cars only.

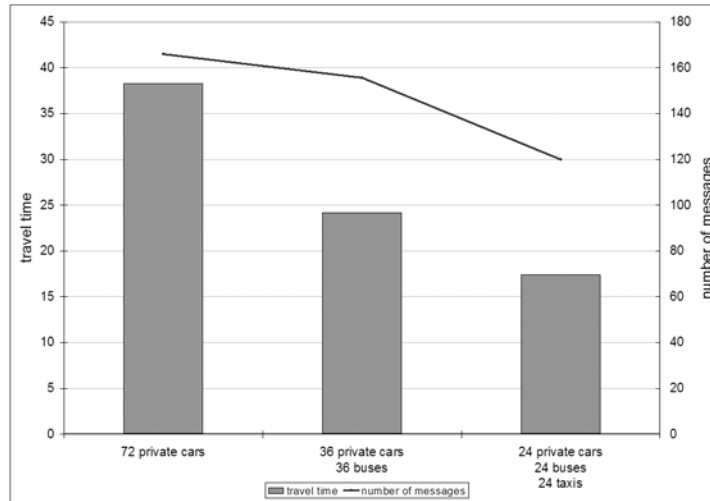


Fig. 1: Comparison of trip planning quality with multiple hosts

CONCLUSION

This experiment allows the preliminary conclusion that multiple types of agents enhance the quality of trip planning under the quickest criterion. Implementations of clients that are able to walk, and of other hosts, are currently developed.

Multiple optimization criteria, such as a relatively cheap and quick trip, will be employed in the future and are expected to change resulting trips. Presently, the client makes the best decision according to the current information at each negotiation cycle, but the whole trips can not be optimal from the global view. Therefore, another goal is to improve clients' way-finding strategies by a learning mechanism. Future research also includes competition among clients, which will involve competing requests. Additionally, more realistic street networks will be used.

REFERENCES

Winter, S. and S. Nittel (2006). "Ad-hoc shared-ride trip planning by mobile geosensor networks." *International Journal of Geographical Information Science*. Accepted for publication.