Intelligent Route Planning with Incomplete Transport Knowledge

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There is a large body of knowledge for efficient and optimal route planning in transportation networks, including time dependent networks generated by phenomena such as scheduled transportation or regular traffic patterns. In all these case the assumption is that the route planner has complete and (near) up-to-date knowledge of the network.

We study route planning in a different environment. We assume that transport is offered by vehicles—our *host* agents—and consumed by pedestrians—our *client* agents. We further assume that the clients do their trip planning autonomously, i.e., trip planning becomes decentralized. Clients do their trip planning ad-hoc, which means that they have to get knowledge of the current transport network. Our hypothesis is that clients need to have only local knowledge of the transport network to come up with nearly optimal trip plans.

This idea suggests employing a mobile geosensor network. In our situation, each participant—clients as well as hosts—form a node in the geosensor network. These nodes are mobile and location-aware (hence 'geo'-sensor), they may know the street network, and they can communicate in an ad-hoc manner (Nittel et al. 2004; Zhao and Guibas 2004). A client that is looking for the current state of the transport network would ad-hoc broadcast a request, and hosts receiving this requests can return an offer if they see some chance to contribute to the trip. The client would collect all offers, construct a space-time network from the offers, and applies a route planning algorithm for selecting the best offers. Hosts of the best offers will be informed by a booking message. This negotiation is done periodically, due to the dynamically changing environment and new opportunities arising.

There are several challenges hidden in this model, which make it an interesting subject of investigation. The negotiation process requires two-way communication, which consequently requires a stable communication network topology. Since all agents are mobile, in reality the topology changes quickly, and hence, the negotiation has to take place in very short time frames. Radio range is limited as well, due to limited battery energy. Sensor networks typically apply multi-hop strategies to transport information over larger distances. However, within short time frames multi-hopping is very limited. Clients can realistically collect only network knowledge from hosts nearby. De facto this means a spatial limitation (by the communication range) and a temporal limitation (since it is bound to the current set of hosts in the communication range).

Another challenge lies in the fact that the collected offers not necessarily contain any connected set of trips leading to the destination. Thus, the client has to apply heuristics to decide in which direction to start the trip. These heuristics can be guided, for example, by general direction, or by street hierarchies, or by learned knowledge of traffic patterns in the city.

The third challenge is in the interplay between clients and hosts. For hosts it is not obvious whether their travel plans contribute to the clients requested trip. Hosts might also get several requests at the same time, from different clients, and try to optimize according to their interests as well. Hosts do also have different modes of traveling (compare for example private cars, taxis, or buses), different business models or fee structures, and different capacities.

We approach the hypothesis by simulation in a multi-agent model. We have shown already that local knowledge is sufficient for nearly optimal trips. The reason lies in the autocorrelation of agents: nearby agents can be at the client’s location soon, and hence, are favored by the client. Currently we introduce different types of hosts into the simulation, and realistic mobility models for the hosts, which again relate to more realistic wayfinding heuristics of the clients.

Related publications are (Winter and Nittel 2005; Winter et al. 2005; Winter and Raubal 2006).

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