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Multi-Agent System for Location of Park-and-Ride Hubs

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Park-and-Ride (P&R) hubs are important elements of modern urban infrastructure. They help to reduce congestion and pollution by allowing travellers to leave their cars in easily accessible locations in the city and commute inside the city by bicycle, scooter, public transit, or other ecological vehicles.

Choosing locations for new P&R hubs can be a challenging task because it must consider competition between existing hubs, travel demand from many regions, customer (or travellers in our case) needs, available locations for the hubs, and other properties. Customer behaviour adds additional uncertainty when locating P&R hubs. Some travellers may always choose the most attractive hub, while others may distribute their choice among several hubs depending on their daily needs and the attractiveness of the hubs. These different behaviour models lead to different estimates of hub utility.

To ensure that new hub locations perform well under different customer behaviours, it is necessary to find solutions that remain effective independent of the customer behaviour. To address this need, it is not necessary to find the best solution for a single customer behaviour model, but rather a robust solution or set of them that are simultaneously good for different customer behaviour models. This solution balances the trade-offs between different customer behaviours and provides a practical recommendation for city planners.

We propose a Multi-Agent System (MAS) to identify robust locations for a given set of new facilities from a given set of location candidates. In this system, Customer Behaviour Agents represent different customer behaviour models and are able to propose solutions considering that customer behaviour. Each customer behaviour agent uses reinforcement

learning to explore candidate solutions, learn from its experience in evaluating the utility of the solutions and propose solutions taking into account the negotiation status. A Mediator Agent coordinates interaction between customer behaviour agents and their negotiation process. Agents follow negotiation strategies to identify optimal candidate locations in the context of different customer behaviour models and highlight the robust solution or a set of them.

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