Review of "Space-Time Adaptive Taxi Routing" Diploma Thesis

Student: **Matej Grajciar**

Reviewer: **Malcolm Egan (Advisor)**

Overall Grade: **C (Good)**

The problem considered in this thesis was how to direct vacant taxis in on-demand transport markets. This is a timely problem as providers such as Uber and Liftago in Prague have recently begun to adopt markets as a means of allocating passengers to taxis, as well as price passengers.

The aims of the thesis were to:

(1) Perform a literature review.
(2) Develop a mathematical formulation of the driver routing problem.
(3) Design algorithms to solve the driver routing problem using the mathematical formulation.
(4) Implement the algorithms in the Mobility Services Testbed.
(5) Evaluate the performance of the algorithms via simulation.

All five aims have been addressed. Overall, this is an interesting solution to the problem of recommending where vacant taxis should be directed in on-demand transport markets. I will now provide more detailed comments on each aspect.

The literature review **(Aim 1)** provides a very brief overview of agent-based modeling in on-demand transport. This is followed by a summary of the role of market mechanisms in artificial intelligence and their use in on-demand transport. The remainder of the literature review addresses previous attempts to direct vacant taxis. It is pointed out that these approaches do not deal with a market allocation algorithm, which provides a clear motivation for a new approach.

The system model chapter details the underlying agent-based model that the rest of the thesis relies on. This includes how the passengers, drivers, and the provider behave and also the underlying market mechanism used to match passengers to drivers. The assumptions are clearly pointed out.

The proposed approach chapter introduces two algorithms to direct vacant taxis, which act as a recommendation system for drivers. The first part of the chapter details how the system is modeled by the recommendation system **(Aim 2)**. Although this is mentioned briefly, the structure of this part is not always clearly described. The simplified model itself is nice in that it clearly features the key parameters in the system.

The second part of the proposed approach chapter is an algorithm called the profit-aware recommendation approach **(Aim 3)**. This is centered on computing a "potential

function”, which represents the expected profit a driver will earn from their next trip at each location. This approach is new and has been submitted for publication.

Another recommendation approach is then introduced that only accounts for the requests and number of taxis, as well as the distance a taxi is required to travel. The relation of this approach to previous work is mentioned, but not fully elaborated on.

The next chapter addresses the implementation of the recommendation system **(Aim 4)** in the testbed. The basic structure of the implementation is detailed well. However, the full algorithm could use further explanation.

The experiments chapter **(Aim 5)** considers the performance of the proposed algorithms from the perspectives of the drivers, passengers, and the provider. The simulation results consider the effect of varying the demand and the number of drivers. The chapter is then concluded with a general summary. There are several interesting trends observed throughout the chapter, suggesting that choosing the right algorithm strongly depends on the type of network that is being considered. A weak point is that this is not elaborated on in the summary.

Overall, the thesis tackles an interesting problem by developing a new recommendation system, tailored to on-demand transport markets. The thesis meets the main conventions of technical writing (page numbering, etc).The main weaker aspects of this work are the detailed description of the mathematical developments, the description of the implementation and the description of conclusions from the simulation study. Nevertheless, although the description could be improved, I believe that the content is sufficient for a Diploma Thesis.

This work satisfies all the aims and introduces new and interesting ideas and results. The student also made sufficient effort on this project work. As such, I believe this work deserves a **grade of C (Good)**.

Reviewer: Date:

Malcolm Egan