LEHRSTUHL FÜR VERKEHRSTECHNIK - TECHNISCHE UNIVERSITÄT MÜNCHEN

UNIVERSITÄTSPROFESSOR Dr.-Ing. FRITZ BUSCH

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Master's Thesis

Route-estimate methods based on detector data

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MASTER'S THESIS

of Van Te Ron Nguyen

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Topic: Route-estimate methods based on detector data

The Master's thesis aims at analysing and evaluating the "DFROUTER" tool contained as part of the SUMO traffic microsimulation suite. DFROUTER uses induction loop values to calculate complete routes for vehicles through (primarily motorway/corridor) simulation networks, which are assumed to be equipped by detectors.

This approach is designed for highway corridors. The algorithm should be well described and compared with other similar approaches that do not necessarily place restrictions on the network type. Special attention should be given to the accuracy, performance, convergence and usability with diverse network sizes and forms.

Suggestions for the improvement of "DFROUTER" tool is expected to be achieved in order to calculate routes more accurately, and to know which use cases are suitable for its application. In addition, future areas for research can be identified, such as lane-specific routing.

The following will be carried out in the thesis work:

- Literature review on route-estimate methods and relevant Origin-Destination matrix estimation methods.
- Introduction about SUMO simulator and DFROUTER tool
- Designing a methodology of the research
- Generating detector data for a variety of networks, vehicles, flows and routes

- Exploring DFROUTER algorithm based on obtained output and comparing with related approaches
- Proposed improvements for DFROUTER
- Conclusion and outlook

The candidate will present intermediate results to the supervisor (Matthew Fullerton, MEng, MSc and Dipl. Inf. Daniel Krajzewicz, Scientific Coworker, Institute of Transportation Systems, DLR, Berlin) in the fifth, tenth, fifteenth and twentieth week.

The candidate has to defend the thesis within at least two months after submission. He has to present the topic and most important results of the thesis in a 30-minute-talk. This presentation is followed by a discussion which involves the broader context of the thesis' subject area. The student also submits a one page thesis outline (DIN A3-Size) as well as a two page abstract.

The master's thesis will be supervised by the Chair of Traffic Engineering and Control. The student is responsible for the results of the thesis. Responsibility for results of the student's work will not be assumed by the Chair of Traffic Engineering and Control.

Univ.-Prof. Dr.-Ing. Fritz Busch

Abstract

The primary purpose of this thesis is to analyze, evaluate and improve the open-source “DFROUTER” tool contained as part of the SUMO traffic micro-simulation suite. DFROUTER uses traffic volume detector values to calculate complete routes for vehicles through simulation networks. This approach is designed for highway corridors; however its algorithm has been not described in detail.

At first, a literature review of Origin Destination matrix estimation methods is presented. The static and dynamic approaches have been developed for the last 30 years and applied to various network sizes and types. SUMO suite and DFROUTER were also introduced in this part.

The thesis then identifies the methodology to investigate DFROUTER. Firstly, DFROUTER’s current functionality was analyzed using several theoretical network types and data availability. The overall goal is that after running the simulation, similar values should be observed at the detection points in the simulation compared to the detector data used to generate the traffic demand and routing for the simulation. To this end, DFROUTER generated validation detectors for the SUMO simulation. Secondly, similar approaches were described and compared with DFROUTER algorithm using the same networks. The main indicator to perform comparisons was route probability. Lastly, in order to improve of the algorithm, changes of the algorithm were proposed and implemented in abstract and practical highway networks.

The result part at first describes the DFROUTER’s algorithm in detail. Basically DFROUTER determines split edges (the legs go out of a junction) having detectors on them and calculates the proportion of flow on split edges using detector data. Destination distribution is computed by multiplying all flow probabilities on all edges constructing that route. The algorithm is simple for route calculation that uses only data from detectors laid on split edges. However this simple algorithm could not work successfully in the case of missing detectors, especially detector data on split edges (in-between or sink detector) as it is not able to guess the missing data. The probability of missing flow would be overestimated to 1.0 as default.

In addition, comparison with similar approaches has shown that the equally split OD matrix method did not generate a plausible result. The gravity mode was not suitable for application to DFROUTER, as the tool generated routes arbitrarily depending on network topology. The comparison results also indicated that DFROUTER is working most similarly to the turning percentage approach and the proportional OD matrix.

Suggestions for DFROUTER improvement then fundamentally changed the method of flow computation that calculates the flow on each edge of the highway network using backward or forward recursion. If the algorithm could not figure out the value after a certain number of recursions, its probability would be returned to 1.0.

The improved DFROUTER was applied successfully to an abstract network corridor as well as to a highway network of Nuremberg containing three main interchanges and other complex intersections. These highway corridors have a low level coverage of detectors. The outputs were more reliable and accurate compared to those from the original DFROUTER in case of lack of detector data. The computation time was longer as a result of performing recursion.

In conclusion, the thesis has been conducted successfully in analysis, evaluation and improvement to DFROUTER. This thesis supports a long missing description of the tool and compares it with other similar approaches that do not necessarily place restrictions on the network type. The improved DFROUTER produces reliable results as expected. Further research can focus on demand calculation for urban areas where route computation is complicated as each edge contains two ways of driving. Another extension can be route calculation on highway rings.

Acknowledgements

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