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ADVANCING ANALYTICS

The boundary between semi-dynamic and dynamic traffic assignment models

INTRODUCTION

Transport model systems are important decision tools on strategic, tactical and operational level to determine the impact of measures and to forecast the future usage of the mobility system. These model systems describe and connect the different behavioral choices of travelers (e.g. mode, destination, departure time) using a separate model for each choice type. The traffic assignment (TA) model describes the route choices (and the corresponding level of service) of travelers on a network based on the utility (of which travel times are an important aspect) of the routing options available.

Within strategic model systems Wardrop user equilibrium (UE) conditions are imposed onto the TA model, which, to a large extent, reflect accurate route choice behavior of travelers. Additionally, UE conditions also ensure that scenario impacts can be directly assessed by comparing scenario results to a reference scenario.

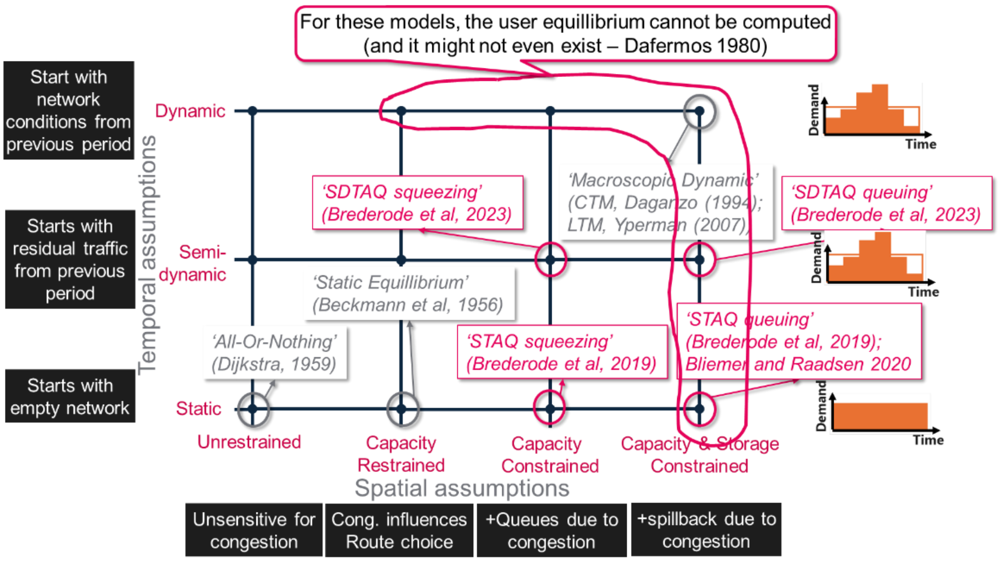

Figure 1: classification framework for macroscopic first order traffic assignment models (*Simplified and adapted from* (Bliemer et al., 2017))

Following the framework above: the majority of strategic TA models to date are either static capacity restrained or dynamic capacity and storage constrained. As both the spatial and temporal assumptions of the static capacity restrained TA model are not realistic on networks with structural congestion, whilst UE conditions cannot be imposed on the dynamic capacity and storage constrained TA model, DAT.Mobility implemented the most realistic model on which UE conditions can still be imposed: the semi-dynamic capacity constrained TA model 'SDTAQ squeezing' (Brederode, 2023, chapter 4). Basically, this model alternatingly runs the static capacity constrained TA model STAQ squeezing and transfers the resulting residual queues to the next time period.

PROBLEM DESCRIPTION

SDTAQ squeezing puts no restrictions on the study period time dimensions (the list of start- and end time of each time period). However, two assumptions in SDTAQ cause conflicting desired time period durations:

1. when transferring residual queues, SDTAQ implicity assumes that the level of service instantaneously changes from one time period to the next. This assumption can cause violations of the FiFo condition (traffic overtaking vehicles within a queue) as described in section 5.4.5 of (Brederode, 2023), thereby reducing model accuracy. To reduce this undesired effect, time period durations should be decreased and/or the transferred demand should be prioritized by changing the capacity of connector links (as suggested in section 4.5.3 of (Brederode, 2023)).
2. within each time period, SDTAQ assumes that all non-queued vehicles arrive at their destination. This assumption becomes less realistic when shorter time periods are used, especially on longer routes, hence to reduce this undesired effect, time period durations should be increased.

As both mechanisms are absent in dynamic capacity and storage constrained TA models, when ignoring its inability to adhere to UE conditions, this model type serves as a ground truth.

RESULT / OBJECTIVE

The conflicting mechanisms described above, suggests an optimum time period duration, given the level of service on the network of a current and next time periods and the distribution of route lengths across the network and conditional to the connector link capacities. The goal of this research it to approximate the accuracy of a dynamic TA model as much as possible within the semi-dynamic model type by developing a method or procedure that aids to define optimal study period time dimensions and connector link capacities for a given network, taking both mechanisms described above into account. Additionally, if time allows the effect of shorter time dimensions on the computational requirements could also be taken into account.

ASSIGNMENT

A rough work breakdown of the assignment could be:

- Do literature research on static, semi dynamic and macroscopic dynamic TA models, focussing on semi dynamic capacity constrained TA models
- Conduct computational experiments on theoretical networks to learn about the relative importance and countermeasures of the two conflicting mechanisms and the effect of connector capacities as described above
- Develop a method or procedure to define optimal study period time dimensions and connector capacities, given a network and travel demand
- Demonstrate the extent to which the accuracy of a dynamic TA model can be approximated, and therefore the practical value of this method by comparing the optimized semi-dynamic approach to a dynamic approach on a real world transport model system
- If time allows: revise the method/procedure, taking into account that computational requirements increase when time period durations decrease

INFORMATION

When interested in this internship assignment please contact: Luuk Brederode at lbrederode@dat.nl. More information on Goudappel and DAT.Mobility can be found via www.goudappel.nl and www.dat.nl.

References

Bliemer, M., Raadsen, M., Brederode, L., Bell, M., Wismans, L., Smith, M., 2017. 'Genetics of traffic assignment models for strategic transport planning'. *Transport Reviews* 37(1), pp.56–78. https://doi.org/10.1080/01441647.2016.1207211

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