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Description of Research Seminar: Bi-objective Traffic Assignment with Multiple User Classes: A Time Surplus Approach

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Research Seminar

offered by Olga Perederieieva (UOA)

in June 2013,

in Göttingen, Germany

Subject: Bi-objective Traffic Assignment with Multiple User Classes: A Time Surplus Approach

Problem: Traffic congestion is an issue in most cities worldwide. One way to model and analyse the effect of congestion on route choice behaviour is traffic assignment (TA). Conventional TA models the behaviour of travellers by assuming that all drivers are selfish and tend to choose the fastest routes from their origin to their destination. As a result an equilibrium state is achieved, when no one has an incentive to switch to another route. Therefore, it is assumed that all drivers make their travel decisions regarding travel time only. However, this is not true in general. According to empirical studies other important factors are travel time reliability and monetary cost.

In the literature on the TA problem where two or more objectives are explicitly distinguished the majority of the models form a weighted sum of the objectives. This approach is not general. It allows to find only a subset of all equilibrium solutions. We propose to use a conceptually different approach - the bi-objective user equilibrium. It considers two objectives separately (travel time and toll) and allows multiple solutions. In order to model user preferences, we apply the time-surplus maximisation model (TSMaxBUE) which can identify one of the solutions.

Time surplus is defined as the maximum time a user is willing to spend minus the actual time spent. The maximum time a user is willing to spend is modelled as an indifference curve - a non-linear function

that depends on the path toll. All drivers are divided into classes with different indifference curves that model preferences of each group. We show that this model admits a mathematical programming formulation and we adapt some conventional TA algorithms to solve TSMaxBUE with multiple user classes.

The TSMaxBUE model allows to obtain various traffic patterns by changing the indifference curves. We observe that this framework is general enough to cover any situation with a flow dependent and a flow independent component of path cost.

Main Results: In case of multiple-user classes we derived the mathematical program and showed that it is equivalent to the user equilibrium condition. The path equilibration algorithm, originally developed to solve the conventional TA problem, was extended to handle the TSMaxBUE problem with multiple user classes and was tested on two small instances.

We studied the relation of the TSMaxBUE model with multiple user classes to its single-class version. In particular, we derived how the model with multiple classes can be transformed into a model with a single user class. This allows to reduce the problem size. However, no information about class flows can be derived. The non-uniqueness of such flows raises the question of imposing additional assumptions on the problem in order to generate consistent and unique class flows.

We have also shown that link flow patter that satisfies the bi-objective user equilibrium condition might contain directed cycles. This means that so-called bush-based approaches (this type of methods represent the group of advanced algorithms, developed for solving the conventional TA problem, that can achieve highly precise solutions in a reasonable amount of time with medium memory requirements) cannot be applied in order to solve the TSMaxBUE model limiting the available techniques to path-based methods.

Participants: researchers and students from UGOE

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