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Description of Research Seminar: Bi-objective Traffic Assignment Based on Time Surplus Maximisation

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Research Seminar

offered by Olga Perederieieva (UOA)

in September 2012,

in Kaiserslautern, Germany

Subject: Solving Bi-objective Traffic Assignment Based on Time Surplus Maximisation

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 are based on the assumption that all drivers minimise their travel time or generalised cost, which usually represents a linear combination of time and monetary cost. This approach is not general. It allows to find only a subset of all equilibrium solutions.

We propose to use a conceptually different approach inspired by the multi-objective definition of optimality – the bi-objective user equilibrium. It considers two objectives separately (here we consider 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.

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: To solve the TSMaxBUE model, we consider two cases separately: one user class (i.e. all drivers are assumed to have the same indifference curve that might differ only for different O-D pairs) and multiple user classes (i.e. there are several groups of drivers corresponding to different indifference curves).

We show that the TSMaxBUE model with one user class can be solved using the time-based traffic equilibrium (TBEQ) model which has an equivalent mathematical program able to find a user equilibrium solution as long as the indifference curve is continuous, strictly decreasing and non-negative.

We propose to apply the following path-based algorithms: path equilibration, projected gradient and gradient projection. Previously these methods were applied to solve the conventional traffic assignment problem with travel time as the objective and were reported to have a very promising performance. This motivates us to adopt these methods to solve the more complicated TSMaxBUE model.

All algorithms were implemented in the C++ programming language and compiled using g++ 4.6.3 (Ubuntu/Linaro 4.6.3-1ubuntu5). All runs were performed under the following environment: Ubuntu Release 12.04 64-bit, Kernel Linux 3.2.0-24-generic; Intel Core i5-2500 CPU, 4 Core, 3.30GHz; 7.7 GB RAM.

In order to compare performance of path-based algorithms we perform tests on the following instances: Sioux-Falls, Anaheim and Barcelona that are available at the web-site: `http://www.bgu.ac.il/~bargera/tntp/`. Link tolls were generated using the marginal cost approach and then scaled. Indifference curves were generated by assigning zero flow to all links and finding efficient paths, cost vectors of which were used as breakpoints of piecewise linear functions. The performance of each algorithm was also analysed with respect to changes to different programming blocks.

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

Participants: students and researchers from UNIKL.

Publication: O. Perederieieva, Solving Bi-objective Traffic Assignment Based on Time Surplus Maximisation, Proceedings of the 46th Annual Conference of the Operations Research Society of New Zealand, Editor: John Haywood, Wellington, December 2012.