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Multi-attribute, Multi-class, Trip-Based, Multi-modal Traffic Network Equilibrium Model

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In this work we consider a trip-based multi-modal approach to network equilibrium. We assume that mode and path choice are carried out at the same level, therefore travel time (TT) depends on travel path and the mode(s) attributes of travelers. This study develops a multi-class model with several parameters per class. Most multi-class flow models, classify travelers by identifying traveler attributes. In the literature, this classification process identifies seven categories of information about travelers: 1- risk taking attitude, 2- economic attributes, 3- general cost function, 4- choice function, 5- knowledge level of network, 6- cost function and 7- social class. Some research uses hybrid classification [1]. In order to describe the traveler behavior, a general cost function that taking into account four of these information (2, 3, 6 and 7), is used. Typically the general cost function (GC) will integrate TT and travel cost (TC), and will take into account the class-dependent Value of time (VOT) [4] denoted α_i for class i , and a vector β_i of economic and social class parameters. Hence the general cost of path p is

$$GC_p(\alpha_i, \beta_i) = TC_p(\beta_i) + \alpha_i \cdot TT_p \quad (1)$$

The vector of parameters β_i includes the mode(s) and social attributes of a traveler.

This study presents a formulation of conditions for user equilibrium based on finite-dimensional variational inequality (in the static case) with qualitative analysis of existence (which is usually straightforward) and unicity (which is usually not satisfied in the multi-modal case). Further we present a formulation for dynamic traffic assignment (DTA) and analyze the equilibrium in test cases by a simulation based approach with the gap function-based method [2]. The unicity in the static case is analyzed analytically [3]. We examine by simulation the formation of the equilibrium when the structure of the demand is given and the level of demand increases. The equilibrium changes qualitatively when the demand is increasing, which results in break points for the demand level at which the equilibrium solution changes significantly.

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