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Origin-Destination Estimation for Traffic Simulation Considering Congestion

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Abstract: Traffic simulations are utilized as support tools to solve traffic-related problems. Scenario analysis is one of the analysis methodologies with simulation. At the first step of scenario analysis, traffic phenomena in the real world should be reproduced in the simulation world as the baseline. Traffic demand, which can be described as a form of the Origin-Destination (OD) matrix, is an important element in the traffic phenomena, which affects directly to the traffic volume or congestion, but it cannot be observed directly. Whereas some OD estimation methods are proposed, most of them require different route-search models or scopes from simulation. Therefore, we propose a new OD estimation method for traffic simulation input data. The target problem is formulated as a quadratic programming problem [QP]: $f(\boldsymbol{x}) = \left\|\overline{\boldsymbol{Q}} - \widehat{\boldsymbol{Q}}\right\|^2 \rightarrow min.\ s.t. \forall i\ 0 \leq x_i \leq x_u$, where $\boldsymbol{x}$ is the OD matrix, $\overline{\boldsymbol{Q}}$ and $\widehat{\boldsymbol{Q}}$ are the observed link traffic volume in the real world and the reproduced link traffic volume in the simulation, respectively. x_u is an upper bound for OD traffic volume x_i. In general, there are multiple traffic situation with same traffic volume: free flow and congested flow. In free flow situation, increment of $\boldsymbol{x}$ incurs linearly increment of $\widehat{\boldsymbol{Q}}$, on the other hand, in congested flow situation, it incurs non-linear decrement of $\widehat{\boldsymbol{Q}}$ because of congestion intensification. Thus, we basically assume that $\widehat{\boldsymbol{Q}}$ is a linear function of $\boldsymbol{x}$ and add some constraints into [QP] when intense traffic congestion in the simulation are detected. As a result of this congestion consideration, it turned out that the considered model makes the simulation more stable to mitigate unrealistic congestion than the non-considered one.

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