FLEXIBILITY OF DISTRIBUTIONALLY ROBUST CHOICE MODELS IN TRAFFIC EQUILIBRIUM

ABSTRACT – Traffic equilibrium models are fundamental to the analysis of transportation systems. The stochastic user equilibrium (SUE) model relaxes the perfect information assumption of the deterministic user equilibrium. SUE models predict traffic equilibrium flow assuming that users choose their perceived maximum utility paths (or perceived shortest paths) while accounting for the effects of congestion that arise due to users sharing links. Inspired by recent work on distributionally robust optimization, we develop two new user equilibrium models. The CMM-SUE model uses the mean and covariance information on path utilities but does not assume a particular form for the distribution. In the MDM-SUE model, the marginal distributions of the path utilities are specified, but the joint distribution is not. Robustness to distributional assumptions is obtained by minimizing the worst-case expected cost over all distributions with fixed two moments for the CMM model and over all distributions with given marginals for the MDM model. We show that under mild conditions, both equilibria exist and are unique. We provide convex formulations for both and develop customized algorithms to calculate the equilibrium flows. Preliminary computational results indicate that CMM-SUE provides a practical alternative to the well-known MNP-SUE (Multinomial Probit-Stochastic User Equilibrium) model that requires distributional (normality) assumptions to model correlation effects from overlapping paths. For specific choices of marginal distributions, the MDM-SUE model recreates the optimization formulation of logit SUE and weibit SUE. Moreover, the model is flexible since it can capture perception variance scaling at the route level and allows for modeling different user preferences by allowing for skewed distributions and heavy tailed distributions.

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