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Project Title:

Efficient Methodology for Traffic Flow Model Calibration

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Brief description of project:
Proactive traffic management and control relies on sound traffic flow models that are central to traffic prediction and analysis. One of the challenges faced by such models is the calibration of these models to prevailing local conditions. As such, an efficient methodology is called for to fine tune model parameters so that they reflect local traffic characteristics. Many calibration procedures have been developed in the past with varying transferability, complexity, and accuracy. For example, some procedures are customized for certain models and are not easy to be adapted to other models; some procedures may involve optimization of multiple levels, so calibrating a model becomes a time-consuming job; some procedures optimize only one side of the model at the cost of the other inherently related side. The objective of this research is to develop a methodology for calibrating equilibrium traffic flow models that is accurate in nature, independent on models, efficient in computation, robust to calibration data. The result of this research can help traffic analysts and transportation agencies to better understand traffic flow characteristics, predict traffic evolution, mitigate traffic congestion, and deploy resources to anticipate incidents.

Describe intended implementation of research:
A calibration problem is essentially to fit a model to a set of empirical data. The model is typically known and expressed in a functional form involving some parameters. The mission of calibration is to find suitable values for these parameters so that they capture the characteristics of the actual system represented by the empirical data. Once the model has been calibrated, it can be used to predict how the real system performs given certain inputs.

Typical in model development is another related, but easily confused process called validation. While the goal of calibration is to find suitable values for model parameters, the mission of validation is to check if the formulation of the model makes sense and, if so, to what extent the output of the model approximates that of the real system under study. The state-of-the-art approaches of traffic flow model calibration involve solving a bi-level optimization problem as follows. Since the functional form of the model is known, the model is explicitly determined if a set of values are assigned to model parameters. Therefore, the lower level optimization tries to find the minimum distance from each data point to the model.

The above state-of-the-art calibration methodology is indeed successful in many aspects. However, it faces great challenges in the context of online applications. For example, the optimization processes typically involve off-line computation in order to use solvers or to solve equations. Meanwhile, it may involve greater computational complexity than what can be handled in an online setting. The computational complexity comes mainly from factors such as the bi-level procedure, fitting model to a large volume of empirical data, the search for minimum distance among large number of possibilities, and the search for optimal result among a multitude of parameters with each varies between a wide range of values.

With an aim to support online applications, this research proposes to address the computational complexity issues by: (A) reducing the volume of empirical data before fitting the model, (B) revising optimization procedure for more efficient searching, and (C) narrowing the ranges of parameter values to realistic levels.

Describe anticipated impacts/benefits of implementation:
The result of this research will be an efficient methodology that can help traffic analysts and transportation agencies to better calibrate equilibrium traffic flow models which are frequently central to traffic prediction and proactive traffic management.

Web links:

- Reports
- Project website

None