M2 Internship position
at Inria Sophia Antipolis Méditerranée

Traffic model calibration by statistical approaches

November 5, 2019

Scientific Context

There exists nowadays a variety of road traffic data sources (magnetic loop detectors, video cameras, floating car data, bluetooth, etc), which can be used for model calibration [1]. In particular, the heterogeneity of traffic conditions in congested regimes makes it hard to obtain a good matching between simulations and reality, thus preventing from obtaining reliable traffic state predictions beyond short time horizons (30 min). Indeed, traffic models are usually set on a unique choice of the fundamental diagram (flux-density relation), independently of the time of the day and the day of the week. Yet, model parameters may be time dependent, as some traffic conditions and driver behavior may be correlated to specific time ranges. Besides, data analysis techniques may help in opening new perspectives in the interpretation of data and the modeling of road traffic [2].

The Bayesian calibration methodology, see e.g., [3, 4], provides a flexible framework to leverage the possible ill-posedness of the inverse problem of finding appropriate model parameters, via a bias term. While it also provides uncertainty quantification on the results, the application to traffic data raises a number of unique challenges, such as time dependence and periodicity, which have started to be addressed recently in the literature, see, e.g., [5].

ACUMES Project-Team has an established experience in (macroscopic) traffic flow models, and disposes of a large set of data coming from 135 loop detectors placed on the freeways in the North of Marseille (A7, A51, A50 and A55). The data-set was provided by the *Direction Interdépartementale des Routes Méditerranée* (DIRMED) and covers 3 months, from September 1st to November 30th, 2015. In particular, calibration results will contribute to the development of TramOpt, a software platform for traffic simulation and control developed by the team.

Job Description

In this perspective, we aim to calibrate and validate a first order macroscopic traffic flow model on the above mentioned data-set.

The study will be based on the following steps:

1. **Data preparation.** Before analysis, data need to be sorted by sensor and direction, and aggregated over time periods (usually 1 or 6 minutes) to obtain averaged quantities measuring density, mean velocity and flow.

2. **Model calibration.** The model parameters, in particular related to the choice of the mean speed function, will be be calibrated on a subset of the data-set, possibly distinguishing week days and time slots. It will require adapting existing methodologies to the specificities of the data.

3. **Model validation.** The resulting parameters will be used to run simulations that will be compared to traffic evolution described by real data belonging to a different subset of the available data-set.

The intern will be based in Sophia Antipolis, under the joint supervision of Drs Paola Goatin (`http://www-sop.inria.fr/members/Paola.Goatin/`) and Mickaël Binois (`https://sites.google.com/site/mickaelbinoishomepage/`).

Requirements

- Last year of MSc (Master 2) in Mathematics, Engineering or Computer Sciences.
- Background in statistical methods.
- Knowledge of R, Python, Matlab.
- Experience in mathematical modelling and/or optimization techniques is considered an additional plus.

Starting date and duration

From March 2020 or later, for 6 months.

Applications

Please send electronic application including CV, a statement of research interests, and contact details of reference persons to:
Dr. Paola Goatin
E-mail: paola.goatin@inria.fr

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References

[1] A. Cabassi and P. Goatin, *Validation of traffic flow models on processed GPS data*, INRIA Research Report no. 8382, September 2013.

[2] M. L. Delle Monache, K. Chi, Y. Chen, P. Goatin, K. Han, J.-M. Qiu and B. Piccoli, *Big data and the fundamental diagram: the three phases of three-dimensional traffic*, submitted.

[3] D. Higdon, M. Kennedy, J. Cavendish, J. Cafeo, and R. Ryne *Combining field data and computer simulations for calibration and prediction*, SIAM Journal on Scientific Computing, 26, 2, 448–466, 2004.

[4] M. Kennedy and A. O'Hagan, *Bayesian calibration of computer models*, Journal of the Royal Statistical Society: Series B, 63, 3, 425–464, 2001.

[5] M. Plumlee, V. Joseph and H. Yang *Calibrating functional parameters in the ion channel models of cardiac cells*, Journal of the American Statistical Association, 111, 514, 500–509, 2016.