Traffic Flow Control – Optimization on Horizon

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Abstract: The paper introduces the concept of a linear programming approach to traffic flows control on a finite time horizon in an urban traffic region. The control problem is to determine relative lengths of traffic lights signals, so called green splits, due to actual traffic conditions to improve the traffic situation in the traffic area. A control criterion of this optimization task is to minimize a weighted sum of queue lengths that are formed on intersections arms due to traffic lights control.

This problem has been solved as a classical sequential linear programming task using a linear model of traffic micro-regions that computes the lengths of the queues. Not only the state vector, but also model parameters can be corrected by filtering that allows utilizing of the maximum of traffic flow information available and minimizes imperfections of an incomplete knowledge of the model parameters or their time course. All restrictions of states and control variables come from relations between them, from the model and a traffic nature of the task, i.e. non-negativity of all variables and their upper and lower limits.

This static task of the optimization can easily fail due to a traffic flow characteristic course during a day and an accidental character of the traffic. For this reason, the time horizon approach of a linear programming is introduced. It is proposed as a synthesis of a sequential modeling on finite horizon that uses point estimates of the input intensities, the queue lengths and the model parameters possibly. The intensity of the traffic flows in a micro-region, that consists of several traffic lights controlled intersections, is predicted by a dynamic regression model. These predictions are then used for the estimating of the queue lengths by the micro-region model introduced previously. The control criterion is a double weighted sum of the queue lengths in the micro-region. These weights allow not only an area preference but also a time preference due to the horizon of the optimization.

The effectiveness of the proposed approach is demonstrated by digital simulations but the more conclusive comparison is given by simulation using real data. That is why a few experiments on real data are also described in the end. For these experiments, the real measurements of the input intensities and occupancies were used. The results proved that the sequential modeling helps to predict better control actions.

References

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