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A linear approach

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Optimum Route Guidance in Multi-region Networks: A Linear Approach

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MOTIVATION

Dynamic congestion pricing is a useful tool not only to mitigate traffic congestion but also to influence people’s route choice and direct a transportation network towards the system optimum. Recent works have tried to tackle computation of the system optimum (i.e., the optimal route guidance) problem by applying a nonlinear control strategy. Considering the shortcomings of local operating controllers and the well-known limitations of nonlinear optimization, this work has the objectives to:

- design a linear formulation of the optimization problem at the network level,
- evaluate the performance of a Linear Rolling Horizon Optimization (LRHO),
- provide optimal route guidance as a benchmark for novel congestion pricing approaches.

MODEL LINEARIZATION

As the dynamic model holds several nonlinearities, the following steps are taken for linearization [1]

Introduction of modeling parameters $a_1(k)$ and $a_2(k)$

- Updated every time a solution is applied to the plant
- Parameters are held constant over the prediction horizon

New decision variables $f_1(k)$ and $f_2(k)$

- With a region design based on
- The geographical reference of the available Loop Detection (LD)

Macrosopic Fundamental Diagram (MFD) designs are conducted with the approach from [2]

LINEAR ROLLING HORIZON OPTIMIZATION

Formulation of the Linear Rolling Horizon Optimization (LRHO) problem:

\[
\begin{align*}
\text{max} & \quad N_k \sum_{t}^{T}(g(k) + f_2(k)) \\
\text{s.t.} & \quad a_1(k) = N_k(k) + \sum_{t}^{T} f_1(k) - \sum_{t}^{T} f_2(k), \\
& \quad 0 \leq f_2(k) \leq a_2(k), \\
& \quad 0 \leq a_2(k) \leq N_{max}, \\
& \quad k = k_N, k_H, \ldots, k_N - 1, \\
& \quad \forall k \in N, \forall \theta \in R.
\end{align*}
\]

By rearranging the definition of $f_2(k)$, final splitting rates are obtained and applied to the plant

CASE STUDY - CITY OF ZURICH

Case study based on an example of the city of Zurich with a region design based on:

- Analyzing the main traffic arterials of Zurich and
- The geographical reference of the available Loop Detection (LD)

Macrosopic Fundamental Diagram (MFD) designs are conducted with the approach from [2]

![Image of the city of Zurich] (Fig. 3)

REFERENCES
