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Analysis of performance of self-organized traffic control with use of cellular automata model for various city traffic networks

Many real complex systems such as vehicular traffic or production networks are characterized by complicated dynamics of the underlying transportation processes. Undoubtedly, optimization in terms of time and cost is of vital importance in such systems. However, due to highly complicated dynamics it is not an easy task.

Flow of vehicles in an urban street network is almost entirely controlled by traffic lights. One of the most popular ways of optimizing traffic is to choose pre-calculated schemes, which are aimed at synchronizing green times along a one-way or two-way main arterials. In principle, such methods force the traffic flow to comply with previously designed patterns minimizing travel times.

In contrast to classical centralized, which are costly and often ineffective (even if responsive) solutions, recently some decentralized and self-organizing optimization techniques were developed. They instantly respond to the local current traffic state, and at the same time lead to a very good global overall performance.

In the presented work, we focus on the strategy proposed by Lämmer and Helbing, 2008 (LH). First we discuss our cellular automaton model corresponding to lattice-like city traffic network, along with some of its statistical properties. Then the LH strategy is implemented and it is shown, how it converges to the known optimal cycle lengths for various conditions.

Next, we consider more complex topologies and the performance of the LH strategy is compared with other constant-cycle, near-optimal solutions found by means of soft computing methods. We analyse statistical properties of the vehicle flow, like platoon lengths, cycle frequency distribution, number of stops per vehicle, etc. Difference w.r.t the constant-cycle approach are stressed and the exceptionally good performance of the decentralized strategy is confirmed.