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Using reinforcement learning to control traffic signals in a real-world scenario: an approach based on linear function approximation

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Reinforcement learning is an efficient, widely used machine learning technique that performs well in problems with a reasonable number of states and actions. This is rarely the case regarding control-related problems, as for instance controlling traffic signals, where the state space can be very large. One way to deal with the curse of dimensionality is to use generalization techniques such as function approximation. In this work, a linear function approximation is used by traffic signal agents in a network of signalized intersections. Specifically, a true online SARSA(λ) algorithm with Fourier basis (TOSFB) is employed. This method has the advantage of having convergence guarantees and error bounds, a drawback of non-linear function approximation. In order to evaluate TOSFB, we use a scenario of the city of Cottbus, Germany, with 22 signalized intersections, implemented in MATSim. We compare our results not only to fixed-time controllers but also to a state-of-the-art rule-based adaptive method, showing that TOSFB shows a performance that is highly superior to the fixed-time, while also being at least as efficient as the rule-based approach. Also, in particular situations (e.g., afternoon peak) it outperforms that method. For more than half of the intersections, our approach leads to less congestion, without the need for the knowledge that underlies the rule-based approach. This work was developed jointly with the Technical University of Berlin and a preliminary version is going to be presented at the 11th International Workshop on Agents in Traffic and Transportation (ATT 2020).