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A reinforcement learning approach to vehicle path optimization in urban environments

by

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Abstract

Road traffic management in metropolitan cities and urban areas in general is an important component of Intelligent Transportation Systems (ITS). With the increasing number of world population and vehicles, a dramatic increase in the road traffic is expected putting pressure on the transportation infrastructure. Therefore, there is a pressing need to devise new ways to optimize the traffic flow in order to accommodate the growing needs of transportation systems. In this work, we propose to use an Artificial Intelligent (AI) method based on reinforcement learning techniques for computing near-optimal vehicle itineraries applied to vehicular ad hoc networks (VANETs). These itineraries are optimized based on the vehicle's travel distance, travel time, and traffic road congestion. We formulated the problem of traffic density as a Markov Decision Process (MDP). In particular, we introduce a new reward function that takes into account the traffic congestion when learning about the vehicle's best action (best turn) to take in different situations. To learn the effect of this approach, we investigated different learning algorithms such as Q-Learning and SARSA in conjunction with two exploration strategies: (a) e-greedy, and (b) Softmax. A comparative performance study of these methods is presented to determine the most effective solution that enables the vehicles to find a fast and reliable path. We conducted simulation experiments that illustrate the effectiveness of our methods in computing optimal itineraries allowing vehicles to avoid traffic congestion while maintaining reasonable travel times and distances.

Keywords: VANET, Reinforcement Learning, Markov Decision Process, Road Traffic Congestion.