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Application of adaptive weights to intelligent information systems: An intelligent transportation system as a case study

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ABSTRACT

Optimization of information feedback technologies is very important for many socioeconomic systems such as stock markets and traffic systems aiming to make full use of resources. In this paper, we propose an adaptive weight method, which has potential value for a variety of information processing contexts. We apply this adaptive weight method to an intelligent transportation system (ITS) as a case study. A feedback strategy named Improved Congestion Coefficient Feedback Strategy (ICCFS) is introduced based on a two-route scenario in which dynamic information can be generated and displayed on the roadside in order to enable drivers to make an informed route decision. Our model incorporates the effects of adaptability into the cellular automaton models of traffic flow. Simulations demonstrate that adopting this optimal information feedback strategy provides a high efficiency in controlling spatial distribution of traffic patterns when compared with the three other information feedback strategies, i.e., Travel Time Feedback Strategy (TTFS), Mean Velocity Feedback Strategy (MVFS) and Congestion Coefficient Feedback Strategy (CCFS).

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1. Introduction

For some socioeconomic systems, it is desirable to provide real-time information or even a short-term forecast about dynamics. For instance, in stock markets it is advantageous to give a reliable forecast in order to maximize profit. In traffic flow, advanced traveler information systems (ATIS) provide real-time information about the traffic conditions to road users by means of communication such as variable message signs, radio broadcasts, or on-board computers [1,13]. The aim is to help individual road users to minimize their personal travel time. Therefore traffic congestion should be alleviated, and the capacity of the existing infrastructure could be used more efficiently. Fig. 1 shows a schematic diagram of an information feedback system, illustrating that feedback information plays a significant role in the loop. We propose an adaptive weight method, which is potentially of value in a variety of information processing contexts. Here, we apply this adaptive weight method to an intelligent transportation system (ITS) as a case study.

With the development of information sciences, traffic flow and related problems become more and more important in the modern world. Researchers from many different disciplines (mathematics, physics and engineering) have targeted this problem, often using sophisticated mathematical tools brought from their own area of expertise [6–8,10,12,14,18,20]. Till now, a lot of different theories have been proposed, such as car-following theory [24], kinetic theory [11,22,23] and particle-hopping theory [4,5,21]. These theories may help scientists to gain understanding of vehicular systems. Therefore these theories

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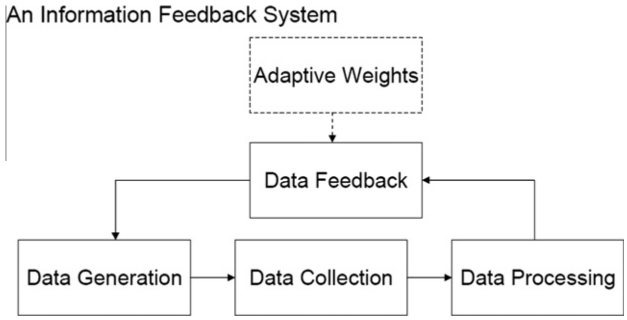

Fig. 1. The schematic diagram of an information feedback system.

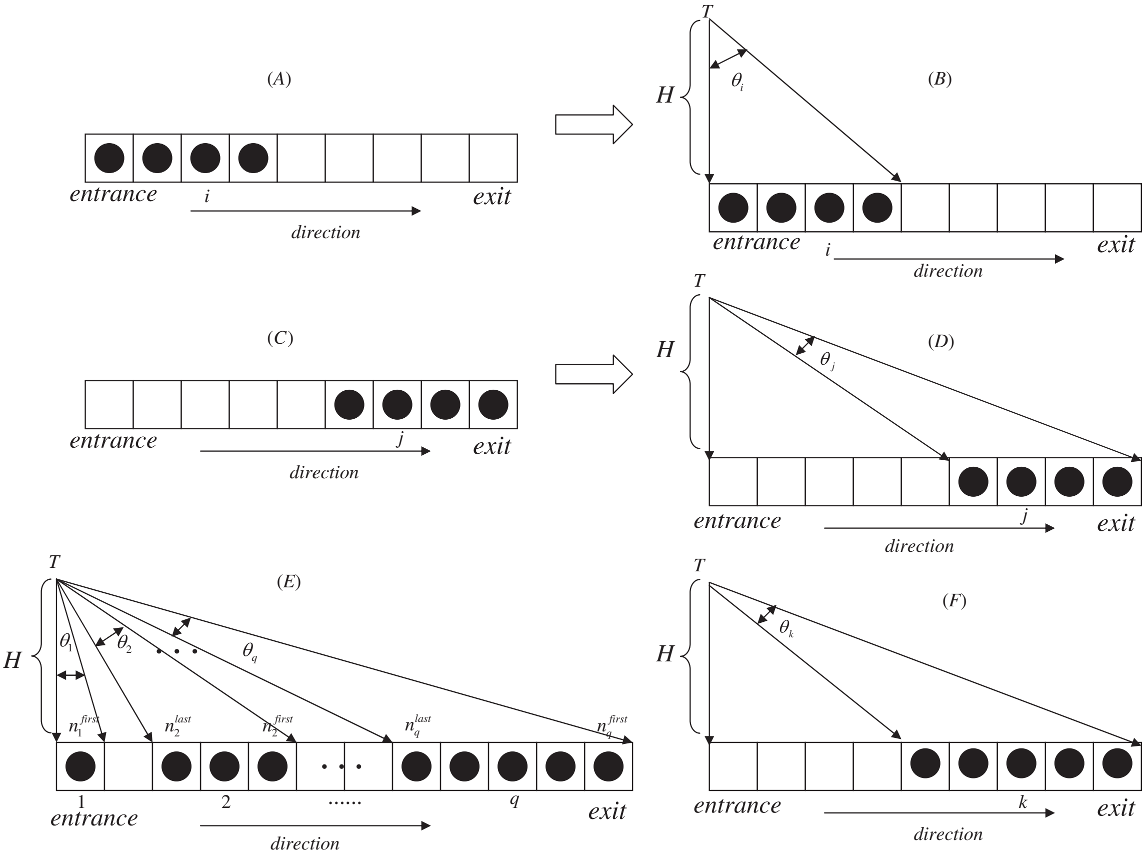

Fig. 2. The illustrations of routes without and with adaptive weights.

indirectly make contributions to alleviating traffic congestion and enhancing the capacity of existing infrastructure. Real-time traffic information plays a significant role in several applications of intelligent transportation system (ITS), such as advanced traffic management systems (ATMS) and advanced traveler information system (ATIS), etc. The traffic information collected can support traffic management administrators in making decisions, taking appropriate actions to alleviate congestion, and improving the global performance of traffic networks. Furthermore, since real-time traffic information can help drivers plan the trip before travelling and decide on the route to take to reduce travel time and improve travel safety, it is one of the most important features.

To date, a vast number of different dynamical model of traffic flow with real-time traffic information have been constructed [2,3,9,15,19,28], but proposing a more efficient feedback strategy is still an overall task. Wahle et al. [25,26] first investigated the two-route scenario with Travel Time Feedback Strategy (TTFS). Subsequently, Lee et al. [17] studied the effect of a different type of information feedback (Mean Velocity Feedback Strategy-MVFS), i.e., instantaneous average velocity. Wang et al. [27] proposed a third type of information feedback (Congestion Coefficient Feedback Strategy-CCFS), i.e.,

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