Coordinated In-Vehicle Routing Built Upon Online Learning and Distributed Optimization Computation for Connected and Autonomous Vehicles

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Abstract. Recent years, wireless communication, on-board computation facilities (personal digital assistants, smart phones, etc.) and advanced sensor techniques (loop detector, camera, GPS-based vehicle probe, etc.) have been integrated into transportation systems. These new technologies make a well-connected and data-rich transportation systems, i.e., connected vehicle system (CVS), under rapid development and is expected to be fully implemented in the near future. Even though CVS has been granted a great potential to intelligently route travelers (or CVs), scholars have recognized that as majority vehicles become CVs, current uniform real-time information provision may lead to even worsen traffic congestion, given each CV still selfishly and independently chooses its own shortest paths. This inherent deficiency of current routing methods is rooted from the inconsistency between system performance (system-optimality) and individual vehicles’ route choice behavior (user-optimality). To address this challenge, our studies develop a novel Coordinated In-Vehicle Routing Mechanism (CRM), which coordinates the routing decisions of a group of CVs en route, seeking to balance the user-optimality and system-optimality. Briefly, the CRM models the routing decisions of a group of CVs as an atomic routing game, in which CVs decide their own online route choice or priorities by a negotiation and coordination process with other CVs. To establish such a CRM, we need to address the research challenges, including learning the online route competition potential among CVs, forming coordination group, establishing routing game models, proving the existence of the equilibrium, developing converging distributed algorithms to approach the equilibrium routing decisions, etc. This presentation will demonstrate how we address these research challenges and present the performance the CRM in the numerical experiments.

Bio: Dr. Du is an associate professor in the Department of Civil and Coastal Engineering, University of Florida. Before joining UF, she worked as an assistant and then an associate professor at Illinois Institute of Technology from 2012-2017. She also worked as a Post-Doctoral Research Associate for NEXTRANS, the USDOT Region V Regional University Transportation Center at Purdue University from 2008 to 2012. Dr. Du received her Ph.D. degree in Decision Sciences and Engineering Systems with a minor in Operations Research and Statistics from Rensselaer Polytechnic Institute in 2008. Dr. Du received her MS degree in Industrial Engineering from Tsinghua University in 2003 and her BS degree in Mechanical Engineering from Xi’an Jiaotong University in 1998. Dr. Du’s research is characterized by applying operations research, network modeling, and statistical methods into transportation system analysis and network modeling. Her current research covers several interdisciplinary research areas in Transportation Engineering, such as Connected and Autonomous Vehicle Systems, Interdependent Infrastructure Network Modeling, Sustainable Multimodal Transportation Systems, Optimization, and Data Fusion Applications in Traffic Flow Analysis. Dr. Du’s studies have been published in several major transportation journals, including Transportation Research Part B, Part C, IEEE Transactions on ITS, Networks and Spatial Economics, etc. Her research has been well funded by National Science Foundation, Illinois Department of Transpiration, and University Transportation Research Center. Dr. Du is a recipient of the NSF CAREER award in 2016. Her recent project “Driverless City” won the First Nayar Prize at IIT in 2015. Dr. Du currently serves on the editorial advisory board of Transportation Research Part B and International Journal of Transportation Science and Technology. She is a member of INFORMS and the Transportation Research Board Committee on Transportation Network Modeling (ADB30), for which she also serves on the committee’s editorial board. She is the chair of the subcommittee on Emerging Technologies in Network Modeling (ADB30(5)).