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Ph.D. DISSERTATION DEFENSE

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Title:	AI-Driven Transportation Flow Analytics for Resilient and Adaptive Operation of Public Transportation Infrastructure Systems
Chairperson:	Dr. Kaijian Liu, Department of Civil, Environmental and Ocean Engineering
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ABSTRACT

Public transportation infrastructure systems provide an indispensable means for people to access essential resources such as goods, services, and opportunities. However, normal operations of public transportation infrastructure systems are frequently disrupted in disasters – imposing restrictions on the mobility of people and limiting their ability to access essential resources to maintain life stability and well-being. There is, thus, a pressing need for advanced flow analytics to support resilient and adaptive operations of public transportation infrastructure systems, ensuring continued resource accessibility and public welfare. To address this need, this dissertation proposes a novel artificial intelligence (AI)-driven transportation flow analytics framework. The proposed framework is composed of three primary components: (1) an unsupervised learning-based origin-destination (OD) flow estimation method, which uses a proposed decoder-encoder architecture and a flow property-based objective function, to estimate OD flows of public transportation infrastructure systems from boarding-alighting data; (2) a probabilistic OD flow characterization method, which integrates Bayesian model, gravity model, and point-of-interest analysis, to characterize OD flows by modeling the trip purpose distributions buried in the flows between each OD pair; and (3) a context-aware long-range OD flow prediction method, which leverages a proposed spatial-contextual-temporal modeling method and an attention-based transformer encoder-decoder, to predict future OD flows. The performance of the proposed framework was evaluated using real-world, public data from the San Francesco and New York City subway systems. This research contributes to the body of knowledge in two primary ways. First, it offers novel AI-based analytics methods for OD flow estimation, characterization, and prediction in public transportation infrastructure systems. Second, by applying the proposed framework in COVID-19, it creates new knowledge about how disasters such as pandemics affect public transportation flows and trip purposes spatially and temporally, and how public transportation flows would evolve across time and space during disaster times. These contributions would pave the way for operating public transportation infrastructure systems, in a resilient and adaptive way, to combat societal challenges posed by climate change and urbanization.