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Ph.D. DISSERTATION DEFENSE

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Date:	Wednesday, May 28th, 2025
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Title:	Intelligent water pipeline failure prediction: novel data-driven solutions for imputation, bias mitigation, and efficient predictive modeling
Chairperson:	Dr. Mohammad Ilbeigi, Charles V. Schaefer, Jr. School of Engineering and Science / Civil, Environmental & Ocean Engineering
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ABSTRACT

The overarching objective of this research is to introduce an intelligent data-driven framework for probabilistic water pipeline failure prediction equipped with novel mechanisms for imputing missing data, mitigating biases, and training the predictive model efficiently. The framework includes three main capabilities: (1) a novel deep learning multivariate/multidimensional auto-regressive forecasting model for probabilistic prediction of water pipe breaks, (2) a novel active learning mechanism for efficient model training that selects the most informative observations based on probabilistic prediction entropy and handles unbalanced and potentially biased data through stratified sampling using multidimensional clustering, and (3) a progressive multivariate heterogeneous imputation method for estimating missing values in water pipeline feature datasets, including both numerical and categorical variables. The proposed framework and its components were empirically evaluated using historical data from water distribution network of Calgary, Canada. The results demonstrated that the proposed methods outperformed state-of-the-art solutions. This research redefines advanced methodologies for data-driven and proactive asset management in water infrastructure systems.