CHE-PETE SEMINAR SERIES

AI for System Resilience: Optimization, Prediction, and Monitoring in Energy and Process Systems

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With the increasing scale and inter-connectivity of engineering systems across different industrial sectors, traditional model-based optimization, prediction, and monitoring approaches often struggle to capture system complexity and balance between safety and longevity. This talk will explore the transition towards data-driven and hybrid frameworks for intelligent resilience of complex system, with focus on Lithium-ion battery management and industrial fault diagnosis. This presentation will start with battery systems and address the fundamental trade-off between performance and safety. We will discuss the leveraging of data-driven optimization, particularly adaptive reinforcement learning and Bayesian optimization, to develop protocols that enable the fast-charging of batteries while strictly preserving safety constraints. Moreover, we will also underpin how advanced predictive frameworks—including transformers and domain-adaptive models—can promote the accurate battery health prognostics by overcoming various challenges such as small data issue and varying operating conditions. The second half of this talk will shift to the reactive resilience and monitoring of chemical processes. We will examine the spatiotemporal coherent patterns, graphical correlations, and local-global features of industrial plants with advanced AI methods including graph neural networks and global-correlation-enhanced CNNs. In addition, data-driven knowledge discovery for industrial processes will also be discussed to shed lights on how to gain insights into the structures of such systems via techniques such as sparsity promoting. The reliable monitoring and early diagnosis of anomalies before system-level failure are critical for engaging corrective control and management to ensure the safety of industrial processes.

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Dr. Qiugang (Jay) Lu is an assistant professor at the Department of Chemical Engineering at the Texas Tech University (TTU). He received his Ph.D. in Chemical and Biological Engineering from the University of British Columbia in 2018. Prior to TTU, he was a Postdoctoral Research Associate at the University of Wisconsin-Madison. His research interest includes process control, data analytics, and system identification, with applications to energy storage, HVAC, pulp & paper, and biomedical diagnosis. Dr. Lu was a Vanier Scholar of Canada, and is the recipient of a number of awards including 2024 NSF CAREER Award, Whitacre Engineering Research Award, George T. and Gladys Abell-Hanger Faculty Awards from TTU. Dr. Lu is also the holder of 4 US patents.