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LUIAS Distinguished Lecture

Advancing Chemical Process Control with Reinforcement Learning: From Foundations to LLM-Based Explainability

Speaker

Professor Jong Min LEE

Professor
Department of Chemical and Biological Engineering
Seoul National University

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Date: 27 January 2026 Time: 11:45AM - 12:45PM

Venue: MBG01, Patrick Lee Wan Keung Academic Building

Mode: Face-to-face

Abstract

For decades, the "curse of dimensionality" in dynamic programming has been a major barrier to the application of optimal control to systems with uncertain or complex dynamics. Against this backdrop, our research group has been investigating a class of algorithms now broadly known as reinforcement learning (RL), or approximate dynamic programming, for over twenty years. While RL has recently gained explosive attention across various fields such as computer science and operations research, systematic research on its effective application to chemical process control—particularly regarding industrial requirements—remains a critical frontier.

In this talk, I will share the systematic methodology our group has developed for applying RL to real-world process control and optimization. We will explore strategies for integrating RL with high-fidelity digital twins in large-scale systems where first-principles models are difficult to construct. A central focus will be placed on the three primary pillars for industrial deployment: Safety, Stability, and Interpretability.

Notably, I will introduce our latest research on enhancing transparency in RL decision-making: a Multi-Agent LLM Framework for Explainable RL (XRL). This framework coordinates specialized LLM agents to provide interactive, natural language explanations, including counterfactual reasoning and alternative policy generation. By bridging the gap between complex RL policies and human operators, this approach—validated on process benchmarks such as the quadruple-tank system—offers a methodological advance in making AI-driven control more trustworthy and accessible.

Finally, I will outline future research directions, including offline RL for safety-critical operations and the design of reward functions tailored to the inherent characteristics of process dynamics.

Biography

Jong Min Lee is a Professor in the Department of Chemical and Biological Engineering at Seoul National University (SNU) (Seoul, Korea). From September 2016 to August 2017, he was a Visiting Associate Professor in the Department of Chemical Engineering at MIT. He also held the Samwha Motors Chaired Professorship from 2015 to 2017. He obtained his B.Sc. degree in Chemical Engineering from SNU in 1996 and completed his Ph.D. in Chemical Engineering at the Georgia Institute of Technology (Atlanta, United States) in 2004. He subsequently held a research associate position in Biomedical Engineering at the University of Virginia (Charlottesville, United States) from 2005 to 2006. From 2006, he served as an Assistant Professor of Chemical and Materials Engineering at the University of Alberta (Edmonton, Canada) before joining SNU in 2010. He is also a registered professional engineer with APEGA in Alberta, Canada.

His current research interests include modeling, control, and optimization of large-scale chemical process, energy, and manufacturing systems under uncertainty, as well as reinforcement learning-based control. He has been an associate member of the National Academy of Engineering of Korea (NAEK) since March 2022 (Chemical and Biological Engineering Division). Since June 2023, he has served as Chair of the IFAC Technical Committee TC 6.1 on Chemical Process Control. He has also been a Senior Editor of the International Journal of Control, Automation, and Systems (IJCAS) since February 2022 and has served on the Editorial Board of Computers & Chemical Engineering since June 2018.

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