Faculty of Engineering and Applied Science
Chemical Engineering Seminar Series

Machine Learning: An Enabler to PDE Control

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Rose Event Commons, Mitchell Hall

In relation to rigorous model-based control, machine learning is a poor substitute but can be a good enabler. A use of ML is proposed in this talk which leverages the control theory's wealth of feedback designs with guarantees of stability and performance. A game-changing supporting role is entrusted to ML, in automating and accelerating by several orders of magnitude the implementation of model-based control designs. The benefit of such a control+ML blend, where both control and ML get to perform complementary roles for which they are best suited, is nowhere as evident as for hard-to-control systems modeled by partial differential equations. I employ, in PDE control, the recent breakthroughs in deep learning approximations of not functions but function-to-function mappings (nonlinear operators) - the so-called "neural operators." With neural operators, entire PDE control methodologies are encoded into what amounts to a function evaluation, leading to a thousandfold speedup in real-time implementation, while retaining the stability guarantees. Motivating applications in chemical engineering include bioreactors, batteries, oil drilling, and additive manufacturing.