2023 62nd IEEE Conference on Decision and Control (CDC)
December 13-15, 2023. Marina Bay Sands, Singapore

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Title: Machine Learning: Bane or Boon for Control?

Abstract: Control theory is hardly alone among scientific communities experiencing some “obsolescence anxiety” in the face of machine learning, where decades - or centuries - of building first-principles models and designs are supplanted by data. While ML real-time feedback is unlikely to attain the adaptive control’s closed-loop guarantees for unstable plants that lack persistency of excitation, our community, adept at harnessing new ideas, has generated in a few years many other adroit ways to incorporate ML - from lightening methodological complexities to circumventing difficult constructions.
Rather than walking away from certificate-bearing control tools built by generations of control researchers, in this lecture seek game-changing “supporting roles” for ML, in control implementation. present the emerging subject of employing the latest breakthrough in deep learning approximations of not functions but function-to-function mappings (nonlinear operators) in the complex field of PDE control. With “neural operators,” entire PDE control methodologies are encoded into what amounts to a function evaluation, leading to a thousandfold speedup and enabling PDE control implementations. Deep neural operators, such as DeepONet, mathematically guaranteed to provide an arbitrarily close accuracy in rapidly computing control inputs, preserve the stabilization guarantees of the existing PDE backstepping controllers. Applications range from traffic and epidemiology to manufacturing, energy generation, and supply chains.