ICTS Mathematics Seminar

Title : Data-Driven Identification and Output Regulation Using Partially Observed Actuated Trajectories: A Koopman Bilinear Approach

Speaker : Debdipta Goswami (Ohio State University, USA)

Date : Thursday, 17 July 2025

Time : 4:00 PM (IST)

Abstract : Data-driven Koopman-theoretic approaches have proven effective in output prediction, state estimation, and control of nonlinear dynamical systems. For control-affine systems, the Koopman generator's affine dependence on inputs enables finite-dimensional bilinear approximations. However, selecting appropriate basis functions remains a challenge in noisy, partially observed settings. Although time-delayed observables help under partial observations, their efficacy diminishes in actuated systems. To overcome this, we model control-affine dynamics as a bilinear Hidden Markov Model defined by Koopman generators with a nonlinear observation map parameterized by a multilayer perceptron. We learn the HMM and decoder parameters via expectation-maximization, using an extended Kalman filter and smoother in the E-step and least-squares and gradient-based optimization in the M-step. We apply model-predictive control using the learned HMM for regulation. We demonstrate our method's effectiveness on: (1) an actuated polynomial system with a slow manifold, (2) a forced Duffing oscillator, and (3) the Kuramoto–Sivashinsky equation with noisy observations.

Venue : Chern Lecture Hall
Zoom Link: https://icts-res-in.zoom.us/j/98545112148?pwd=JtAqov6DOXsbIKSvs0CKqyYXxzTfba.1
Meeting ID: 985 4511 2148
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