THE UNIVERSITY  OF HONG KONG

Department of Mathematics

Qualifying Research Seminar

On the Efficiency and Robustness of Model reduction method for Dynamical Systems

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Rm 309, Run Run Shaw Building, HKU

Abstract

Model reduction methods construct low-dimensional surrogates for expensive dynamical systems, yet two fundamental challenges persist: can we directly compute quantities of interest without solving the full system, and do reduced models remain reliable when parameters change?

We address both questions. For the first, we develop a moment-based Recursive Polynomial Chaos (mRPC) method that directly evolves statistical moments by recursively reconstructing orthonormal bases from the moments themselves. By entirely bypassing the need for full trajectory simulations, this closed-loop design significantly reduces computational overhead for moderate-dimensional systems while maintaining strict accuracy.

For the second, we turn to Proper Orthogonal Decomposition (POD) for the viscous G-equation arising in combustion modeling. We prove that the approximation error grows only linearly with parameter perturbations—rigorously justifying the reuse of pre-computed bases. Numerical experiments confirm the sharpness of this bound.

All are welcome