中国科学院数学与系统科学研究院应用数学所

偏微分方程及其应用中心

学术报告

报告题目： **Mitigating distribution shift in machine learning-augmented hybrid fluid simulation**

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时　　间： **2024 年 08 月 14 日（星期三）10:00-11:00**

地　　点： **思源楼 615**

摘　　要： We study the problem of distribution shift generally arising in machine-learning augmented hybrid simulation, where parts of simulation algorithms are replaced by data-driven surrogates. A mathematical framework is established to understand the structure of machine-learning augmented hybrid simulation problems and the cause and effect of the associated distribution shift. We show correlations between distribution shift and simulation error both numerically and theoretically. Then, we propose a simple methodology based on tangent-space regularized estimator to control the distribution shift, thereby improving the long-term accuracy of the simulation results. In the linear dynamics case, we provide a thorough theoretical analysis to quantify the effectiveness of the proposed method. Moreover, we conduct several numerical experiments, including simulating a partially known reaction-diffusion equation and solving Navier-Stokes equations using the projection method with a data-driven pressure solver. In all cases, we observe marked improvements in simulation accuracy under the proposed method, especially for systems with high degrees of distribution shift, such as those with relatively strong non-linear reaction mechanisms, or flows at large Reynolds numbers. The preprint is available at https://arxiv.org/abs/2401.09259. If time permits, I will also talk about some recent progress on integrating this methodology to the large eddy simulation of the wall-bounded turbulence.