



The Hong Kong Polytechnic University Department of Applied Mathematics

Seminar

Bioinspired Robust Identification for stochastic dynamical systems and its applications

By

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Abstract

Neural network based on data-driven has been widely applied and made extensive progress in the identification of dynamical systems, especially for stochastic differential equation. Due to the need for a large amount of trajectory data as training sets, sampling strategies and training energy consumption remain challenging issues as the dataset and network complexity increase. This paper proposes a stochastic dynamical system identification framework to overcome the problems of data overload and high energy consumption. The framework consists of a residual-based multi-peak sampling (RBMS) algorithm and Hybrid Spiking Neural Networks (HSNNs) model. The RBMS algorithm is a fully adaptive algorithm, which employs the moment information of small samples to obtain the governing equation of the system without selection of hyperparameters. The HSNNs utilizes the pulse frequency of neurons for encoding, resulting in a sparse structure of the neural networks and reduction of training energy consumption.

The Rayleigh van der Pol system subjected to parametric excitation is used as a case study. The results show that the framework proposed in this paper requires only $20\sim30\%$ size of the uniform grid sampling to obtain an accurate surrogate model, which is robust in the presence of initial value perturbations. Moreover, the P-bifurcation behavior of the surrogate model is accurately predicted with RMS error less than 1.59×10^{-2} . Finally, the low energy efficiency of the proposed framework was verified by defining energy consumption indicators.

Biography

Prof Du Lin received the B.S., M.S., and Ph.D. degree in applied mathematics from Northwestern Polytechnical University (NPU), Xi'an, China, respectively. During the period, she has visited Arizona State University, Novosibirsk State University, et.al. She is currently a professor, vice president of School of Mathematics and Statistics, NPU, and the deputy director of MIIT Key Laboratory of dynamics and control of Complex System (DCCS).

She is mainly engaged in teaching and research in mathematics, mechanics, and their interdisciplinary fields, especially in the areas of nonlinear dynamics, computational neuroscience, complex systems, and intelligent science. She has presided over 4 National NSF projects of China and published more than 50 papers in academic journals.

Based on the above, she has awarded honorary titles such as the Teaching Master, Excellent Teacher, May Day Labor Award, the young outstanding talents in Shaanxi Province. And has successively won the first prize of Science and Technology in Shaanxi Province's higher education institutions and the second prize of National Teaching Achievement Award.

Date:7 December 2023 (Thursday)Time:02:00-03:00 pm (Hong Kong Standard Time GMT +8)Venue:TU817, Core TSpeaker:Prof Lin DU, Northwesstern Polytechnical UniversityHost:Prof Zhonghua QIAO, The Hong Kong Polytechnic University

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