



THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

SPECIAL COLLOQUIUM

A new machine learning algorithm, complex systems and AI predictions

By

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Abstract

We propose a novel machine learning algorithm inspired by complex analysis. Our algorithm has a better mathematical formulation and can approximate universal functions much more efficiently. The algorithm can be implemented in two self-learning neural networks: The CauchyNet and the XNet. The CauchyNet is very efficient for low-dimensional problems such as extrapolation, imputation, numerical solutions of PDEs and ODEs. The XNet, on the other hand, works for large dimensional problems such as image and voice recognition, transformers and likely LLMs, often improving the current method by several orders of magnitude.

In the context of modern AI, we also pose the following question: given data from a single observable g in a dynamical system, is it possible to recover the underlying system? For instance, with a large dataset of positional observations from an n -body system, can we predict its future motion without resorting to Newtonian mechanics? Surprisingly, the answer is yes for almost any typical observable. We introduce the principle of space-time swap: the absence of spatial information in a dynamical system can be compensated by leveraging temporal information. This principle is grounded in Takens' Embedding Theorem (building upon Whitney's embedding theorem). We believe this idea has broad potential for applications in the analysis and prediction of complex systems.

Bio: *Zhihong Jeff Xia received his PhD from Northwestern University in 1988. He held a Benjamin Pierce Lecturer and Assistant Professorship at Harvard University, and a tenured faculty position at the Georgia Institute of Technology before joining Northwestern University as a professor of mathematics in 1994. In 2000, Xia was appointed the Arthur and Gladys Pancoe Professor of Mathematics at Northwestern. He joined the Great Bay University in 2024.*

Xia's field of research is Dynamical Systems, Solar system dynamics and Machine learning algorithms. He solved the century old Painleve conjecture in mathematics; discovered (jointly with Jian Li) that a large planet from outside of the solar system once flew by our solar system a few hundreds of million years ago; He also created an efficient machine learning algorithm.

Xia was named an Alfred P. Sloan Fellow in 1989. He was awarded the Blumenthal Award for advancement of pure mathematics (1993), he was awarded the Monroe H. Martin Prize in applied mathematics (1995). He was NSF's National Young Investigator. He was invited to speak at the 1998 International Congress of Mathematicians. Xia was the founding chair of the department of mathematics at the Southern University of Science and Technology.

Xia is currently co-editor-in-chief of 《知识分子》, he is one of the founding members of the science committee of the Future Science Prize.

Date : 24 February 2025 (Monday)

Time : 4:00p.m. – 5:00p.m.

Venue : Room 4621 (near Lift 31/32)

All Are Welcome!