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THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

SPECIAL COLLOQUIUM

Generalized Transferable Neural Networks for Steady-State Partial Differential Equations

By

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Abstract

Within neural network-based solvers for partial differential equations(PDEs), architectures with prescribed neural feature have become an appealing approach, offering both high accuracy and computational efficiency in practice. Among them, the transferable neural network (TransNet) is a special class of shallow neural networks, whose single-hidden-layer parameters are predetermined according to the principle of uniformly distributed partition hyperplanes. However, its accuracy and stability may deteriorate in the presence of highly oscillatory solution structures, where activation saturation and system conditioning issues become limiting factors. In this talk, we present a generalized transferable neural network (GTransNet) for solving steady-state PDEs, which augments the original TransNet design with additional hidden layers while preserving its interpretable feature-generation mechanism. Specifically, the first hidden layer of GTransNet retains TransNet's parameter sampling strategy but incorporates an additional symmetry constraint on the neuron biases, while the subsequent hidden layers omit bias terms and employ a variance-controlled sampling strategy for selecting neuron weights. This architecture effectively mitigates saturation effects and enhances adaptability to local solution variations, as supported by theoretical analysis and quantitative studies of neuron behaviors. We further extend this approach to a lift-and-decoupling GTransNet tailored for interface problems with piecewise discontinuous solutions. Extensive numerical experiments and comparisons in two and three dimensions are presented to demonstrate superior accuracy and robustness of our GTransNet.

Bio: Professor Lili Ju received his B.S. degree in Mathematics from Wuhan University in 1995, his M.S. degree in Computational Mathematics from Institute of Computational Mathematics and Scientific/Engineering Computing, Chinese Academy of Sciences in 1998, and his Ph.D. degree in Applied Mathematics from Iowa State University in 2002. From 2002 to 2004, he conducted postdoctoral research at Institute for Mathematics and Its Applications at University of Minnesota. He then joined Department of Mathematics at University of South Carolina, where he served as Assistant Professor from 2004 to 2008 and Associate Professor from 2008 to 2012, and has been a Professor since 2013. He was elected a SIAM Fellow in 2025. His research interests include numerical partial differential equations, nonlocal models and computation, mesh generation and optimization, deep learning algorithms, computer vision, and high-performance computing, with applications in materials science, geoscience, and data science. He has published more than 200 research papers with a H-index of 50 on Google Scholar. He has served as an Associate Editor for several leading journals in numerical analysis and scientific computing, including SIAM Journal on Numerical Analysis, Mathematics of Computation, and Journal of Scientific Computing. He currently serves as the Editor-in-Chief of Numerical Methods for Partial Differential Equations.

Date : 9 December 2026 (Wednesday)
Time : 3:00p.m.-4:00p.m.
Venue : Room 1409 (near lift 25/26)

All Are Welcome!