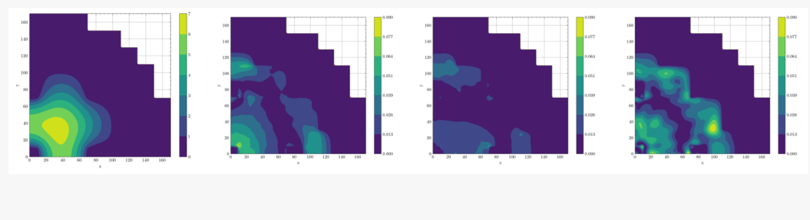
A Breakthrough in Reactor Physics: Advanced Neural Networks Unveil New Potential in Solving K-eigenvalue Problems



CHINA, November 16, 2023 /EINPresswire.com/ -- Traditionally, K-eigenvalue problems have been tackled using a myriad of numerical methods, such as the finite difference method, nodal expansion method, and finite element method, among others. However, as the field has evolved, so too has the need for more sophisticated solutions, especially given the increasing complexity of nuclear reactor designs. Despite their potential, state-of-the-art neural networks to resolve K-eigenvalue problems remain in early stages of development.

A study in reactor physics is published in the journal of Nuclear Science and Techniques, researchers from Sichuan University, Shanghai Jiao Tong University, have introduced two innovative neural networks to address the longstanding challenges associated with K-eigenvalue problems in neutron diffusion theory. These problems, which are fundamental in the nuclear engineering realm, are pivotal for the simulation and analysis of nuclear reactors.

This study introduced two pioneering neural networks, the Generalized Inverse Power Method Neural Network (GIPMNN) and its advanced version, the Physics-Constrained GIPMNN (PC-GIPMNN), to address challenges in reactor physics. While the GIPMNN utilizes the inverse power method to iteratively pinpoint the lowest eigenvalue and the associated eigenvector, the PC-GIPMNN elevates this approach by seamlessly incorporating conservative interface conditions. This advancement proves crucial when tackling interface challenges inherent in reactors with varied fuel assemblies. Notably, in a side-by-side performance evaluation across intricate spatial geometries, PC-GIPMNN consistently surpassed both its counterpart GIPMNN and others. Distinctively, this study opted for a data-independent approach, focusing purely on mathematical and numerical solutions, thereby eliminating potential biases.

These findings herald a new era in nuclear reactor physics, paving the way for enhanced understanding and more streamlined simulations. The adaptability of the introduced neural networks hints at their potential use in other scientific arenas grappling with interface challenges. In essence, the study spotlights the revolutionary promise of neural networks in reactor physics. Future endeavors will indubitably refine these networks and probe their effectiveness in increasingly intricate scenarios.

DOI
10.1007/s41365-023-01313-0

Original Source URL
https://doi.org/10.1007/s41365-023-01313-0

Funding information
The National Natural Science Foundation of China (11971020)
The Natural Science Foundation of Shanghai (23ZR1429300)
Innovation Funds of CNNC (Lingchuang Fund)

Lucy Wang
BioDesign Research
email us here