

PiAI Seminar Series: Physics informed AI in Plasma Science
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Web Seminar

A Dual Neural Network Framework for Plasma Simulation

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With the development of artificial intelligence and machine learning in the last decades, we nowadays have a new powerful tool for plasma simulation, i.e. solving partial differential equations (PDEs) governing plasma via deep learning in form of deep neural networks (DNNs). DNNs can be used as a black box method to approximate a physical system, which is called physics-informed neural networks by some researchers. The philosophy of learning differential equations through neural networks is not a new idea but recent experience has shown that deep networks with many layers seem to do a surprisingly good job in modelling complicated datasets. During this seminar, I would like to share an idea of dual neural network for plasma simulation, in which one network is used to express governing equations of plasmas, and the other to express the mapping from variables to be solved to variable dependent coefficients in equations. To demonstrate the power of this dual neural network, several cases including 1-D arc plasma model and Boltzmann equation model will be presented and discussed.

- [1] M. Raissi, P. Perdikaris and G. E. Karniadakis, *Journal of Computational Physics* 378, 686-707 (2019).
- [2] L. Zhong, Q. Gu and B. Wu, *Computer Physics Communications* 257C, 107496 (2020).