Modeling of transport phenomena in tokamak plasmas with neural networks

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A new transport model that uses neural networks (NNs) to yield electron and ion heat flux profiles has been developed. Given a set of local dimensionless plasma parameters similar to the ones that the highest fidelity models use, the NN model is able to efficiently and accurately predict the ion and electron heat transport profiles. As a benchmark, a NN was built, trained, and tested on data from the 2012 and 2013 DIII-D experimental campaigns. It is found that NN can capture the experimental behavior over the majority of the plasma radius and across a broad range of plasma regimes. Although each radial location is calculated independently from the others, the heat flux profiles are smooth, suggesting that the solution found by the NN is a smooth function of the local input parameters. This result supports the evidence of a well-defined, non-stochastic relationship between the input parameters and the experimentally measured transport fluxes. The numerical efficiency of this method, requiring only a few CPU-μs per data point, makes it ideal for scenario development simulations and real-time plasma control.

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