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# Neural network-assisted electrostatic global gyrokinetic toroidal code using cylindrical coordinates


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Gyrokinetic simulation codes are used to understand the microturbulence in the linear and nonlinear regimes of the tokamak and stellarator core. The codes that use flux coordinates to reduce computational complexities introduced by the anisotropy due to the presence of confinement magnetic fields encounter a mathematical singularity of the metric on the magnetic separatrix surface and at the X-point. To overcome this constraint, we develop a neural network-assisted Global Gyrokinetic Code using Cylindrical Coordinates (G2C3) to study electrostatic microturbulence in realistic tokamak geometries. In particular, G2C3 uses a cylindrical coordinate system for particle dynamics, which allows particle motion in arbitrarily shaped flux surfaces, including the magnetic separatrix of the tokamak. We use an efficient particle locating hybrid scheme, which uses a neural network and iterative local search algorithm, for the charge deposition and field interpolation. G2C3 uses field lines estimated by numerical integration to train the neural network in universal function approximator mode to speed up the subroutines related to gathering and scattering operations of gyrokinetic simulation. Finally, to verify the capability of the new code, we present results from self-consistent simulations of linear ion temperature gradient modes in the core region of the DIII-D and ADITYA-U tokamak.

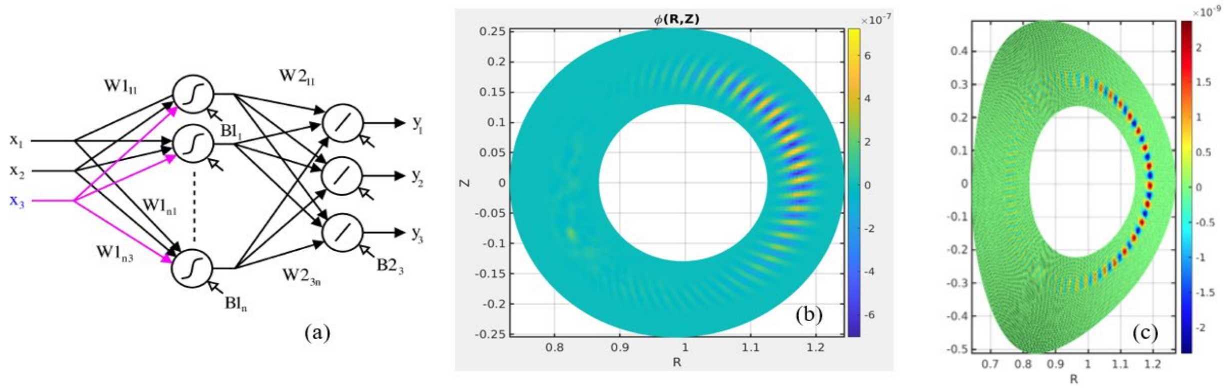


Figure 1: (a) Three layers of vanilla neural network. For training the parallel projection module and triangle locator, we used dataset sizes of $7.5\times10^5$. 2D poloidal mode structure of linear electrostatic modes for ADITYA-U (middle) and DIII-D tokamak (right).

References


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