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A machine learning approach to the solution of Poisson's equations for plasma simulations[1] JAN TRIESCHMANN, TOBIAS GERGS, YUE LIU, THOMAS MUSSENBROCK, Brandenburg University of Technology Cottbus-Senftenberg — The solution of Poisson's equation in one or multiple dimensions is an essential requirement in many plasma simulations. While the computational effort is minor in 1D configurations, it may become significant in multi-dimensional simulation setups. We propose a potential remedy using a machine learning Poisson solver. The approach utilizes an unsupervised learning scheme to train an artificial neural network on charge density distributions from Particle-in-Cell plasma simulations. A proof of concept for the inference of the artificial neural network on the electric potential for a given space charge density is demonstrated and discussed. Moreover, the unsupervised learning procedure, the incorporation of boundary conditions, an accuracy assessment, and implementation aspects within Particle-in-Cell simulations are detailed. It is concluded that the proposed solution scheme is applicable in other simulation methods (e.g., plasma fluid simulations) as well.

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