Data driven reduced modelling of the Vlasov-Poisson equation

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Nowadays, deep learning neural networks are widely deployed and they flourish in many fields of applications. We propose to use them to develop a new Model Order Reduction technique for kinetics models. It will be elaborated on the Vlasov-Poisson model. Indeed, this model describes the evolution of a charged particle distribution submitted to an electromagnetic field. The latter may be self-consistent, i.e. generated by the above-mentioned distribution, in consequence dynamics can be strongly non-linear.

There exist classical methods based on PCA [1] in the linear case, i.e. neglecting the self-consistent field. It achieves to preserve the Hamiltonian structure of the model. Nonetheless, within a self-consistent field, the problem become much harder to reduce. We propose a new and efficient process based on neural networks to reduce the ODE [2] derived from Vlasov and learn a reduced model with good stability properties [3].

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