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Deep Learning for Non-Local Thermodynamic Equilibrium in hydrocodes for ICF. GILLES KLUTH, CEA de Bruyeres-le-Chatel, KELLI HUMBIRD, BRIAN SPEARS, HOWARD SCOTT, MEHUL PATEL, LUC PETERSON, JOE KONING, MARTY MARINAK, LAURENT DIVOL, CHRIS YOUNG, LLNL — We are developing new techniques to accelerate radiation hydrodynamics simulations. A deep neural network can be called in place of a traditional physics package to obtain absorption coefficients and emissivities. The neural network is not only dramatically faster, but uses substantially less memory. We examined the NLTE physics of mid-Z materials for ICF simulations as a test application. This entails great numbers of ion quantum states that set the computational size of the resolved linear system used in the collisional-radiative model. We used CRETIN for in-line collisional-radiative computations in the radhydro code HYDRA. We then trained a deep neural network on a set of CRETIN data under a broad set of plasma conditions. This is a hard regression problem: computing spectra with high-dimensional inputs and outputs (both are around 100). We attacked the dimensionality issue using auto-encoders to reduce the dimensionality and DJINN (random-forest based neural networks) to link latent spaces. Finally, we replaced the in-line atomic physics computation in HYDRA with the well-trained neural network accelerator. We address both the accuracy of the results and the feasibility for implementation in high-precision predictive simulation.

Gilles Kluth
CEA de Bruyeres-le-Chatel

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