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An efficient implementation of Neural network models into particle-in-cell simulations for Compton scattering events

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We propose a methodology for the efficient implementation of deep learning methods within the particle-in-cell algorithm. The presented approach allows for neural networks to be trained in a python environment, where advanced machine learning tools are readily available to proficiently train and generate deep learning models [1]. Later those models are efficiently deployed within highly-scalable and fully parallelised particle-in-cell simulations during runtime. This is achieved through the implementation of a machine learning module within the PIC framework, which can load the model into memory and execute it within its own source code without calling for external libraries. We demonstrate this state-of-the-art methodology with the PIC code OSIRIS [2, 3, 4] and provide a proof-of-concept for this work by applying it to Compton collisions [5]. We demonstrate that the deep learning simulation reproduces the same results as the conventional method. And achieves comparable computational performance. These results offer a promising avenue for future applications of ML-based methods in PIC, especially for problems where a deep learning approach can provide a higher performance increase.

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