Using machine learning to identify magnetic reconnection in two-dimensional simulations

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The understanding of fundamental processes at play in a collisionless plasma such as the solar wind, is a frontier problem in space physics. We investigate here the occurrence of magnetic reconnection in a plasma with parameters corresponding to solar wind plasma and its interplay with a fully-developed turbulent state. Ongoing magnetic reconnection can, at the moment, be accurately identified only by humans. Therefore, as a first step, the goal of this study is to present a new method to automatically recognise reconnection events in the output of two-dimensional HVM (Hybrid Vlasov Maxwell) simulations where ions evolve by solving the Vlasov equation and the electrons are treated as a fluid with mass. A large dataset with labelled reconnection events was prepared, including parameters such as the magnetic field, the electron velocity field and the current density. We consider two types of machine learning models: classical approaches using on physics-based features, and convolutional neural networks (CNNs). We will investigate which approach performs better, and which input variables are most relevant. In addition, we will try to categorize magnetic reconnection regions (current sheets). This work has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 776262 (AIDA, www.aida-space.eu).