PiAI Seminar Series: Physics informed AI in Plasma Science
9:30-10:30, 14 December 2020 (CET)
17:30-18:30, 14 December 2020 (JST)
Web Seminar

Using unsupervised machine learning techniques to detect magnetic reconnection events in 2D plasma simulations and 1D time-series

Manuela Sisti

Aix-Marseille University, Marseille, France

The formation of coherent current structures in turbulent collisionless magnetized plasmas and their disruption through magnetic reconnection has been extensively studied in past years via in situ observations, numerical simulations, and theoretical models.

Presently there is no automatic verified way to detect reconnection events so that only an accurate human analysis can be performed.

We set-up a machine learning unsupervised technique aimed at automatically detecting the presence of current sheet (CS) magnetic structures where reconnection is occurring. We make use of clustering techniques as KMeans and DBscan, and compare their efficiency to that of simpler methods which do not use machine learning but are only based on thresholds on important physical quantities. The unsupervised machine learning method turns out to be the one with the best performance.

We applied these techniques to 2D kinetic HVM (Hybrid Vlasov Maxwell) plasma turbulence simulations, where ions evolve by solving the Vlasov equation while the electrons are treated as a fluid. Electron inertia is included. After that, we are extending the techniques to 1D time-series extracted from our simulations aiming at reproducing the kind of data recorded by satellite.

This work has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 776262 (AIDA, www.aida-space.eu).