

PiAI Seminar Series: Physics informed AI in Plasma Science
9:30-10:30, 07 December 2020 (CET)
17:30-18:30, 07 December 2020 (JST)
Web Seminar

Proposed Stellarator Simplification by ML/AI

Francesco A. Volpe

Renaissance Fusion, Grenoble, France

Renaissance Fusion is one of only two stellarator companies worldwide, and lays special emphasis on making stellarators smaller (via High-Temperature Superconducting coils), less radioactive (via mesoscale liquid walls) and simpler to build. To that end, it is developing simplified manufacturing techniques and co-developing innovative coils that are at the same time simple and able to generate very high fields while exerting minimal forces onto each other. Major progress has been obtained on force minimization. Regarding coil simplification, a major contribution could come from Machine Learning (ML) and Artificial Intelligence (AI). A simple idea will be presented from a stellarator design perspective, with the intent of stimulating discussions and inspiring collaborations with ML/AI experts. The premise is that the direct problem [given a surface current $\mathbf{j}(\mathbf{x})$, compute the magnetic field $\mathbf{B}(\mathbf{x})$] is trivial and computationally fast. This facilitates the generation of a large domain of currents $\mathbf{j}(\mathbf{x})$ and a large co-domain of fields $\mathbf{B}(\mathbf{x})$. The map is injective. Hence, although built on the direct problem, the algorithm is also learning which given \mathbf{j} corresponds to a known \mathbf{B} . That is, it is learning to solve the inverse problem. Such correspondence can be generalized to new \mathbf{B} (and new \mathbf{j}) by arguments of superposition. Since the machine only learnt simple inputs to the direct problem, $\mathbf{j}(\mathbf{x})$, the solutions to the inverse problem will presumably also be simple -as desired-, as far as we prevent the machine from "being too clever".