A machine learning approach towards a disruption prediction and avoidance system: developments and perspectives

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Disruptive events still represent one of the main concerns for the protection of in-vessel components of large size tokamaks, imposing several constraints on the design of the next step experimental devices such as ITER and DEMO. This work aims to summarize the efforts in the development of an innovative machine learning approach, based on a generative model, towards the implementation of a disruption prediction and avoidance system.

In the proposed approach the first step is the construction of a reliable database [1] and to the proper selection of the discharge phases of interest for the study: the analysis, in particular, will be mainly focused on the flat-top phase of the plasma current. In order to effectively extract the information contained in the raw signals, a feature engineering approach has been combined with the definition of physics-based indicators related to more structured spatial and/or temporal information, such as the time evolution of kinetic plasma profiles, the spatial distribution of the radiation and MHD rotating modes. In this framework, the potential of a machine learning tool [2] built upon the Generative Topographic Mapping [3] algorithm will be discussed emphasizing the effectiveness of the tool for the investigation of the operational space where the relevant physics takes place [4]. Typical patterns, describing different processes and characterizing different types of disruption, will be compared for different scenarios developed at JET with the ILW, extending the analysis presented in [5] to the recent high power experimental campaign carried out in 2016. The paper will discuss how the operational boundaries appearing in the considered parameters space are potentially modified and how this could affect the definition of robust disruption avoidance schemes.

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