Boundary Inspection in SOM Mapping of Plasma Disruption Scenarios at ASDEX Upgrade

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Disruptions pose indeed a serious problem for tokamak development. Thus, one of the most challenging problems in nuclear fusion research consists in the understanding of disruption events. The identification of characteristic regions in the operational space where the plasma undergoes to disruption is crucial for tokamak development.

Data clustering consists on the classification of similar objects into different groups, or more precisely, the partitioning of a data set into subsets (clusters), so that the data in each subset (ideally) share some common features, according to some defined distance measures. Due to the inherent predisposition for visualization, the Self-Organizing Map (SOM) [1] is among the most popular and widely used clustering technique.

In [2] the authors analyze the information encoded in ASDEX Upgrade seven-dimensional database using the SOM. Data for that study consisted of signals recorded at ASDEX Upgrade between June 2002 and July 2004. The resulting 2D-Map allows the identification of characteristic regions for plasma scenario. It clearly highlights the presence of a large safe region formed by safe plasma states and a smaller disruptive region formed by disruptive plasma states. Moreover, a transition region, where safe and disruptive plasma states coexist, appears as a boundary between the safe and disruptive regions.

In this paper, in order to better refine the definition of the transition region, statistic criteria, e.g., the Mahalanobis distance [1], will be employed for a classification of safe and disruptive states of each plasma discharge. Moreover, the produced mapping will be deeply analysed. The SOM Component plane representation displays the values of each input variable on the 2D-Map. In each of three regions, by inspecting all the component planes simultaneously, one may observe the relative values of plasma parameters and even roughly distinguish some structure in the input data. In particular, the transition region will be carefully studied in order to identify the relationships between the plasma parameters in the boundary and identify particular combinations of plasma parameters that lead to disruption.