Unsupervised classification of confinement regimes on DIII-D

Z. Daniel[1], N. Leuthold[1], C. Hansen[1], C. Paz-Soldan[1], A. Samaddar[2], D.R. Smith[3], F. Ebrahimi[3]
[1] *Columbia University*
[2]*Argonne National Laboratory*
[3]*University of Wisconsin-Madison*
[4]*Princeton Plasma Physics Laboratory*

Accessing and sustaining Edge Localized Mode (ELM)-free regimes will be crucial for future tokamak fusion pilot plant (FPP) operation. However, it is still an open challenge to automatically identify the ELM regime of the plasma directly from diagnostic data. The distinctions between different ELM regimes are often heuristic or phenomenological, giving rise to the need for analysis that relies solely on data, and can be compared to classifications made by operators *a posteriori*. In this work, data from the beam emission spectroscopy (BES) system and midplane magnetics sensors on DIII-D are analyzed for use in hierarchical clustering–an unsupervised machine learning technique. Our database consists of three different ELM-free regimes: Quiescent H-mode (QH), Wide Pedestal QH mode, and L mode. Methods from multidimensional time series analysis[1] are applied to the data to determine clusters within the data. The discharge parameters, as well as the signal characteristics, between the clusters are analyzed to determine the set of conditions that make ELM regime prediction the most reliable. We show that unsupervised learning applied to BES and magnetics recovers the main ELM-free regimes present in the database. In both cases, clusters that contain a mixture of different ELM-free regimes are analyzed to determine the signal characteristics that cause different regimes to appear similar to one another.

1- Y., Kiyoung, and C. Shahabi. *Proceedings of the 2nd ACM International Workshop on Multimedia Databases*, November 13, 2004, 65–74. https://doi.org/10.1145/1032604.1032616.

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