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Multidimensional linear model for disruption prediction in JET

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The implementation of Machine Learning (ML) techniques has considerably improved the prediction of disruptions. However, they usually provide outcomes difficult to understand from a physics point of view due to their mathematical formulation. The objective of this work is to attain an interpretable equation of an accurate ML disruption predictor. The equation could be used for real-time prediction and possibly for the off-line analysis of the disruption cause. To create the linear model, in addition to physic quantities, time derivatives (TDs) have been considered. TDs represent the difference of the amplitude values of a signal X at two different times divided by their temporal difference (i.e. dX/dt). An initial dataset of 11 signals, together with 7 TDs of each quantity, have been used. To select the best combination of signals and TDs that provide the best linear model, genetic algorithms have been applied. The dataset to train the predictor includes 100 disruptive and 1000 non disruptive JET discharges. The results, obtained with an independent test database of 133 disruptive and 1330 non disruptive shots, show 97% of success rate (93,3% with at least 10 ms of warning time) and 4.3% of false alarms. These rates were achieved with a linear equation derived from the training process. It relates 8 plasma signals and TDs: 1) poloidal beta (Pb); 2) line integrated plasma density (ne); 3) plasma elongation (ELO); 4) mode lock amplitude (ML); 5) plasma vertical centroid position (PVP); 6) total radiated power (Rad); 7) toroidal magnetic field (Bt); 8) time derivative of the stored diamagnetic energy (W_der).

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