Data-driven disruption prediction in GOLEM Tokamak using ensemble classifiers

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Authors: Chandrasekar, Jayakumar (https://content.iospress.com:443/search?q=author%3A%28%22Chandrasekar, Jayakumar%22%29) | Madhawa, Surendar (https://content.iospress.com:443/search?q=author%3A%28%22Madhawa, Surendar%22%29) | Sangeetha, J. (https://content.iospress.com:443/search?q=author%3A%28%22Sangeetha, J.%22%29); *

Affiliations: School of Computing, SASTRA Deemed University, Thirumalaisamudram, Thanjavur, Tamilnadu, India

Correspondence: [*] Corresponding author. J. Sangeetha, School of Computing, SASTRA Deemed University, Thirumalaisamudram, Thanjavur-613401, Tamilnadu, India. E-mail: sangeetha@it.sastra.edu (mailto:sangeetha@it.sastra.edu).

Abstract: A robust disruption prediction system is mandatory in a Tokamak control system as the disruption can cause malfunctioning of the plasma-facing components and impair irrecoverable structural damage to the vessel. To mitigate the disruption, in this article, a data-driven based disruption predictor is developed using an ensemble technique. The ensemble algorithm classifies disruptive and non-disruptive discharges in the GOLEM Tokamak system. Ensemble classifiers combine the predictive capacity of several weak learners to produce a single predictive model and are utilized both in supervised and unsupervised learning. The resulting final model reduces the bias, minimizes variance and is unlikely to over-fit when compared to the individual model from a single algorithm. In this paper, popular ensemble techniques such as Bagging, Boosting, Voting, and Stacking are employed on the time-series Tokamak dataset, which consists of 117 normal and 70 disruptive shots. Stacking ensemble with REPTree (Reduced Error Pruning Tree) as a base learner and Multi-response Linear Regression as meta learner produced better results in comparison to other ensembles. A comparison with the widely employed stand-alone machine learning algorithms and ensemble algorithms are illustrated. The results show the excellent performance of the Stacking model with an F1 score of 0.973. The developed predictive model would be capable of warning the human operator with feedback about the feature(s) causing the disruption.

Keywords: GOLEM Tokamak, stacking, REPTree algorithm, multi-response linear regression, disruption prediction

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