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Predicting disruption in future tokamaks with fewer data by more physics-guided

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It is a crucial challenge that disruption prediction should learn from limited data due to the considerable expense of obtaining an extensive experimental dataset in future tokamaks. To reduce the data requirements for future tokamaks, utilizing existing knowledge of disruption physics and tokamak discharge could be helpful. IDP-PGFE (Interpretable Disruption Predictor based on Physics-Guided Feature Extraction) exhibits commendable performance with a True Positive Rate (TPR) of approximately 90% and a False Positive Rate (FPR) of around 10% when handling a modest number of disruptive discharges, about 20 shots (alongside about 120 non-disruptive discharges) in J-TEXT. However, as the number of disruptive discharges decreases to about 10 shots, the data from a single tokamak becomes insufficient for training a satisfactory model, resulting in a TPR of about 75% and an FPR of approximately 15%. To overcome this limitation, we have adopted a domain adaptation algorithm called CORAL (CORrelation ALignment) for the disruption prediction task. Through the combined advantages of PGFE and CORAL, a cross-machine disruption prediction performance of TPR ~90% and FPR ~30% can be achieved when transferring knowledge from J-TEXT to EAST using only 10 disruptive discharges (and 100 non-disruptive discharges) from EAST. Consider the worst-case scenario, there could even be no data to access at tokamak's initial operation for future tokamaks. Therefore, for disruption prediction, it is crucial to establish a zero-shot disruption prediction model that exhibits both reliable and satisfactory performance. In recent years, computer vision (CV) and natural language processing (NLP) have achieved numerous zero-shot machine learning models, providing a wealth of experience that can be leveraged for disruption prediction. The input for CV tasks consists of pixel values, while NLP tasks involve tokenized words. Unlike NLP and CV tasks, disruption prediction tasks lack normalized feature inputs. Therefore, we aim to identify more widely applicable normalized input features for fracture prediction. At the same time, we aim to improve the data quality of the training data by incorporating more human input to realize a kind of zero-shot for disruption prediction.

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