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Machine Learning for Nuclear Astrophysics

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Phenomenologies are essential in various physics research. They typically contain various parameters to reproduce observational data, where each parameter determination affects the others. Some models include parameters that do not correspond to observables of a system, and frequently ambiguity in the values of unobservables can change the model predictions of observables. Additionally, if the number of unobservable parameters is large, the fitting process will be challenging.
The R-matrix phenomenology is dominantly used in nuclear physics to extract nuclear information from measurements. However, it contains unobservable parameters that disturb the fitting analysis of physical properties as the choices of the parameters are somewhat arbitrary. These parameters have complicated the determinations of the critical properties in nuclear physics. Here, we demonstrate that we can disregard such problematic parameters using deep learning. A deep learning model is trained to predict main nuclear properties from observational data without any information on the unobservables. The model finds patterns of the nuclear properties that appear in the observational data. The model successfully predicts the properties with high performance even in the presence of measurement noises. The methodology is applicable to any other physics phenomenology if one tries to connect the observational data and desired parameters without the others.

Experimental study on nuclear physics

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