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**Analysis of NIF scaling using physics informed machine learning**[1]

ABIGAIL HSU, Stony Brook University, LANL, BAOLIAN CHENG, PAUL BRADLEY, LANL — Hundreds of thermonuclear (TN) ignition experiments in inertial confinement fusion (ICF) were conducted on the National Ignition Facility (NIF). None of the experiments achieved ignition. Although experiments to fine-tune the target designs are the focus of the national ICF program, insightful analysis of the vast amount of existing data is a pressing need. In highly integrated ignition experiments, it is impossible to vary only one design parameter without perturbing all other implosion variables. Thus, to determine the nonlinear relationships between the design parameters and performance from the data, a multivariate analysis based on physics model is necessary. We apply machine learning methods to the existing NIF data to uncover patterns and physics scaling laws in TN ignition. We focus on the scaling laws between the implosion parameters and neutron yield by using different supervised machine learning methods including: Polynomial Regression, Connected Neural Network, and Deep Jointly-Informed Neural Network (LLNL). Our results show that these models could predict the outcomes reasonably from the trained experimental data and agree with the theory. This exploratory study will help build new capability to evaluate capsule designs and provide inputs for new designs.

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