

Data-Driven Prediction of Parametric Sensitivities of Stellarator Blanket Performance

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Design optimization of stellarator blanket shapes is a high-dimensional, computationally expensive black box problem. Gradient-based optimization methods are well suited to find optimal solutions for this problem efficiently, when focusing on neutronic and basic economic metrics. However, due to the lack of spatial derivative information in the Monte Carlo radiation transport kernel, gradients must be estimated for each design point. For such a high-dimensional application, these gradients are themselves computationally expensive to estimate directly if using a method such as finite difference. To alleviate compounding computational expense in a proposed gradient-based approach, a machine learning model can be trained to predict parametric sensitivities at a design point. The parametric sensitivity field can then be used in place of gradient information. Using intelligent design of experiments, an efficient set of training data can be generated to reduce the total cost of this surrogate-assisted approach below that of a purely gradient-based approach. This presentation focuses on the training and validation of a parametric sensitivity model using gradient boosted regression trees.

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