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Physics-informed statistical learning for model comparison and uncertainty quantification of thermoacoustic instability HANS YU, MATTHEW JUNIPER, Department of Engineering, University of Cambridge —

Thermoacoustic instability remains a persistent challenge in the design of jet and rocket engines. While experiments and high-fidelity simulations are useful for physical understanding, reduced-order models are used in design because high-fidelity simulations are barely feasible, and the acquisition of experimental data is both expensive and difficult. Consequently, when data is assimilated into reduced order-models, these models must be chosen and calibrated carefully. We present a statistical learning framework based on Bayesian regression and Gaussian processes in order to assimilate the data and to evaluate the reduced-order model. The key features of our analysis are: (i) a generative picture of reduced-order models consisting of governing equations, parameters and states; (ii) uncertainty quantification for state predictions and parameters estimates; and (iii) a discussion regarding the role of physics in statistical learning. We apply our statistical learning framework to experimental measurements from a laboratory-scale system and a linear model of its thermoacoustic behavior. This physics-informed statistical learning framework balances the robustness and interpretability of reduced-order models against the expressive and predictive capabilities of machine learning.

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