Multi-fidelity methods exploiting the synergy of reduced order modeling and machine learning

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ABSTRACT

Modern engineering systems are becoming pervasively equipped with sensors to monitor and measure physical quantities of interest in-service. These measured data can be used in a transformative way to inform health monitoring [1, 2, 3], diagnostics and prognostics [4], autonomy functions [5], and even the design of next generation smart systems and vehicles. To properly enable these scenarios, the availability of sensor measurements and the collection of large data sets alone are not sufficient. The datasets have to be paired with forms of intelligent reasoning that (1) learn from multiple sources of information (sensors acquisitions, historical data, numerical models, experimental models, etc.), (2) compute efficient representations by extracting and processing the information content, and (3) use these representations to map data into intelligent decisions.

This presentation discusses multi-fidelity and multi-source modeling approaches to obtain computationally efficient representations in support of such forms of intelligent reasoning. In particular, we present computational strategies that exploit the synergy of reduced order modeling and machine learning techniques to obtain multisource-informed efficient and interpretable models that embed physics and learn from data. The approaches will be demonstrated for engineering problems that can be encountered in both aerospace and marine applications, with particular attention to the case of measured data affected by uncertainties.

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