

LEARNING FROM DATA: BAYESIAN METHODS FOR SAFER AND SMARTER COMPUTATIONAL MODELING IN SCIENCE AND ENGINEERING

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ABSTRACT

All models in engineering and the applied sciences rely on approximations and uncertain parameters, making their predictions inherently uncertain. Rather than ignoring this, it is essential to quantify, analyze, and incorporate uncertainty into decision-making to ensure safer, more reliable, and robust computational results.

Bayesian methods gather a collection of techniques for learning from data, improving models and predictions, and performing optimization, explicitly accounting for uncertainty. With a solid mathematical foundation, advances in computational algorithms, and increased data availability, Bayesian approaches are now widely used for model calibration, machine learning, surrogate modeling, optimization, and control. These techniques are being applied across diverse domains, from computational mechanics and climate modeling to materials design, biomedical engineering, aerospace, and energy systems.

This minisymposium invites contributions on the development and application of Bayesian methods in computational science and engineering. We welcome new algorithms, theoretical advances, and practical implementations in areas including but not limited to computational solid, fluid, and biomechanics. We also encourage contributions from researchers developing software tools or frameworks that facilitate Bayesian analysis in complex environments.

Our aim is to foster cross-disciplinary exchange among those applying Bayesian thinking to improve the safety, reliability, and predictive power of computational models across a wide range of scientific and engineering applications.