

STOCHASTIC MODELING FOR PERFORMANCE AND DESIGN ACROSS SCALES

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Abstract

Stochastic models entail packaging knowledge in a way that enhances its relevance to decision making. Specifics of this task clearly depend on 1) what knowledge is available, 2) which decisions are of interest, and 3) what tools are available for packaging knowledge. While decision-making undoubtedly benefits from anticipating the future, the value of the associated inference is limited by the confidence in this anticipation. A distinguishing feature of today's scientific exploration is the ability to not only observe physical phenomena at their smallest constituents, but also to resolve their behavior with mathematical models. This was enabled by technological advances in sensing and computing, and matched by advances in theoretical and computational mathematics. As a result of these developments, new perspectives have recently emerged on the substance of scientific knowledge that have critical significance to uncertainty quantification. Specifically, we are constantly faced with the need to integrate, on the one hand, streams of information associated with a hierarchy of fundamental principles (entailing causality) and on the other hand information associated with joint observations. Distinct mathematical constructs have typically been associated with these flavors of knowledge, yielding, respectively, advances in computational science and data analytics. There is a pressing need to develop rational and credible concepts and algorithms for fusing these manifestations of knowledge in a way that best articulates the value of technological developments. This talk will describe recent advances at the University of Southern California in tackling design-relevant predictions for applications where characterization of extremes is crucial notwithstanding multiscale and multiphysics effects.