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Entropy-based adaptive design for contour finding and estimating reliability

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In reliability analysis, methods used to estimate failure probability are often limited by the costs associated with model evaluations. Many of these methods, such as multifidelity importance sampling (MFIS), rely upon a computationally efficient, surrogate model like a Gaussian process (GP) to quickly generate predictions. The quality of the GP fit, particularly in the vicinity of the failure region(s), is instrumental in supplying accurately predicted failures for such strategies. We introduce an entropy-based GP adaptive design that, when paired with MFIS, provides more accurate failure probability estimates and with higher confidence. We show that our greedy data acquisition strategy better identifies multiple failure regions compared to existing contour-finding schemes. We then extend the method to batch selection, without sacrificing accuracy. Illustrative examples are provided on benchmark data as well as an application to an impact damage simulator for National Aeronautics and Space Administration (NASA) spacesuits.

Keywords

Gaussian process, reliability, design

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