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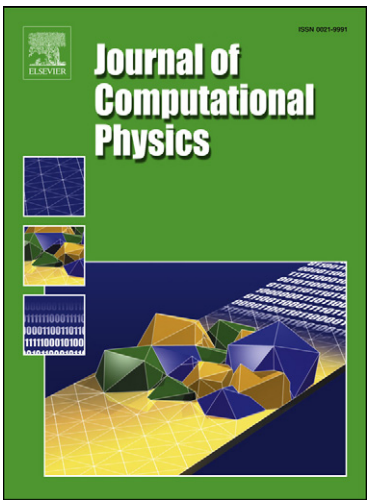

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William Rider, Walt Witkowski, James R. Kamm, Tim Wildey

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Robust Verification Analysis

William Rider[a,1,*], Walt Witkowski[b], James R. Kamm[c], Tim Wildey[a]

[a]*Sandia National Laboratories, Center for Computing Research, Albuquerque, NM 87185, United States*
[b]*Sandia National Laboratories, Verification and Validation, Uncertainty Quantification, Credibility Processes Department, Engineering Sciences Center, Albuquerque, NM 87185, United States*
[c]*Los Alamos National Laboratory, Methods and Algorithms Group, Computational Physics Division, Los Alamos, NM 87545, United States*

Abstract

We introduce a new methodology for inferring the accuracy of computational simulations through the practice of solution verification. We demonstrate this methodology on examples from computational heat transfer, fluid dynamics and radiation transport. Our methodology is suited to both well- and ill-behaved sequences of simulations. Our approach to the analysis of these sequences of simulations incorporates expert judgment into the process directly via a flexible optimization framework, and the application of robust statistics. The expert judgment is systematically applied as constraints to the analysis, and together with the robust statistics guards against over-emphasis on anomalous analysis results. We have named our methodology Robust Verification.

Our methodology is based on utilizing multiple constrained optimization problems to solve the verification model in a manner that varies the analysis' underlying assumptions. Constraints applied in the analysis can include expert judgment regarding convergence rates (bounds and expectations) as well as bounding values for physical quantities (e.g., positivity of energy or density). This approach then produces a number of error models, which are then analyzed through robust statistical techniques (median instead of mean statistics).

*Corresponding author
Email address: wjrider@sandia.gov (William Rider)

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