Assessing the Impact of Sensitivity/Uncertainty Selection Criteria on Computational Bias Prediction

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Overview

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Motivation

Sensitivity/Uncertainty (S/U)-based selection criteria can be used to form a validation suite of experiments similar to an application to estimate computational bias.

If using a quantitative metric, some threshold must be chosen to delineate similarity.

*How is the selection criterion affecting the computational bias prediction?*
Scope

• Investigate this question for $c_k$ and $E$, two integral indices for similarity produced by TSUNAMI-IP
  – $c_k$ is the correlation coefficient between data-induced uncertainties in two systems
  – $E$ is a measure of similarity based solely on shared sensitivities to nuclear data

• Use the Verified Archived Library of Inputs and Data (VALID), a collection of reviewed critical benchmark evaluation models and sensitivity data, to assess effects of S/U criteria cutoff.
$c_k$ and $E$ as Integral Indices Between Two Systems

$c_k$ near -1
There is a large inverse correlation of shared propagated nuclear data uncertainties

$c_k = 0$
The systems do not share sensitivities OR the data with shared sensitivity has no uncertainty

$c_k$ near 1
There is a large positive correlation of shared propagated nuclear data uncertainties

$E$ near -1
There is a large inverse correlation to shared sensitivities

$E = 0$
The systems do not share sensitivities

$E$ near 1
There is a large positive correlation to shared sensitivities
Method

• Develop a tool to calculate the predicted computational bias for a given application as a function of the chosen trending parameter

• Apply this tool to critical experiment benchmarks with known computational biases
  – Computational bias is defined by $\beta = C/E - 1$

• Each application’s bias is predicted by averaging the computational biases of similar benchmark experiments

• Then calculate the bias error
  – The difference between the predicted and actual computational bias
Method Application - VALID

- This method was applied to a set of benchmark experiments in VALID, with the following breakdown of benchmark case types

- Total: 616
Results: HMF and LCT Bias Prediction Error with $c_k$

HMF: Average bias error near 0 but large spread

LCT: Average bias error near 0 but small spread
Results: MCT and PST Bias Prediction Error with $c_k$

MCT: Bias error averages high but approaches 0 with $c_k$ near 1

PST: Bias error averages low but approaches 0 with $c_k$ near 1
Results: USI and UST Bias Prediction Error with $c_k$

USI: Bias error averages high but approaches 0 sharply with $c_k$ near 1

UST: Bias error with large spread relatively unaffected with threshold
Results: LCT and USI Bias Prediction Error with $E$

**LCT:** Bias error with low spread and low $E$ dependence for bias error - typical

**USI:** Bias error with large spread relatively steadily approaches 0 error average near 1
Conclusions and Future Work

• Each system type features unique behavior when assessing bias error as a function of $c_k$ or $E$

• The examples presented here are just a subset on the effect of selection criteria cutoffs for predicting computational bias

• Typical $E$ threshold dependence was low-none for bias prediction error (with exceptions), but $c_k$ trending effects were typically more prominent

• Further analysis would be needed to support a statement on updated cutoff guidance
More Considerations

• The results of these analyses are dependent on the data available, so results will change as more experiments are incorporated into VALID.

• Generalization is still tricky for similar reasons, and the method assumes all experiments are independent of one another.
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