Engineering Risk Analysis Group
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Master's thesis

Sensitivity Measures for Continuous Actions and Multiple Parameters

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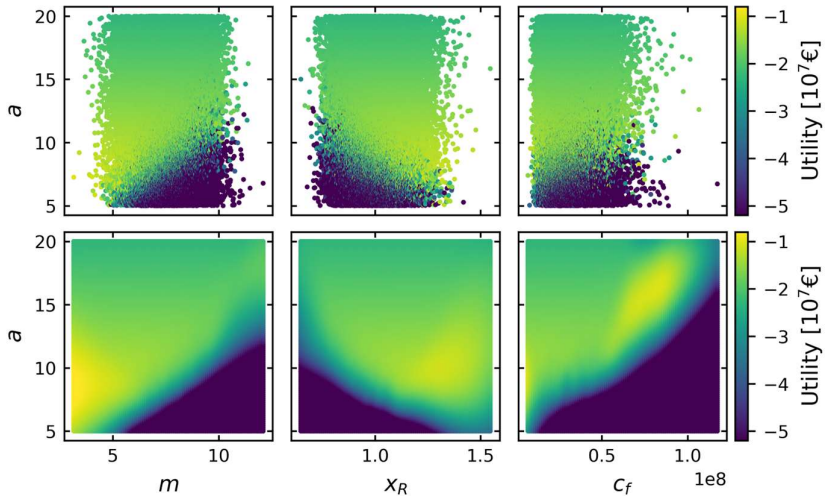
Background

The information value is a dedicated measure of the decision sensitivity that quantifies the expected gain in decision quality when the uncertainty in a specific input is eliminated. Unlike other measures, it not only allows the relative ranking of factors but also provides an absolute interpretation in terms of the gain in utility. However, until now, its use in engineering applications remains limited and focused on discrete decision cases. This thesis addresses this gap by aiming to develop a robust implementation for a sample-based computation that estimates the information value for continuous decision problems.



The top row of plots shows the original utility of each Monte Carlo sample for all model parameters and their corresponding value of the continuous decision parameter a. The bottom row illustrates the 2D LOESS smoothing onto a pseudo continuous utility surface, from which the a-posteriori optimal decision of each sample of a parameter value is identified as the one that maximizes the smoothed utility.

Methodology

The computation relies on nonparametric LOESS smoothing to estimate the a-priori and a-posteriori optimal decisions from a single set of samples. Based on these values of the decision parameter the information value can either be determined by the smoothing or the reevaluation estimator. The former one relies solely on the utility values obtained by the two smoothing steps, while the latter utilizes the determined optimal decisions for a model revaluation. To assess the accuracy of both estimators, they are tested on a working example with semi-analytical reference solutions.

Conclusion

The numerical investigations showed that the general performance of both estimators depends significantly on the specific choice of hyperparameters for the LOESS smoothing function. Overall, the reevaluation estimator consistently outperformed the smoothing estimator in terms of accuracy relative to the semi-analytical reference solutions. The remaining challenge for a general practical application is the selection of the most suitable hyperparameters in the absence of a reference solution.

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