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Global Sensitivity Analysis Reporting Tool for Easily Detecting Variable Impact and Interaction

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Explainable Artificial Intelligence (XAI) stands as a crucial area of research essential for advancing AI applications in real-world contexts. Within XAI, Global Sensitivity Analysis (GSA) methods assume significance, offering insights into the influential impact of individual or grouped parameters on the predictions of machine learning models, as well as the outcomes of simulators and real-world processes.

One area where GSA proves particularly valuable is in black-box optimization. When setting up an optimization problem, it is crucial to meticulously select parameters that play an important role and are therefore suitable as variables. This choice significantly influences the outcome of the optimization procedure; if the wrong variables are chosen, the effectiveness of the optimization process is compromised. Additionally, the performance of many black-box optimizers is influenced by the dimensionality of the problem. To obtain reliable results, the amount of sampled data needs to grow exponentially with the dimensionality. Therefore, choosing to optimize only the significant parameters allows for reducing the dimensionality of the problem and, consequently, the number of queries to the objective function.

In this talk, we present GSAreport [1,2], an open-source software recently developed by our team. GSAreport generates elaborate reports that describe the global sensitivities of input parameters using a variety of GSA methods. These reports allow users to inspect which features are crucial for a given real-world function/simulator, or model.

To provide a usage example, we evaluate the tool's performance on a real-world test case in engineering design. We examine the impact of parameters of different nature on the performance of a crash box, for varying dimensions and sample sizes. Our findings underscore the relevance of our tool as (1) an instrument for gaining a deeper understanding of the features contributing to component performance and (2) a preliminary step to reduce dimensionality in optimization, thereby enhancing algorithm efficiency while maintaining flexibility. Despite the specific use-case considered, we show the potential of GSAreport as an interdisciplinary and user-friendly tool capable of expediting design processes and enhancing the overall understanding across diverse application areas.

References:
[1] B. Van Stein, E. Raponi, Z. Sadeghi, N. Bouman, R. C. H. J. Van Ham, and T. Bäck, A Comparison of Global Sensitivity Analysis Methods for Explainable AI with an Application in Genomic Prediction. IEEE Access (2022).
[2] B. Van Stein, E. Raponi, GSAreport: easy to use global sensitivity reporting. Journal of Open Source Software (2022), 7 (78), 4721.

Type of presentation

Invited Talk

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