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Fair Universe HiggsML Uncertainty Challenge

Measurements and observations in Particle Physics fundamentally depend on one's ability to quantify their uncertainty and, thereby, their significance. Therefore, as Machine Learning methods become more prevalent in HEP, being able to determine the uncertainties of an ML method becomes more important. A wide range of possible approaches has been proposed, however, there has not been a comprehensive comparison of individual methods.

To address this, the Fair Universe project organized the HiggsML Uncertainty Challenge, which took place from Sep 2024 to 14th March 2025, and the dataset and performance metrics of the challenge will serve as a permanent benchmark for further developments. Additionally, the Challenge was accepted as an official NeurIPS2024 competition. The goal of the challenge was to measure the Higgs to tau+ tau- cross-section, using a dataset of particle 4-momenta. Participants were evaluated on both their ability to precisely determine the correct cross-section, as well as on their ability to report correct and well-calibrated uncertainty intervals.

In this talk, we present an overview of the competition itself and of the infrastructure that underpins it. Further, we present the winners of the competition and discuss the performance of their winning uncertainty quantification approaches.

The challenge itself can be found under https://www.codabench.org/competitions/2977/
And more details are available as https://arxiv.org/abs/2410.02867

Significance

The Fair Universe HiggsML Uncertainty Challenge presents the first comprehensive benchmark dataset for machine learning uncertainty quantification in HEP

References

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Experiment context, if any

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