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FAIR Universe : HiggsML Uncertainty Challenge Competition

The **Fair Universe** project organised the **HiggsML Uncertainty Challenge**, which took place from Sep 2024 to 14th March 2025. This groundbreaking competition in high-energy physics (HEP) and machine learning was the first to place a strong emphasis on uncertainties, focusing on mastering both the uncertainties in the input training data and providing credible confidence intervals in the results.

The challenge revolved around measuring the Higgs to tau+ tau- cross-section, similar to the **HiggsML challenge** held on Kaggle in 2014, using a dataset representing the 4-momentum signal state. Participants were tasked with developing advanced analysis techniques capable of not only measuring the signal strength but also generating confidence intervals that included both statistical and systematic uncertainties, such as those related to detector calibration and background levels. The accuracy of these intervals was automatically evaluated using pseudo-experiments to assess correct coverage.

Techniques that effectively managed the impact of systematic uncertainties were expected to perform best, contributing to the development of uncertainty-aware AI techniques for HEP and potentially other fields. The competition was hosted on **Codabench**, an evolution of the Codalab platform, and leveraged significant resources from the **NERSC infrastructure** to handle the thousands of required pseudo-experiments.

This competition was selected as a **NeurIPS competition**, and the preliminary results were presented at the **NeurIPS 2024** conference in December. As the challenge concluded in March 2025, an account of the most innovative solutions and final outcomes will be presented at this conference.

AI keywords

Benchmark; Uncertainty Quantification; Simulation- Based Inference;

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