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Conformal Inference Methods for Uncertainty Quantification in High-Energy Physics

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In high-energy physics, detecting rare events and computing their properties demand precise and reliable statistical methods, with uncertainty quantification being crucial. Today, most research relies on machine learning methods, where calibrating output probabilities can be complex. How can we then draw conclusions with the required five sigma statistical significance, which is essential for validating new findings?

The significance of calibrating the output probabilities of machine learning methods is immense. Accurate calibration ensures that predicted probabilities reflect the true likelihood of events, allowing for more robust decision-making and reliable interpretation of results. Poor calibration can lead to erroneous conclusions, particularly in high-stakes fields like high-energy physics where rare event detection is critical.

Conformal prediction methods are becoming a primary approach in both academia and industry to quantify uncertainty, calculate confidence intervals in regression tasks, and calibrate probabilities in classification tasks. This presentation will introduce the fundamental principles of conformal prediction and discuss data exchangeability and conformity scores.

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