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Introduction to Bayesian methods and uncertainty quantification

SARAH WESOLOWSKI, Salisbury University

The nuclear physics community has largely embraced Bayesian statistical methods in the past decade, due to an increasing need for uncertainty quantification (UQ) on predictions and measurements and the availability of computational power. The Bayesian interpretation of probability allows for an expanded view of what can be treated as a random variable, and also facilitates the inclusion of physical knowledge quantitatively in the form of prior probabilities. Priors make the assumptions in a statistical analysis explicit, which enhances both reproducibility and clarity. I will discuss how Bayesian statistics can be used in nuclear physics for parameter estimation (fitting), quantitative model comparison, and for UQ. I will also discuss the advantages of being able to perform validation of statistical analyses, e.g., uncertainties should neither be over- or under-estimated and how to test that statistically.