

# FITTING ASTROPHYSICAL MODELS: CHI-SQUARE, KS TESTS, BOOTSTRAP, AND MLE

JOGESH BABU

ABSTRACT. Complicated models from astrophysical theory are often fit to observational data. An example from X-ray astronomy, fitting a complicated thermal model with several temperatures to a spectrum from the Chandra X-ray Observatory, is considered here. First, ‘chi-square minimization’ is commonly used for fitting functions often disregard mathematical assumptions. Second, the Kolmogorov-Smirnov (KS) test for goodness-of-fit testing is misused in astronomy when the model parameters are estimated from the dataset under study. Third, the KS is inefficient at detecting deviations between the data and model at the tails of the distribution. Fourth, the KS test cannot justifiably be applied to multivariate data as KS is no longer ‘distribution-free’. After a historical review of maximum likelihood approaches to model fitting, we show how bootstrap resampling methods, a simple Monte Carlo procedure on data, can be used to estimate the null distributions in such cases including multivariate problems. Recent extensions of resampling methods address inference when the data are drawn from an unknown distribution which may or may not belong to a specified family of distributions. This is the ‘model misspecification’ problem; e.g. does the X-ray spectrum arise from thermal or nonthermal processes?

CENTER FOR ASTROSTATISTICS, PENNSYLVANIA STATE UNIVERSITY  
*E-mail address:* babu@psu.edu