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Bayesian analysis of multichannel measurements

A typical experiment in high energy physics is considered. The result of the experiment is assumed to be a histogram consisting of bins or channels with numbers of corresponding registered events. The expected background and expected signal shape or acceptance are measured in separate auxiliary experiments, or calculated by the Monte Carlo method with finite sample size, and hence with finite precision. An especially complex situation occurs when the expected background in some of the channels (usually at the right end of the physical histograms, where the expected signal to background ratio is maximal) happens to be zero due to either a fluctuation of the auxiliary measurement (or simulation) or because it is truly zero. Different statistical methods give different confidence intervals for the full signal rate and different significance of the signal+background hypothesis versus the pure background hypothesis. The Bayesian method is discussed in this report. Detailed analysis and numerical tests are presented. A simple modification of central intervals and a simple empirical rule for choosing priors for nuisance parameters allow the user to obtain credible intervals with the frequentist coverage. There is a method to find an optimal number of channels and to retain the claimed coverage.

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