Stability and uniqueness of $p$-values for likelihood-based inference

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Abstract: Likelihood-based methods of statistical inference provide a useful general methodology, which are appealing as a straightforward asymptotic theory may be applied for their implementation. It is important to assess the relationships between different likelihood-based inferential procedures, in terms of accuracy and adherence to key principles of statistical inference, in particular those relating to conditioning on relevant ancillary statistics. An analysis is given of the stability properties of a general class of likelihood-based statistics, including those derived from forms of adjusted profile likelihood, and comparisons are made between inferences derived from different statistics. In particular, we derive a set of sufficient conditions for agreement to $O_p(n^{-1})$, in terms of the sample size $n$, of inferences, specifically $p$-values, derived from different asymptotically standard normal pivots. Our analysis includes inference problems concerning a scalar or vector interest parameter, in the presence of a nuisance parameter.