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# Some asymptotic results for fiducial and confidence distributions

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**Abstract.** Under standard regularity assumptions, we provide simple approximations for *specific* classes of fiducial and confidence distributions and discuss their connections with objective Bayesian posteriors. For a real parameter the approximations are accurate at least to order  $O(n^{-1})$ . For the mean parameter  $\boldsymbol{\mu} = (\mu_1, \dots, \mu_k)$  of an exponential family, our fiducial distribution is asymptotically normal and invariant to the importance ordering of the  $\mu_i$ 's.

**Keywords:** ancillary statistic, confidence curve, coverage probability, natural exponential family, matching prior, reference prior.

## 1 Introduction

Confidence and fiducial distributions, often confused in the past, have recently received a renewed attention by statisticians thanks to several contributions which clarify the concepts within a purely frequentist setting and overcome the lack of rigor and completeness typical of the original formulations. For a wide and comprehensive presentation of the theory of confidence distributions and a rich bibliography we refer the reader to the book by Schweder & Hjort (2016) and to the review paper by Xie & Singh (2013). This latter also highlights the importance of this theory in meta-analysis, see also Liu et al. (2015). For what concerns fiducial distributions Hannig and his coauthors, starting from the original idea of Fisher, have developed in several papers a *generalized fiducial inference* which is suitable for a large range of situations; see Hannig et al. (2016) for a complete review on the topic and updated references.

Given a random vector  $\mathbf{S}$  (representing the observations or a sufficient statistic) with distribution indexed by  $\boldsymbol{\eta} = (\theta, \boldsymbol{\lambda})$ , where  $\theta$  is the real parameter of interest, a *confidence distribution* (CD) for  $\theta$  is a function  $C$  of  $\mathbf{S}$  and  $\theta$  such that: i)  $C(\mathbf{s}, \cdot)$  is a distribution function on  $\mathbb{R}$  for any fixed realization  $\mathbf{s}$  of  $\mathbf{S}$  and ii)  $C(\mathbf{S}, \theta)$  has a uniform distribution on  $(0, 1)$ , whatever the true value of  $\boldsymbol{\eta}$ . The second condition is crucial because it implies that the coverage of the intervals derived from  $C$  is exact. If it is satisfied only for the sample size tending to infinity,  $C$  is an *asymptotic* CD and the coverage is correct only approximately. Given a CD, it is

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