BARNDORFF-NIELSEN, O. E., BLÆSILD, P. and MORA, M. (1989). Generalized higher order differentiation. *Acta Appl. Math.* To appear.

BARNDORFF-NIELSEN, O. E. and COX, D. R. (1989). *Asymptotic Techniques for Use in Statistics.* Chapman and Hall, London.

BARNDORFF-NIELSEN, O. E. and JUPP, P. E. (1989). Approximating exponential models: *Ann. Inst. Statist. Math.* To appear.

BARTLETT, M. S. (1953). Approximate confidence intervals. *Biometrika* **40** 12–19.

BLÆSILD, P. (1987a). Yokes: Elemental properties with statistical applications. In *Geometrization of Statistical Theory* (C. T. J. Dodson, ed.) 193–198. ULDM Publications, Lancaster.

BLÆSILD, P. (1987b). Further analogies between expected and observed geometries of statistical models. Research Report 160, Dept. Theoretical Statistics, Aarhus Univ.

BLÆSILD, P. (1988). Yokes and tensors derived from yokes. Research Report 173, Dept. Theoretical Statistics, Aarhus Univ.

BLÆSILD, P. and MORA, M. (1988). Differential strings: Basic theory. Research Report 183, Dept. Theoretical Statistics, Aarhus Univ.

FOSTER, B. L. (1958). Differentiation on manifolds without a connection. *Michigan Math. J.* **5** 183–190.

FOSTER, B. L. (1961). Some remarks on tensor differentiation. *Ann. Mat. Pura Appl.* **54** 143–146.

FOSTER, B. L. (1986). Would Leibniz lie to you? (Three aspects of the affine connection). *Math. Intelligencer* **8** 34–40, 57.

FOSTER, B. L. (1988). Higher derivatives in geometry and physics. Research Report 178, Dept. Theoretical Statistics, Aarhus Univ. *Proc. Roy. Soc. London Ser. A.* To appear.

MCCULLAGH, P. (1987). *Tensor Methods in Statistics.* Chapman and Hall, London.

MORA, M. (1988). Geometrical expansions for the distributions of the score vector and the maximum likelihood estimator. Research Report 172, Dept. Theoretical Statistics, Aarhus Univ.

SKOVGAARD, I. M. (1986). A note on the differentiation of cumulants of log likelihood derivatives. *Internat. Statist. Rev.* **54** 29–32.

Comment: On Multivariate Jeffreys' Priors

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Kass presents a lucid, well written description of the differential geometric foundations of such pervasive concepts in statistics as Fisher information, the Kullback-Leibler metric and information numbers, or the loglinear structure of exponential families. As the author points out, these topics directly relate to the role of reference priors in Bayesian Inference—an issue he regards as of "ongoing vital importance"—and one would expect a deeper understanding of such an issue from his work. I will concentrate on this point.

JEFFREYS' PRIORS

Kass very clearly describes some of the more basic aspects of Jeffreys' priors. Specifically, I would like to draw your attention to four of those:

(i) Jeffreys' general rule is generated by the *natural* volume element of the information metric.

(ii) The main intuitive motivation for Jeffreys' priors is *not* their invariance, which is certainly a necessary, but in general far from sufficient, condition to determine a sensible reference prior; what makes Jeffreys' priors unique is that they are *uniform* measures in a particular metric which may be defended as the "natural" choice for statistical inference.

(iii) The existence of Jeffreys' priors requires rather strong, if fortunately frequent, regularity conditions.

(iv) Multivariate Jeffreys' priors are often inadequate to obtain marginal reference posterior distributions for its elements—as Jeffreys himself realized—and there does not seem to be an agreed *systematic* alternative; independent treatment of orthogonal parameters, when applicable, is only an *ad hoc* partial solution. Key references for the type of problems which may be encountered from routine use of Jeffreys' multivariate priors are Stein (1959) or Dawid, Stone and Zidek (1973).

While (i) and (ii) are possibly sufficient to be suspicious about any method for generating reference priors which does not reduce to Jeffreys' in *one-dimensional regular* problems, (iii) leaves room for improvement and (iv) clearly requires new work. When reading Kass' paper, I was hoping for some new hints about (iv) but I could not recognize any; I hope to see some comments in the rejoinder.

REFERENCE PRIORS

In my development of *reference* priors (Bernardo, 1979)—which reduce to Jeffreys' for one-dimensional regular problems—I explicitly recognized the importance of identifying *parameters of interest* and

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