Appl. Statist. (1978),
27, *No.* 3, *pp.* 344

Miscellanea

Conference on Ecological Statistics—a Summary Report

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Introduction

The conference, held on May 5th, 1978, was jointly organized by the Department of Mathematical Statistics of the University of Hull, the Statistical Laboratory of the University of Manchester, and the Department of Probability and Statistics of the University of Sheffield. It attracted about eighty participants from a wide range of academic and governmental organizations, and was timed to coincide with the visit of Professor E. C. Pielou (Dalhousie University, Halifax, Nova Scotia) to the three departments. The meeting comprised three major talks and a session of four short talks. The success of the meeting was due partly to the lively discussion that followed these lectures.

The Papers

Dr E. D. Ford (Institute of Terrestrial Ecology, Penicuik) started the proceedings by describing the need for a stochastic model for the branching process of a tree. The model is a link between environmental effects and the development of stand structure and interplant competition, and is essential to the production of a scheme for forest growth. Dr Ford outlined some of the field work necessary to find adequate parameters for such a model and showed, via some entertaining slides, how they could be used to simulate tree structures.

This was followed by Professor Pielou who discussed two problems from the area of biogeographical statistics. The first concerned inference about the range of species on the basis of data of variable quality (a reflection on the practical difficulty of data collection in such studies). The second involved deductions about the evolution and interaction of related species from a knowledge of their geographic ranges: The example Professor Pielou gave was motivated by oil exploration work. It concerned sample cores taken from the sea-bed at varying depths. These cores are then examined for microfossils (especially of benthic *Foraminifera*) which are useful as indicators of palaeoclimatic conditions. Also discussed were problems raised by noisy data and the use of groups of species as indicators.

The afternoon session started with the short talks. Mr F. S. Daly (University of Hull) looked at properties of branching random walks as models for the location of successive generations of an ephemeral plant species. Dr R. Hunt (University of Sheffield) gave a review of methods of fitting curves in order to find empirical models of plant growth. He included recent work on the use of splines, with objectively and subjectively determined knots. Miss R. McNamee (University of Manchester) discussed a continuous time model for the spread of an epidemic through a commuting population, specifically in the case where individuals have small probabilities of leaving their own communities. Mr S. Tavaré (University of Sheffield) reviewed ways of analysing certain selective predation experiments and, in the light of recent sequence data, suggested a simple model which was compared to other methods with the aid of simulation.

The meeting was brought to a close by Professor R. M. Cormack (University of St Andrews) who described recent developments in Mark-Recapture. He showed, in passing, the subject's connection with sampling theory. This entertaining talk illustrated the interaction between mathematical models and the real problem and highlighted a heart-felt drawback. As the mathematical models get nearer to reality the analyses become less useful in practice, since more parameters usually mean less precision. Some escapes from this trap were described.

Appl. Statist. (1978),
27, *No.* 3, *pp.* 345

Simple Approximations for the von Mises Concentration Statistic

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[Received December 1977. Revised April 1978]

Summary

This paper describes some simple approximations which can be used to obtain the maximum likelihood estimate of the concentration parameter of the von Mises distribution.

Keywords: VON MISES DISTRIBUTION; CIRCULAR STATISTICS; NUMERICAL APPROXIMATION

1. Introduction

The von Mises distribution on the circle is, in many ways, analogous to the Normal distribution on the straight line. In the notation of Mardia (1972), it is denoted by $M(\mu_0, \kappa)$ and has probability density function

$$g(\theta;\, \mu_0, \kappa) = \{2\pi I_0(\kappa)\}^{-1} \exp\{\kappa \cos(\theta - \mu_0)\}, \quad 0 < \theta \leqslant 2\pi,$$

where $\mu_0 (0 \leqslant \mu_0 < 2\pi)$ is the mean direction, $\kappa (\kappa \geqslant 0)$ is the concentration parameter and I_0 is the modified Bessel function of the first kind and order zero.

If $\theta_1, \ldots, \theta_n$ are a random sample from $M(\mu_0, \kappa)$ then the maximum likelihood estimator (Mardia, 1972, Section 5.4.1) of κ is $\hat{\kappa}$, the solution of

$$A(\hat{\kappa}) = \bar{R} = (\bar{C}^2 + \bar{S}^2)^{\frac{1}{2}},$$

where $\bar{C} = n^{-1} \Sigma_{i=1}^n \cos \theta_i$, $\bar{S} = n^{-1} \Sigma_{i=1}^n \sin \theta_i$ and $A(x) = I_1(x)/I_0(x)$, where I_1 is the modified Bessel function of the first kind and order one. Thus, $\hat{\kappa} = A^{-1}(\bar{R})$. Limited tables of A^{-1} are given by Mardia (1972, p. 298) based on those in Gumbel *et al.* (1953) and Batschelet (1965). Mardia and Zemroch (1975) give a computer algorithm for calculating several circular statistics including $\hat{\kappa}$ which is obtained iteratively.

In this paper several functions are given which approximate A^{-1} well throughout its range and can be easily computed using a hand calculator. From these functions the statistic $\hat{\kappa}$ can be obtained fairly accurately without the use of tables and interpolation formulae or sophisticated computing equipment.

2. Approximations

Amos (1974) proved that

$$\frac{x}{\frac{1}{2} + (x^2 + \frac{9}{4})^{\frac{1}{2}}} < A(x) < \frac{x}{\frac{1}{2} + (x^2 + \frac{1}{4})^{\frac{1}{2}}}, \quad x \geqslant 0.$$