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STATISTICAL SMOOTHING METHODS: SOME PRACTICAL ASPECTS

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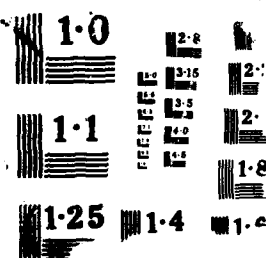
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Statistical smoothing methods: some practical aspects

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FOURTH PERIODIC REPORT

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EQUIPMENT

A colour hard copy unit has now been acquired, and has already been of considerable use in the research.

PERSONNEL

Dr R. H. Glendinning left the project on 31 January 1988 to take up a longer-term appointment at another university. Because of uncertainty about the future funding of the project, and because of the deteriorating foreign exchange rate, it has not been possible to replace him, but it is expected that the project will have the services of Dr M. C. Jones from 1 July 1988 as a Research Officer.

SCIENTIFIC WORK *includes these topics:*

Parsimonious additive models

Work on this important idea has continued, mainly aimed at revising the previously submitted paper [4] to satisfy the referees' comments. At the end of the period covered by this report, the final version was nearly ready for submission. It is clear that this work is already exciting some interest, and its presentation as a major discussion paper at the 1988 ASA meetings should be of considerable help in propagating the idea.

ICM and Annealing

The work referred to in the last periodic report on the study of the Iterated Conditional Modes Algorithm for Image Reconstruction has now been completed. A substantial paper [7] on this work has been submitted for publication. A copy is attached, which see for further details.

Nonparametric discriminant analysis

Work on the CART method has been continued. The major achievement during the reporting period has been the successful writing of a very novel display program for presenting the successive splits carried out by CART on a colour display. This program, together with the use of our new colour hard copy unit, has enabled methodological problems in the present CART algorithm to be pinpointed. A particular subject for further attention, spotted in this way, is the necessity to include an "anti-end-cut" factor to prevent very small parts of the data being sectioned off too early. Considerable attention has been devoted to a comparison of several different splitting criteria, some old and some new.

Image Refinement *indirectly observed images (KR)*

Work on this topic has continued and the computer program to fit boundaries of objects with piecewise straight edges further developed. This program is now able to deal automatically with quite general two colour scenes and produces impressive results. It is also serving as the basis of a full exploration of the scope of the method, including an investigation of the possible advantages of a hierarchical approach to image reconstruction in which successively finer images are produced as greater detail in the original data is used.

Further developments of the methodology are presently being considered. These include generalisations of the methodology to grey-level scenes; the use of simulated annealing to search more widely for a better fitting restored image; development of a

criterion for choosing the smoothing parameter, possibly by a form of cross-validation.

Indirectly observed images

A substantial paper [8] on the work on indirect image reconstruction has now been submitted for publication. A copy is attached. This paper covers both the one-dimensional and the pixel image case, and introduces to the literature the important new smoothed EM algorithm. See the paper for further details.

The joint theoretical work with Johnstone has now led to a very substantial theoretical paper [9], which has been submitted for publication. A copy is attached. Investigation has begun of an alternative approach involving a tapered orthogonal series method.

TRAVEL AND CONFERENCES

Dr Jennison visited the Night Vision & Electro-Optics Center at Fort Belvoir, Virginia, from 21 to 22 January 1988. He presented talks on the work that has been completed so far on this project and discussed topics on which future work should be undertaken. He illustrated the use of the GLIM program for analysing confusion matrix data and discussed the design of future experiments in which more data of this type will be collected.

Dr Jennison presented a seminar entitled "Statistical Image Analysis and Refinement" at Cornell University on January 27, 1988.

PUBLICATIONS

- [1] Silverman, B. W. and Young, G. A. (1987). The bootstrap: to smooth or not to smooth? *Biometrika*, 74, 469-479.
- [2] Brown, T. C. and Silverman, B. W. Edge process models for regular and irregular pixels. Technical Report No. 267, Department of Statistics, Stanford University, Stanford, California.
- [3] Jennison, C. and Jubb, M. Statistical image restoration and refinement. To appear in Proceedings of the Tenth International Conference on Information Processing in Medical Imaging, held in June 1987 in Utrecht, The Netherlands.
- [4] Brown, T.C., Jennison, C. and Silverman, B.W. Edge process models for regular and irregular pixels. (33 pp.) Submitted for publication.
- [5] Friedman, J.H. and Silverman, B.W. (1988). Flexible parsimonious smoothing and additive modeling. *Technometrics*, accepted for publication and reading as a special discussion paper at the 1988 American Statistical Association Annual Meetings.
- [6] Wilson, J.D. A smoothed EM algorithm for the solution of Wicksell's corpuscle problem. (37 pp) Submitted for publication.
- [7] Glendinning, R.H. An evaluation of the ICM algorithm for image reconstruction. (42 pp) Submitted for publication.
- [8] Jones, M.C., Silverman, B.W. & Wilson, J.D. A smoothed EM approach to a class of problems in image analysis and integral equations. (31 pp, 8 plates) Submitted for publication.
- [9] Johnstone, I.M. and Silverman, B.W. Speed of estimation in positron emission tomography. (44 pp) Submitted for publication.

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