numbered grouped O.T.U., group two contains the next lowest, etc.

For full classification, the results are only given at the level specified, but this is given on the print-out as a caption. The complete process is given, including the results of the initial single linkage classification, the O.T.U.s forming the nuclei, with a classification of these to show the actual nuclei, a list of additions made to each of the nuclei, in the order in which these additions were made, and a final full classification, captioned as for the single linkage case.

The amount of output required will depend on the data, and the ease with which it classifies, but a request for 500 lines will be adequate for most problems.

Computing time

It is not possible to estimate the amount of computing time required, as this will depend to a very great extent on the number of iterations needed in the second stage. For small data matrices (< 100) a request for 2 minutes on Atlas should suffice. For larger matrices, for which a full classification is required, the amount of time needed will have to be determined specifically for that data.

Conclusions

The programs described in this paper have been used to classify biological and medical data, in studies of the 'twilight zones' of a large city by town and country planners, and in population movement studies by social geographers. Each of these pieces of work warrants separate description. However, our general observations have been that in many cases, single link analysis is more than adequate and no gains are to be made by continuing the analysis by using the de-chaining algorithms. Where a large number (for example 500) of attributes are used to describe each O.T.U., the risk of chaining increases, and in one of our medical applications the de-chaining process has proved invaluable.

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Book Review

Cybernetic Modelling, by J. KLIR and M. VALACH (Tr. P. DOLAN), 1967; 437 pages. (London: *Iliffe Books Ltd.*, 63s.)

This long, ambitious, and rather strange book was first published in Czechoslovakia in 1965. Its characteristics are the authors' obvious lack of advanced computing facilities, their ignorance of, or lack of interest in, current Western research and their adherence to a completely materialist viewpoint. In consequence the book has a somewhat archaic flavour, with much time spent putting forward philosophical and terminological arguments and introducing research ideas now of largely historical interest.

The book begins with the sentence—'The basis of our world is *matter*, which is in continuous motion in space and time in the widest sense of the word'. The vague generality of this statement is fairly typical. The authors then distinguish between *inanimate* and *animate* matter, and remain fascinated by this distinction.

The first one hundred and twenty pages are devoted primarily to introducing and defining concepts and to discussing the elements of what may ultimately become a useful cybernetic theory. By 'cybernetics' the authors mean, roughly, the study of the structure and behaviour of collections of elements which interact with one another, and with their environment. They formulate a definition of what they mean by one system being a model of another in terms of identity of structure and behaviour at a given level of observation.

The next seventy pages of the book are devoted to practical methods of modelling, primarily using analogue and digital computers and using logical networks. The discussion of computers concentrates on the organisation of the machines themselves and the basic ideas of programming. Programming languages more complex than machine code are given only a single paragraph, and Monte Carlo methods about a page. A simple form of time-sharing is briefly described, as is the concept of a Turing machine.

This is followed by a long discussion in general terms of the meaning of such words and phrases as 'decision making', 'goal seeking', 'communication', and 'consciousness', when applied to machines, and then two specific topics are treated at some length. The first is machine understanding of natural language. The authors propose graphical representations of sentence and text structure and indicate how a machine might answer questions and form abstracts by operations over these graphs. The second topic considered is the detection of moving objects in a visual field. The authors propose a simple method involving the matching of successive views. I feel that the authors' treatment of each of these topics contains little of interest for the informed research worker, and yet is too special to serve as an introductory text. No actual experimentation is mentioned.

The final chapter of the book is an unimpressive excursion into what one might call 'Science Fiction philosophy' concentrating on the difference between animate and inanimate systems, and on the future of man and robots.

In sum, I find this book more suitable for the collector of curios and for the graduate student with time and interest to spare than for the research scientist, or the person requiring an introduction to cybernetics. However, it is often thought-provoking, and has a large bibliography with many useful references to work in the U.S.S.R. and elsewhere.

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