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BOOK REVIEWS

Constantino Arce, *Escalamiento multidimensional. Una técnica multivariante para el análisis de datos de proximidad y preferencia. [Multidimensional scaling. A Multivariate technique for the analysis of proximity and preference data]*, Barcelona: Promociones y Publicaciones Universitarias, 1993, pp. 146.

This small monograph is in the spirit of the Sage series on Quantitative Applications in the Social Sciences (yes, those little green books). Although Arce (1993) has about 50% more pages than the Sage books, the book's much larger typesetting yields about as much available space as Kruskal and Wish's (1978) *Multidimensional Scaling*, and somewhat less space than Arabie, Carroll, and DeSarbo's (1987) *Three-way Scaling and Clustering*. How does Arce's book compare to these two with which it shares evident similarities? Well, although both Sage books devote considerable space to applications, Arce's book certainly beats them in being a "hands on" monograph. He devotes 25% of his book (39 pp.) to describe computer programs and provide examples of input files for most of them. Then he uses another 25% to present detailed examples of nonmetric multidimensional scaling (MDS) applications, whereas only 26 pages sketch the MDS models and algorithms.

Arce's book is organized as follows. After an introduction (Chapter 1), he presents in Chapter 2 a simplified version of Coombs's (1964) theory of data, followed by the presentation of such concepts as ways, modes, conditionality, and scales of measurement. In Chapter 3 he presents the "classical" MDS models for proximity data: Torgerson's metric scaling, Shepard

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and Kruskal's nonmetric scaling, the INDSCAL model of Carroll and Chang, and Ramsay's MULTISCALE models. Chapter 4 is devoted to MDS of preference data. Chapters 5 and 6 are respectively devoted to examples of applications of MDS to proximity and preference data. The final chapter introduces software for fitting the models and examples presented previously. The programs discussed include: MULTISCALE-II, ALSCAL, MAPCLUS, SINDSCAL, and PREFMAP, along with SPSS (used for property vector fitting) and FMATCH (used for assessing the congruence of scaling solutions in cross-validation samples).

Viewed as a cookbook-type monograph, Arce's account omits two topics. First, Arce assumes all along that the researcher has used a sampling design that will provide a matrix of similarities or preferences directly (e.g., pairwise judgments of dis/similarity). However, researchers frequently collect two-mode data and wish to transform them into a matrix suitable for analysis by the procedures described in the monograph. Arce does not discuss such a possibility, nor does he offer guidelines on how to proceed in such cases. Arce's emphasis is, of course, very much in the spirit of Shepard (1962a, 1962b) and Kruskal (1964a, 1964b), but readers interested in going from two- to one-mode matrices can consult Coxon (1982, Ch. 2).

Second, Arce is obviously fond of the goodness-of-fit tests yielded by Ramsay's models but does not emphasize that such goodness-of-fit indices are only correct if the models' distributional assumptions are met. Moreover, Arce does not provide any suggestions as to how to perform the necessary model checking.

In summary, Arce's book is a solid, scholarly, accurate, and well-written monograph that will prove very useful to applied researchers wishing to learn MDS over a weekend, and who just wish to learn the essentials needed (a) to choose an appropriate model for analyzing data, (b) to select the most suitable software for the analysis, and (c) to interpret the results correctly.

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J. Skrzypek and W. Karplus, Eds., *Neural Networks in Vision and Pattern Recognition,* World Scientific, 1992.

Artificial neural networks are currently enjoying an envious level of popularity across a broad spectrum of human endeavors, and the field of vision and pattern recognition is no exception to this phenomenon. In addition to a large body of conference and journal papers, several books, mostly edited volumes, have appeared on artificial neural networks in pattern recognition and vision in recent years. While a few of these edited volumes have a constant theme running through all chapters, most of them generally tend to be a hotchpotch collection of chapters and usually fail to present a balanced picture of the field to readers. Unfortunately, the present volume belongs to the latter category of edited volumes.

The book is based on a collection of papers that appeared in the special issue of the *International Journal of Pattern Recognition and Artificial Intelligence* (Vol. 6, No. 1, 1992). There are a total of 10 papers in the volume, covering a wide range of topics. The papers can be basically divided into two groups. The first group of papers, consisting of the first two contributions in the book, focus on the use of artificial neural networks towards the understanding of human perception of patterns. The second group of remaining eight papers is mostly concerned with the machine perception of patterns.

The first paper, Lightness Constancy From Luminance Contrast by J. Skzypek and D. Gunger, examines the lightness constancy phenomenon (Herring 1920) that permits visible surface perception under conditions of varying illumination. The focus of the paper is a neural network model that adaptively controls light sensitivity at the sensory level to account for lightness constancy. The second paper, Bringing the Grandmother Back into the Picture: A Memory-Based View of Object Recognition by S. Edelman and T. Poggio, deals with the problem of three-dimensional object recognition. Specifically, the authors describe a recognition scheme for wire-frame objects that makes use of a library of views, assembled during training, to perform recognition. Instead of storing the views in pictorial form, they are stored as weights of a generalized radial basis function network. It is an approach which, in the past (Freeman and Chakravarty 1980, Sarvarayudu and Sethi 1983) without neural learning, has given promising results. With the

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incorporation of neural learning to store relevant views, it is expected that memory-based object recognition schemes will become popular again.

The emphasis in the second group of eight papers is more of engineering flavor. The first paper in this group and the third paper of the book, Internal Organization of Classifier Networks Trained by Backpropagation by D. F. Michaels, addresses one of the often-asked questions about backpropagation networks, i.e., how do the networks organize themselves internally during training to capture the training environment? The empirical results of this paper suggest that the hidden units of a trained backpropagation network function as difference operators rejecting features shared by all input patterns. The fourth paper of the book, System Identification with Artificial Neural Networks by E. R. Tisdale and W. J. Karplus, approaches system identification as a pattern recognition problem. The authors suggest the use of a vector quantizer classifier to determine the model for a system based on system response and claim that their technique can be used as a preprocessing step for variational techniques for system identification (Ljung 1987). The fifth paper by D. Sutter, Mixed Finite Element Based Neural Networks in Visual Reconstruction, presents an analog neural network implementation of a regularization technique for visual reconstruction. Regularization techniques (Poggio and Girosi 1990) have become popular in computer vision for early processing where the problems such as shape from shading and optic flow are ill-posed. Analog neural networks have a lot to offer here and in fact, some very interesting work by integrating analog neural networks with sensors is being done at several places. The next paper, the sixth of the book, is by V. Atalay, E. Gelenbe, and N. Yalabik and is titled, The Random Neural Network Model for Texture Generation. It presents an approach for natural texture synthesis whose computational cost appears less than that of other texture synthesis approaches such as Markov random fields. The seventh paper, Neural Networks for Collective Translational Invariant Object Recognition by L.-W. Chan once again addresses the problem of object recognition. However this paper only considers two-dimensional or flat objects but the objects are allowed to overlap. The eight paper, Image recognition and Reconstruction Using Associative Magnetic Processing, by J. Goodwin, B. Rosen and J. Vidal presents an interesting and novel technique for implementing a Boltzmann machine neural network using magnetic thin films and opto-magnetic control which is then used to solve the image recognition and reconstruction problems. The ninth paper, Incorporating Uncertainty in Neural Networks, by B. Kammerer is concerned with the issue of noisy and imperfect measurements. It is an issue that has not received its due attention in the neural network literature despite the fact that most real world situations involve uncertainty in measurements. The tenth and the final paper of the book, Neural Networks for the Recognition of Engraved Musical Scores, by

P. Martin and C. Bellisant truly presents a novel application of neural networks. A multilayer perceptron network is used for image segmentation. It is followed by standard image analysis and a decision tree scheme to perform final classification.

While the broad range of topics within vision and pattern recognition covered by the ten papers in the book demonstrates the appeal of the neural network paradigm, the utility of having such a diverse range of topics in a book is questionable as it lessens the book's usefulness for most readers, who are generally interested in getting more material on a smaller number of topics. Furthermore, the book does not contain any chapter on several important vision topics such as motion and stereo, nor does it have chapters that address classification, clustering, and feature selection and extraction issues. It would have been far better if the editors had incorporated several more chapters in the volume to provide a complete coverage of the important topics from vision and pattern recognition. In that case, the value of the book would have been much greater. As it is now, it only has a limited utility and appeal.

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J. Eliashberg and G. Lilien, Eds., *Handbook in Operations Research and Management Science: Marketing,* New York: Elsevier, 1993, pp. xiv + 895.

The plethora of handbooks currently available in the statistical and behavioral sciences would be daunting even to a ten-handed Natraj. Is the publication of yet another (expensive) one justified? In the present case, the answer is a resounding YES! The project began most auspiciously with the choice of editors, who both have extensive editorial experience and are also highly distinguished contributors to quantitative techniques in marketing.

These editors assembled a virtuoso group of contributors who are generally *the* leading researchers in the areas covered by their respective chapters. This review will focus only on the four (of eighteen) chapters covering methodology relevant to this *Journal.* For a more comprehensive and substantively motivated review, see Putsis (1994).

Chapter 5, ''Non-spatial Tree Models for the Assessment of Competitive Market Structure: An Integrated Review of the Marketing and Psychometric Literature,'' by DeSarbo, A. K. Manrai, and L. A. Manrai, is a comprehensive review of the development and application of ultrametric, additive tree, network, tree-unfolding, and other clustering approaches to market structure. The substantive introduction, the general organization of the material, and the level of technical depth are all excellent. This chapter alone would justify the high price of the volume.

Chapter 10, ''Conjoint Analysis with Product-Positioning Applications,'' by Paul Green and Abba Krieger, is yet another of those authors' masterful papers on conjoint analysis (e.g., Green and Srinivasan 1990a, 1990b; Green and Krieger 1994). Although this chapter is not as technically demanding as the one just discussed, it is nonetheless extremely comprehensive and offers the reader many details on how leaders in the field conduct applications. The didactic style which has made Green such a successful author of textbooks and monographs is well in evidence here.

Lee Cooper, the author of Chapter 6, ''Market-Share Models,'' acknowledges that the material relies heavily on the book by Cooper and Nakanishi (1988). The chapter is interesting, but I refer the reader to Thompson's (1990) review of the book for detailed discussion.

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Chapter 2, "Explanatory and Predictive Models of Consumer Behavior," by J. H. Roberts and G. L. Lilien, includes a brief overview of methodology for representing perceptions of and preferences for products. No one will be surprised to find multidimensional scaling (MDS) included here, but citing (p. 49) a 15-year old comparison between ease of use for MDS versus factor analysis and an uncritical reference (p. 50) to Fishbein's work on attitude formation seem very passé. Although correspondence analysis is mentioned, up-to-date references are lacking.

The last points notwithstanding, the book is a triumph, and the editors have certainly surpassed their hope (p. 22) that "these chapters will define the state of the art for at least a few years to come."

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P. J. Coughlin, *Probabilistic Voting Theory*, New York: Cambridge University Press, 1993, pp. 252

The book is devoted to the analysis of political equilibria in an election model. The reason for such a study stems from the fact that political decisions in democratic countries are quite stable, whereas election models based on a majority rule imply a different interpretation, that is, except in rare cases, any policy is replaced by alternative policies in the next election, meaning disequilibrium in politics.

In his book, P. Coughlin analyzes spatial voting models that satisfy the binary version of Luce's axiom. An important premise is the assumption that there is an inherent unpredictability about voters' choices in the minds of candidates, and the central questions addressed by the book are: i) Given the unpredictability of voter behavior, can candidates devise optimal strategies to secure votes? and ii) What strategies will candidates actually adopt in their pursuit of votes?

Chapter 1, "Majority Rule and Models of Elections," contains an exhaustive review of the literature on majority rule, voting, and political equilibrium.

Chapter 2, "Income Redistribution and Electoral Equilibria," develops and analyzes an election model in which the candidates' strategies are redistributional reputations. In the model considered, each candidate selects a reputation for the distribution of income that can be expected if the candidate is elected. The existence of equilibria of two alternative ways of formulating candidates' expectations about voters' choices is analyzed.

Chapter 3, "Properties of the Redistributional Equilibria," analyzes the nature of redistributional equilibrium for a logit model of the candidates' expectations. In particular, it is proved that there is always a unique equilibrium, given a simple procedure for finding the precise location of this equilibrium where the sum of the voters' utility functions is maximized.

Chapter 4, "A More General Election Model," deals with the further generalizations of the model considered in Chapters 2 and 3. It is shown that there need not be either a unique equilibrium or convergence of the candidates' strategies. The earlier concept of the location of the electoral equilibrium is therefore generalized to the concept of an electoral outcome.

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Moreover, an implicit social objective function that is maximized by the set of electoral outcomes is identified.

Chapter 5, "Concave Social and Candidate Objective Functions," investigates the model that results from dropping the assumption that each group's scaling function is necessarily concave. The primary focus is on identifying more general assumptions that assure concavity properties for the implicit social objective function identified in Chapter 4.

Chapter 6, "Directional, Stationary, and Global Electoral Equilibria," generalizes the election model of the preceding chapter in two ways: (i) the new model allows much greater flexibility in the specification of the number of groups in the electorate and the distribution of voters across groups; (ii) the set of possible locations for the candidates is not assumed to be convex. In this chapter, a distinction is made between the global concept of an electoral equilibrium studied in previous chapters and the notion of an equilibrium on the margin. The idea of candidates simultaneously making their decisions on the margin is formulated as a directional game. This chapter's theorems provide global existence and location results for a significant subset of the class of elections in which there is a compact set of possible locations for the candidates and the candidates also use a C^1 binary Luce model.

Chapter 7, "Epilogue," contains a summary of Chapters 2-6 from a methodological standpoint. Specifically, the broad significance of the results established is discussed, focusing on (i) the existence of political equilibria, (ii) the maximization of implicit social welfare functions by these equilibria, (iii) normative interpretations of the implicit social welfare maxima, and (iv) future applications of election models.

Thus the book proves the existence of political equilibrium under rather general assumptions. In a sense, the studies on political equilibria are complementary to the studies on market equilibria, contributing to the understanding of mechanisms of contemporary democratic systems based on competitive economy. The book by P. Coughlin, one of the principal contributors to the probabilistic voting theory, can be recommended as an up-to-date monograph on the subject, containing both original results and well-annotated references.

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W. P. Krijnen, *The Analysis of Three-Way Arrays by Constrained PARAFAC Methods,* Leiden, DSWO Press, 1993, pp. 123.

This book considers constrained versions of the so-called PARAFAC model (Harshman and Lundy 1984), sometimes also called CANDECOMP (Carroll and Chang 1970, Carroll and Pruzansky 1984). PARAFAC is a generalization of principal component analysis for three-way data (Kroonenberg 1983) in which persons score on several variables on several occasions. Data from each occasion define a two-way slice that can be subjected to a traditional principal component analysis. The idea in PARAFAC is to analyze all such slices simultaneously using the same components. According to the PARAFAC model, the relative weights of these components may however differ between occasions. For example, current psychological theories in skill learning predict the same factor structure underlying performance with respect to simple skills before and after practice, but specific changes are expected in the relative weights of the various factors over the course of practice (Ackerman 1987).

In PARAFAC, there are three parameter matrices A, B, and C that contain the coefficients of the persons on the components, of the variables on the components, and of the occasions on the components, respectively. The book discusses constrained PARAFAC models defined in terms of different types of constraints on these parameter matrices as exemplified below (Kiers 1991). In each case, efficient alternating least squares algorithms are also provided, and there are many applications and small simulation studies illustrating the constrained models and their advantages.

There are several reasons for considering constrained PARAFAC models. Firstly, the constrained models are not subject to certain degeneracies that can occur with the original PARAFAC model. Secondly, although the PARAFAC components are unique under weak conditions, the surface spanned by the sum-of-squares loss function may be relatively flat so that different sets of components may represent the data almost as well as the unique least-squares solution. This phenomenon, termed weak uniqueness, is relatively likely to occur with small data sets and renders suspect the

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interpretation of any particular set of components. If a constrained model fits the data almost as well as the original PARAFAC model and leads to a different solution, evidence of weak uniqueness is found. Thus, a second objective for studying constrained PARAFAC models is to assess the extent of weak uniqueness. In addition, if the constraints are satisfied by the "true" components underlying the noisy data-generating process, the constrained model can be expected to yield more accurate and more stable estimates of the underlying components than the original PARAFAC model. Thirdly, the constrained models, being more parsimonious, are usually easier to interpret.

For example, in the domain of intelligence measures, variables are usually correlated positively and therefore span a so-called positive manifold. When analyzed with PARAFAC, positive manifolds are often represented by means of a component that contributes positively to each variable and additional so-called contrast components that have positive and negative coefficients on the variables. This is shown to be true even when the data set is generated from a model in which so-called non-contrast components have only nonnegative coefficients on the variables. Non-contrast components are often easier to interpret than contrast components. Krijnen therefore defines a constrained non-contrast PARAFAC model in which the elements of the coefficient matrices B and C as well as the covariances of components and variables are constrained to be nonnegative. Reanalyses of real data and simulation studies illustrate the enhanced interpretability of the non-contrast components obtained with this model.

Another interesting and useful constrained model is constructed with the confirmatory objective to show that the components underlying the three-way data are defined by given non-overlapping clusters of variables (Harshman and DeSarbo 1984): the coefficients of each variable on the components are zero for all except one predetermined component. While this model presupposes a hypothesis about number and composition of the clusters, a new exploratory variant is also developed that searches for an optimal cluster structure. Many other constrained models are considered that readers will find useful to address the general objectives explained above as well as more specific questions.

All in all, the book reviews existing and new constrained PARAFAC models. It provides precise summaries of relevant theoretical and algorithmic developments. The numerous applications to real data sets ensure, on the other hand, that the book will also be helpful for the investigator who is not interested in the technical background but merely wishes to use these methods. Clearly, the field is now developed far enough for a stochastic error theory to be called for: Hierarchies of nested models have now been defined so that it would be highly desirable to be able to evaluate the significance of differences in goodness-of-fit of these models.

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Fred Glover, Darwin Kingman and Nancy V. Phillips, *Network Models in Optimization and Their Applications in Practice,* New York: Wiley, 1992, pp.284.

The happy marriage between network theory and mathematical programming took place in the late 50s and has been blessed by innovative work, both theoretical and applied, ever since. Shortly after the discovery, in 1956, of the Min Cut-Max Flow theorem, by Ford and Fulkerson, Dantzig and Fulkerson and Elias, Feinstein and Shannon, a wealth of new and efficient algorithms were proposed for maximum static or dynamic flow, transportation, transhipment, network synthesis and many other problems. This first phase culminated with Fulkerson's (1961) "Out-of-kilter method" for minimum cost flows and the publication of Ford and Fulkerson's (1962) book *Flows in Networks.* While the problems solved were linear programs, it was clear that specialized network-based algorithms were more efficient than general LP algorithms in their solution. Also, the ease of formulating a large variety of problems (often without any underlying physical network, as, e.g. multiperiod production and inventory problems) in terms of network flows became apparent.

The next major advance took place in the 70s and was more closely connected to computer science and particularly the then emerging field of design and analysis of algorithms. The first generation algorithms, in which a set of mathematical rules were set down, were replaced by second generation algorithms, in which in addition the best data structures were selected for each step, and details of their use were specified. Computing times were drastically reduced. Although they barely mention it, the first two authors of this book played a crucial role in this endeavor (see Golden and Magnanti [1977] for references). Since then on Glover and Kingman, joined later by Phillipps, solved numerous practical problems of government and industry using network flow methods. In the process, they refined the algorithms and even more the modeling techniques. The present book is devoted to this last topic. As many books present network flow algorithms, only their use is discussed here (references to several excellent recent texts are given). The situation regarding books on modeling is the reverse: very few of them are

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available and, to this reviewer's knowledge, none except proceedings is entirely devoted to applications of network flow methods. So this book clearly answers a need. The authors coin the term *netform* for network flow-based formulation. A first introductory chapter details advantages of using netform, both methodological (ease of solution of very large problems on mainframes, of moderate-size ones on personal computers, possibility of interactive solution) and communicational (improved communication, model fidelity, sensitivity analyses and implementation of results due to the "visual content" of netform models). Fundamental models for pure networks are introduced in Chapter 2 and additional techniques for such models in Chapter 3: goal programming, modeling decreasing returns to scale and combined flow restrictions. Dynamic flow is taken up in Chapter 4 and generalized networks (or flows with multipliers) in Chapter 5. The less well-known uses of netform to model discrete requirements are studied in the last Chapter. Detailed case studies are provided throughout, often as a succession of increasingly detailed models. Numerous exercises are given. The style is clear and lively and the book carefully edited. It is likely to become a classic of modeling and operations research practice.

The question which arises is then "To what extent is network modeling relevant to specialists of classification?" No direct applications to classification are mentioned, although an example on solving large-scale personnel assignment problems for the military comes quite close. Connections between classification and network flow concepts and algorithms have been studied in the past by Hubert (1977) and Matula (1986) among others. The very clear presentation of netforms and their uses given here might suggest some novel ones.

Closing with an aside, one may recall Glover is the inventor of Tabu Search, and its main developer. This metaheuristic is very useful in clustering (and a recent outgrowth, the Ejection Chain technique most promising). So classification specialists should ask Glover to write a book on Tabu Search of as high quality as the one reviewed here.

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W. J. Post, *Nonparametric Unfolding Models. A Latent Structure Approach*, Leiden: DSWO Press, 1992, pp.206.

Topic of the Book

The scaling technique of unfolding has recently received considerable attention. Whereas the original model (Coombs 1964) was deterministic these recent approaches all pursue a probabilistic formulation of the unfolding problem. The latent structure approach presented by Post is suited for the analysis of dichotomous data that result from the presentation of n stimuli to N respondents. The stimuli are typically statements about political or ethical issues that correspond with levels of an underlying attitude or preference continuum. An example frequently cited in the book concerns 8 statements about capital punishment (for example, "Capital punishment is not an effective deterrent to crime"). Picking a statement means that a respondent agrees with it (score 1) whereas not picking it means disagreement (score 0). The respondents are allowed to pick as many statements as they wish (pick any/n). The 1-0 data are used to construct a unidimensional scale for the stimuli.

The model presented here rests on 5 assumptions: 1) existence of a latent trait (unidimensionality), i.e., each respondent is characterized by a position on the latent trait θ; 2) local stochastic independence of the responses of a respondent to the set of n stimuli. The other three assumptions pertain to the probability of picking a particular item i given θ, denoted $p_i(\theta)$; this is the trace line. The third assumption is that $p_i(\theta)$ is a weakly unimodal function of θ. Loosely stated, this means that the smaller the distance between a respondent's latent trait position θ and the stimulus location θ^i, the greater the probability that stimulus i is picked.

The first three assumptions are not sufficient to derive observable properties of the joint distribution of the observable scores on the n stimuli. Given that a model is pursued of which the properties hold irrespective of the latent cdf $G(\theta)$, two additional technical assumptions are formulated. They stipulate that the trace lines are characterized by total positivity of order 2 (TP_2) and total positivity of order 3 (TP_3), respectively. TP_2 is equivalent to stochastically increasing ordering in the latent stimulus location of the distribution of θ given that stimulus i has been picked. TP_3 is equivalent to unimodal ordering in the latent stimulus location of the probability that θ

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belongs to a fixed closed interval given that stimulus i has been picked.

The model is nonparametric because 1) the trace lines are subject only to order restrictions, and 2) the properties of the model hold irrespective of the distribution of the respondent parameter θ.

Contents

Chapter 1 contains a general introduction to unfolding theory for dichotomous data on the basis of Coombs' (1964) parallelogram model. Deterministic unfolding models with error theory are criticized because their scale criteria are based on a deterministic model or the null model of statistical independence. Statistical parametric models are criticized because the parametric choice of the trace line may be unnecessarily restrictive for empirical data. Therefore, the preference is for a nonparametric statistical model which is less restrictive than parametric counterparts, whereas the response process that generates the data is statistically modeled.

Chapter 2 contains the formulation of the general unfolding model outlined above. From the model, two matrices with observable statistics are derived. These are the $n \times n$ conditional adjacency matrix (CAM) which has elements $P(i \mid j)$, the proportion of respondents that pick row stimulus i given that column stimulus j was picked, and the $n \times n$ correlation matrix of the stimuli. Given the ordering of the items on the scale, the proportion of respondents picking stimulus i, and provided that the 5 model assumptions hold, these matrices show a particular arrangement that can be used to evaluate the fit of the model to the data.

In Chapter 3, a statistical test is derived for the hypothesis that the arrangement of each row (corresponding to a stimulus) of the CAM under the 5 model assumptions is valid against the alternative that it is not. Testing procedures are derived for investigating the unimodality of trace lines and for investigating whether or not the maximum of a trace line appears where it is expected on the basis of the arrangement of the CAM. It is noted that the test is conservative under the null hypothesis and lacks power under the alternative hypothesis.

Chapter 4 uses simulated data to study the CAM as a diagnostic tool for model-fitting. The sample correlation matrix is neglected here because it seems less effective for this purpose. The sensitivity of several diagnostic statistics that express violations of the arrangement of the CAM is investigated under several conditions, for example, respondent distributions and form of the trace lines. The diagnostic statistics are affected by the choice of the respondent distribution, and are approximately the same for the strong (all 5 assumptions) and the weak (dropping TP_3) model. The deviating items detected by the statistics predominantly have inverse unimodal trace lines. One of the diagnostic statistics is more effective than the others.

Chapter 5 deals with the statistical aspects of the scalability coefficient H that was proposed in the nonparametric unfolding model MUDFOLD (van Schuur 1984). Van Schuur (1984) defined such coefficients for stimulus triples, individual stimuli, and sets of n stimuli. Post derives the conditional mean and variance of each of these coefficients under the null model of statistical independence and presents a statistic for each of them that asymptotically has a standard normal distribution.

In Chapter 6 several empirical data sets are analyzed by means of the diagnostics that were developed in this book. Because the approach advocated in the book assumes a known stimulus ordering but does not provide a scaling procedure to find such an ordering, MUDFOLD is used to determine an order of the stimuli from each of the data sets. Results are compared with results obtained by means of the error theory MUDFOLD model (van Schuur 1984) and the parametric PARELLA model (Hoijtink 1991).

Finally, Chapter 7 is devoted to a discussion of a few topics that have not been treated in the book, such as ordering of respondents and defining an unfolding model for polytomous stimuli.

Personal notes

This book provides a valuable contribution to probabilistic unfolding theory. Rather than choosing a particular parametric formulation for the trace line, the conditions for unfolding and for deriving observable consequences from a set of minimal assumptions are explored.

A few critical notes are in order. First, the book deals exclusively with the investigation of the characteristics of the stimuli. The estimation of a respondent ordering is not discussed. Second, much attention is given to the scale coefficient H which was originally proposed in a deterministic context with error theory (MUDFOLD). Although a hint is given (p. 194) about the relation between H and the unimodal trace line family proposed here, it would be useful to know more about it. Third, the simulation study used as deviant stimuli two extreme cases of unimodal trace lines (horizontal and Rasch) which are, however, allowed by the model, and the inverse unimodal trace line, which seems highly unrealistic in practical data sets. The strength of the results might have profited from the addition of presumably realistic deviant trace lines such as irregularly shaped (two or more local maxima and minima) trace lines. Finally, in several places (e.g., pp. 36, 37, 138) proofs are withheld because they are believed to be either too simple or too complex for explicit exhibition. I would have preferred to have the simple proofs and at least an outline of the complex ones.

Despite these minor notes, the book is a pleasure to read because of the many useful contributions to unfolding theory. In addition to rigorous theoretical results, the application of these results to empirical data receives much attention. Several results have been incorporated in a commercially available computer program. I can recommend the book to anyone who is interested in unfolding theory and, more generally, in scaling by means of latent structure modeling.

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Journal of Classification 12:157-158 (1995)

O. Opitz, B. Lausen, and R. Klar, Eds., *Information and Classification: Concepts, Methods and Applications,* Berlin: Springer-Verlag, 1993, pp. xi + 517.

This book contains refereed versions of 52 of the over 160 papers presented at the 16-th Annual Conference of the Gesellschaft für Klassification e.V., the German Classification Society. The meeting was held in April, 1992. All of the papers are in english.

This annual volume has grown rapidly in recent years and offers a diverse collection of interesting papers in many areas of classification and clustering. The participants were from many countries, so that this compilation is international in nature. The collection is organized as follows.

I. Data Analysis and Classification (25 papers)
Classification methods, fuzzy classification, conceptual analysis, mathematical considerations, multidimensional scaling, various methods for data analysis.

II. Information Retrieval, Knowledge Processing and Software (14 papers)
Information retrieval, neural networks, expert systems and knowledge processing, computational linguistics, software.

III. Applications and Special Topics (13 papers)
Sequence data and tree reconstruction, data analysis and informatics in medicine, thesauri, archeology, musical science, psychometrics.

The number and diversity of the papers prevents any discussion of more than a few. The following are among those that might be of interest to many of our readers and give some idea of the range of topics in this volume.

At one end of the spectrum, Critchley and Van Cutsem is one of the more mathematically "intense" papers. They present mathematical generalizations of dendrograms and hierarchies, and bijections between these structures and sets of dissimilarities. They believe that this unifying theory will "open a wide range of methodological advances: such as the ability to treat multi-attribute dissimilarities, the possibility to study the asymptotics of

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hierarchical cluster analysis, the introduction of asymmetry and the facility to extend to multi-way data.''

Heiser, in ''Clustering in Low Dimensional Space,'' introduces a procedure and associated algorithm for combining cluster analysis and various problems in multidimensional scaling. In particular, he describes clustering of variables rather than objects and combines this with scaling. This paper is interesting not only for the methods it describes, but also for the clear presentation of the ideas it contains.

One of the topics of current interest represented in the collection is the relationship between neural networks and classification. Ultsch, for example, has two papers discussing self-organizing neural networks. The first integrates neural networks with a rule-based expert system. The neural nets are used to extract regularities out of case data, so that the ability of the expert system to deal with incomplete cases is enhanced. The second uses neural nets to map high dimensional data onto a two dimensional surface in three dimensional space, so that topological relationships (e.g., dissimilarities) among the objects produce topographical structures such as mountains and ''walls'' on the surface, allowing one to classify the input data visually.

Artificial animals have been used for years to test taxonomic classification methods. Among the more famous are Caminalcules (Camin and Sokal 1965). Wirth, in one of the papers in Part III, discusses whether these artificial animals even have a phylogeny similar to that of real organisms. He proposes an alternative, the ''Didaktozoa,'' which he believes to be an improvement on Caminalcules.

These papers are not really representative or necessarily the best of those appearing in this volume. I can safely say that the collection is worthwhile for anyone interested in classification methods. The articles range from the theoretical to the very applied and offer something for everyone, particularly those interested in information organization and retrieval. The graphical presentations alone provide valuable tools for researchers in any area of classification and clustering.

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