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BOOK REVIEWS
Editor: Niels Keiding

1. *Gerhard H. Fischer and Ivo W. Molenaar* (*eds*), Rasch Models. Foundations, Recent Developments and Applications.

2. *G. Arminger*, *C. C. Clogg and M. E. Sobel* (*eds*), Handbook of Statistical Modeling for the Social and Behavioural Sciences.

1. RASCH MODELS. FOUNDATIONS, RECENT DEVELOPMENTS, AND APPLICATIONS. Gerhard H. Fischer and Ivo W. Molenaar (eds). Springer-Verlag, Berlin, 1995. No. of pages: 436. Price: DM 88. ISBN: 0-387-94499-0

1. INTRODUCTION

Around 1900 Spearman invented factor analysis, a technique to analyse two-way tables of numbers using a simple multiplicative model. In 1918 Fisher invented analysis of variance, a technique to analyse two-way tables of numbers with simple additive models. Around 1960 Georg Rasch invented an equally simple additive model to analyse two-way tables of binary responses. All three inventions have been very successful, and have been generalized in almost all conceivable directions. In fact, in many cases the generalizations have been so thorough that the original contribution can hardly be recognized any more, and so far-reaching that in the process many of the simple data analytical properties of the original proposal were destroyed.

Of course, there is a considerable difference in the impact of the three innovations. Analysis of variance, generalized to the linear model, dominates classical applied statistics. Factor analysis has dominated psychometrics for a long time, but the field is now in disarray and the technique has been discredited by sloppy mathematics, grandiose claims, and sleazy applications. The Rasch model has generated a much smaller industry. It is, as it were, the responsible, green version of factor analysis. Most of the Rasch work is done in Scandinavia, in Germany, in Austria, and in the Netherlands, with some relatively minor branches in England, Australia and the U.S. Not too many people are actively involved in the research, and, certainly, the group was somewhat sectarian, and very convinced they were doing the Right Thing. As in the case of factor analysis, this has been somewhat counterproductive, but, unlike factor analysis, this problem now seems to be resolved. Statisticians like Andersen, Holland, Haberman, Clogg, Pfanzagl and Lindsay have placed the Rasch model solidly in the statistical mainstream, and their work has shown to people outside the inner circle how beautiful and interesting the Rasch model is.

2. THE MODEL

In case you have not been introduced yet, the model in its simplest form is developed for a table of binary variables, such as we find for example if a number of individuals try a number of test items, or if a number of politicians vote on a number of issues. The model says that individual v is characterized by a single parameter ξ_v and item (or variable) i by a single parameter ε_i. The probability that individual i gives a positive (yes, correct) response on item v is

$$\text{prob}(x_{iv} = 1) = \frac{\xi_v \varepsilon_i}{1 + \xi_v \varepsilon_i}.$$

Moreover, all elements of the table are independent. This makes it possible to write down a simple product of Bernoulli likelihoods, and the usual statistical machinery seems to apply. However, unfortunately it does not, because the number of parameters increases with the number of individuals. Solutions to the problems that are created by this fact use, and illustrate, much of modern

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statistics. The theories of incidental and structural parameters, of partial sufficiency and conditioning, of random parameters and marginal likelihood, and of semi-parametric models have some of their simplest and most convincing examples in the Rasch model literature.

It almost goes without saying that the model has been extended to multivalued (polytomous) responses, to incomplete data, to time-series data, and so on. With each generalization, some of the beautiful simplicity of the basic model disappears. A few of the generalizations seem to be motivated by the same type of reason Sir Edmund Hilary gave for climbing Mount Everest: because it is there. Nevertheless, the basic intuition of Rasch goes a long way, and is very much worth studying by all statisticians, theoretical or applied.

3. THE BOOK

As I mentioned above, the early history of the Rasch model is somewhat peculiar. This was partly due to Rasch himself. He was a very capable mathematician, and possibly a good philosopher of science, but he certainly was not a statistician. The strangeness of the history was also partly due to the fact that the model initially fell into the hands of psychometricians, who are, again, outside the mainstream of statistics. They reacted to the model in two different ways. Their first reaction was technical; they tried to integrate the model into the common framework of factor analysis and latent structure analysis. This solidified its position in psychometrics, but it also emphasized how strong and unrealistic the model was in many situations. The second reaction was to form a Rasch sect within psychometrics that was doing the Right Thing. That the model usually did not fit the data very well was handled with classical Hegelian bravado (umso schlimmer fuer die Wirklichkeit), or with Wolfle's recipe to save the Spearman model (if we remove all triads that violate the two-factor model, then the remaining triads will satisfy the two-factor model). Again this attitude did not make the Rasch model acceptable for organizations such as ETS and ACT, which were by their very nature not deeply interested in doing the Right Thing.

The statisticians I mentioned above were an important factor in making the Rasch model more well known and more respected (in the same way as Lawley and E. B. Wilson made factor analysis more respected). They were motivated partly by psychometric-type problems, and partly by finding nice examples of dealing with nuisance parameters. I think the book edited by Fischer and Molenaar, which I am supposed to review here, nicely illustrates both the peculiar history and the modern acceptance of the model. On the one hand, the book is overcomplete and heavy-handed in places. It is true that the Rasch model is interesting, but it is not *that* interesting. On the other hand, the book is well-written and very comprehensive.

The introductory Chapters 1 and 3 by Molenaar are beautifully done. In Chapter 3 the various estimation procedures for item parameters are explained clearly and in considerably detail. Chapter 4 by Hoijtink and Boomsma does the same for the person parameters. The philosophy of science emphasis of Rasch, which I find both fascinating and infuriating, obviously inspired Chapter 2 by Fischer, which has various axiomatic derivations of the model. Chapter 5 by Glas and Verhelst and Chapter 6 by Klauer discuss model tests and other forms of model criticism. Chapter 7 by Timminga and Adema is rather specialized. It discusses discrete programming method to construct optimal item banks of Rasch items.

One easy way to generalize a basic model is to impose restrictions on the parameters. This is done in Part II of the book, on extensions of the basic model. We can, for instance, add a linear model for the item difficulty parameters. This is the linear model discussed in various forms, in Chapters 8, 9 and 10 by Fischer and by Verhelst and Glas. Hoijtink discusses linear models for the person parameters in Chapter 11. Verhelst and Glas discuss relationship with other latent trait models in Chapter 12, while Forman's Chapter 13 links the Rasch model with latent class analysis. Chapter 14, by Rost and Von Davier, analyses mixtures of Rasch models.

Part III of the book discusses polytomous models, in which the assumption of binary responses is relaxed. Erling Andersen, bearer of the cloak of Georg Rasch, gives a beautiful introduction and overview in Chapter 15. Gerhard Fischer generalizes his earlier axiomatics, and the previous ideas on mixtures, tests of fit, and linear design matrices are extended to polytomous responses as well. Each of the chapters is an admirable overview of the literature, and the author(s) then add original research.

The last chapter is special. Its title is 'What Georg Rasch would have thought about this book'. It is written by Erling Andersen, and it is intimately linked with the special history of the Rasch model. I cannot imagine a book on survival analysis with a chapter 'What David Cox would have thought about this book'; it is easier to imagine a book on Dianetics with imagined comments by L. Ron Hubbard. The chapter is a delight, of course, and it emphasizes how strong the personal influence of Rasch is, even though probably very

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few of the contributors ever met him (he died about 20 years ago).

4. SUMMARY

To quote Andersen: 'Generally, I believe that Georg Rasch would have been very pleased with the book – even proud to see the amount of scientific work on a high academic level which has been carried out concerning the Rasch model over the last 15 years.' I do not know if Georg Rasch would have been pleased. I have my doubts – but I must say that I was very pleased with the book. It is a solid, comprehensive, and generally excellent treatment of a fascinating approach to measurement. Sociologists of science may want to find explanations why the small group of dedicated followers doing the Right Thing developed in this way, and why there are so many of them in the Netherlands (probably because we Dutch specialize in doing things the Right Way), but ultimately, what counts is that the group produced an excellent product in a mainstream statistics series, telling us in glorious TeX all there is to know about the model introduced by Georg Rasch in 1960.

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2. HANDBOOK OF STATISTICAL MODELING FOR THE SOCIAL AND BEHAVIORAL SCIENCES. G. Arminger, C. C. Clogg and M. E. Sobel (eds), Plenum Press, New York, 1995. No. of pages: 592. Price: $59.50. ISBN: 0-306-44805-X

This volume consists of ten review articles by different authors of statistical subfields, which are commonly applied in social and behavioural sciences. There are sections on causal inference, missing data, mean structures, covariance structures, contingency tables, latent classes, qualitative variables, event histories and random coefficient models.

The ambition of the articles is generally very high. The style and mathematical content differs very much between the articles, probably because there are different authors. Characteristic of all articles is that they are very much fitted to social and behavioural science applications and the common practice for statistical work in these sciences. This applies to the choice of material in the articles as well as to the choice of fields treated. This means that the interest is more directed to analyses of epidemiological data than to analyses of data from designed experiments. Thus for example there is no content of experimental design and there are no non-parametric methods, to mention a few missing central subjects. There is not even a section on time series analysis, which has very many applications in modern economics and ought to be of interest also in social sciences.

To mention something about the separate articles, there is, for example, a nice and thorough discussion of causal inference by Michael E. Sobel. It is easily read and yet it has a lot of content. Also the section on random coefficient models by Nicolas T. Longford is a nice general discussion. It has a suitable mixture of verbal formulation and mathematical descriptions and I think that this article gives a good view of the presented subfield.

The article on analysis of event histories by Trond Petersen presents purely parametric specific models. Nothing is said about semi-parametric Cox regression models and the view of the problem is rather narrow. This is a typical example of the restricted selection of material in the book, with concentration on a number of methods which have found application in social science. However, it also restricts the use of the book outside social and behavioural sciences.

Another example indicating that the book is devoted to the statistical methods commonly used in the social and behavioural sciences, appears in the article on panel analysis for qualitative variables, concerned with categorical and ordinal data. It has numerous references, but standard statistical references like Alan Agresti's books *Analysis of Ordinal Categorical Data* and *Categorical Data Analysis* (Wiley 1984 and 1990) are not given. This indicates how a statistical subfield can live its own life in an area of application without more intensive contact with the main stream of statistical theory.

The chapter on regression models by Gerhard Arminger and the one on contingency tables by Michael E. Sobel are well written general reviews of these basic subfields. These have a general view and do not suffer from the restricted view mentioned before.

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