Bookreviews

Applied Multilevel Analysis by *J.J. Hox, TT-Publikaties, Amsterdam, 1994, pp112, NLG 25 or $15, ISBN 90 801073 2 8*

As multilevel modelling becomes more widely used, there is clearly a need for texts which explain why the models are important and how they work, without going into too many technical details. Hox's short book sets out to meet this need for social scientists. The introductory chapter is followed by chapters on multilevel regression models, working with different multilevel packages, applications of multilevel modelling to meta analysis as a way of introducing models for proportions, and finally a chapter on multilevel structural equation modelling. All the exposition is restricted to two level models.

The selection and ordering of the material is a little curious at times. For example, the potentially confusing topic of centering is introduced very early in the first chapter, whereas the important notion of 'shrinkage' of level two residuals is not discussed at all. Also, the chapter on multilevel structural equation modelling is perhaps a little difficult for beginners.

On the whole, the methods are presented accurately. However, it is not true to say (p.14) that the level two variance necessarily rises with the value of the explanatory variable when slopes are random (it depends on the sign and size of the covariance term). And it is generally not advisable (p.17) to judge the importance of random effects by comparing their values with their standard errors (examining differences between the likelihood statistics are more appropriate).

Supplied with the book, there is a disk which contains the example data and some utility programs. Social science researchers new to multilevel modelling could find this book useful, although, if they became regular users, they would need to supplement it with one of the more advanced texts. (*Ian Plewis*)
(Order can be made through authors by email: a716hox%hasara11.bitnet@sara.nl or fax: 31 20 5703500)

Multilevel Statistical Models by *Harvey Goldstein, London:Edward Arnold, New York: Halsted, 1995, pp178 , price £29.99,ISBN 0 340 59529 9*

Introduction

This book is formally the second edition of Goldstein's *Multilevel Models in Educational and Social Research*, which appeared in 1987. But since 1987 many things have changed. The title, for one thing. The book also *looks* very different, because it is now in the prestigious *Kendall's Library of Statistics*, published by Edward Arnold. The first part of the book is still fairly close to the first edition, but the remainder is more or less completely new. Thus the contents of the book are also very different. We shall treat it, consequently, as a new book, and not as an upgrade of an existing one. The book has a wealth of new material.

The multilevel market place has changed since 1987. Goldstein's first edition was the first book on multilevel models, but in the meantime Bryk and Raudenbush, *Hierarchical Linear Models*, and Longford, *Random Coefficient Models*, have appeared. We shall compare the three works at various places in the review, in order to answer the all-important question for which audience this book is intended.

Basics

We shall first review the book in its role as an expository book on multilevel models. Which audience is it aimed at ? The preface and the first chapter are not completely clear on this, and actually throughout the book there is some ambiguity. Each chapter has appendices with ``technical" material, but unless I am mistaken, the set of people who *can* read and appreciate the main chapters and who *cannot* read and appreciate the appendices is not large.

The introductory chapter is clear, although characteristically short. It discusses, as is usual in books of this type, the ubiquity of hierarchical data, the promise of multilevel models, and the wide variety of existing statistical techniques that can be converted to multilevel versions. There is a section on caveats at the end of the chapter, but this is (also characteristically) even shorter than the other sections.

Chapter 2, which is the core of the expository part of the book, discusses the linear multilevel model. One interpretation of it, is that it tries to condense to 20-30 pages what Bryk and Raudenbush discuss in 200 pages and what Longford discusses in about 150 pages. It fails at this impossible enterprise. A more plausible interpretation is that the chapter defines the notation and terminology, plus some of the basic ideas and problems having to do with algorithms, assumptions, testing, and diagnostics.

A corollary of this analysis of Chapter 2 is that the book is not useful as a textbook on multilevel analysis, even at the graduate or postdoc level. If you want to learn about linear multilevel models, this is not the book for you. Statisticians familiar with variance components analysis, and educational and behavioural statisticians who are already familiar with the multilevel literature, can get quite a bit of mileage out of the chapter, because in a compact form it gives them the necessary background to tackle the remaining chapters.

By the way, the word ``compact'' describes much of the book. The amount of information crammed in these pages is astounding. Obviously, a more or less complete treatment of all these topics would require a book of, say, 1000 pages. This is why I think the book is perhaps largely *programmatic*, it gives entries into many additional publications where details are worked out, and it promises a lot of additional research on these topics. Chapter 2, for instance, has a one-page appendix on the EM-algorithm and a one-page appendix on Gibbs sampling. This is just enough to provide one of two references, and a very global idea what these terms refer to, but anybody interested in these matters still has a lot of work to do before they even understand the basics.

Extensions

It is clear that Goldstein thinks of the multilevel idea as a very general one, as indeed it is. If hierarchies are everywhere, then existing statistical models should be adapted to hierarchical data. It must be emphasized that, on the model level, this is a fairly straightforward process. Implementing such a technique is not trivial, however, and making it work in a truly satisfactory way may be quite difficult. The problem with all these extensions and generalizations is that the basic linear multilevel model already has some serious and largely unsolved problems. Most parametrizations tend to be badly conditioned, likelihood functions are flat, and consequently estimation can be problematic. Vendors of software can afford to ignore these problems, but statisticians cannot. If a person is both a vendor of software and a statistician, then this person has a problem. It is not enough to get carried away by all the analyses we can now do with our new software, indeed this is not the statisticians job at all. We have to analyze critically what the properties of the new techniques are, and if they are presented in batches, in a staccato tempo, it becomes very difficult for a statistician to do her job properly.

A first batch of extensions

In the 20 pages of Chapter 3, we encounter complex variance structures, sampling weights, parameter constraints, resampling standard errors, meta analysis, and aggregate level analysis.

Only the first topic gets more than cursory attention. It is based on the observation that first-level residual variances can be modelled in much more detail than is usually done. Indeed, this is a major research topic in regression analysis and generalized linear models. In the spirit of multilevel analysis, we can incorporate first level predictors directly into the first level disturbances. This is easy to do with the MLn software, and the examples are quite interesting, but the full implications of extending the multilevel models in this way are not well understood.

Multivariate Models

In this very short chapter it is pointed out that the multilevel linear model can be extended, in much the same way as the ordinary linear model, to deal with multivariate responses.

Nonlinear Models

Some nonlinear examples of the growth curve type are discussed, by using linearization. The chapter is sketchy, but it appears that experts can indeed handle such nonlinearities in the existing framework.

Repeated Measures Data

The books of Bryk and Raudenbush and of Longford give a lot of attention to repeated measures data, because this is an obvious area in which to apply the linear multilevel model. Goldstein incorporates the possibility of autocorrelated errors, with a quite general autocorrelation function. This gives rise to an enormous number of possible models, of which only a tiny number are illustrated in the example on adolescent growth. It also gives rise to quite a few additional model-choice problems, and these are (characteristically) left not discussed.

Discrete Response Data

We know, from GLM, how to extend linear models so that they can deal with discrete response data. It is most easily done through using a link function. This chapter is a fairly extensive discussion of the various link functions, with applications to counts and multiple responses. Again the treatment is rather sketchy, but less so than in other chapters.

Multilevel Cross Classification

If the data are not purely nested, but the second level is a cross-classification of, say, school and neighbourhood, then of course the multilevel model has to take this cross-classification into account. There is a nice discussion in the book about such designs, and how they translate into variance components. Then cross-classified design are combined with complicated variance structures, and with multivariate data. This is an example of a recurring theme: if you introduce an extension, it can be combined with all previously introduced extensions. This goes without saying, but nevertheless Goldstein says it in various places. This produces a heavy emphasis on the generality, the enormous amount of possible models. It does not emphasize the flip-side of the coin, which is the very serious model choice problems and the possible lack of stability.

Event History Models

Event history models are, or used to be, quite popular in sociology and economics, and they seem to be gaining popularity in education. They are introduced in a couple of pages, and then hierarchies are used to introduce variance components in here as well. This chapter is quite interesting, although it has the usual problem of not telling the reader why particular choices were made, and how a particular analysis was actually done. At least not precisely. Many of Goldstein's examples in the book are not, to use a currently popular term, *reproducible research*. We don't have enough information.

Measurement Errors

Measurement errors can create havoc in ordinary linear model situations, and of course they can do this even more so in multilevel situations. This chapter gives a number of formulas and corrections to deal with measurement error in the covariates at both levels. It is difficult to get the feeling for a general approach to these problems from the chapter, but it seems that there is quite a bit of ongoing research that will clarify the details.

Software and some loose ends

In the last chapter there is a nice unbiased summary of the available multilevel software, although for some largely mysterious reason Goldstein feels that it is necessary to slip in a few more extensions even in this chapter. In general, I want to emphasize that Goldstein's treatment of the multilevel market place is eminently fair. There has been a tendency, especially in the US (of course), to sketch the development of the field as a Darwinian battle between competing software products. Goldstein systematically refuses to

enter the fray, and gives major credit to Aitkin, Longford, and others. He barely mentions his computer program, in fact not enough for my taste, because it would be interesting to know how some of the extensions were actually done.

Summary

It is important to emphasize that Goldstein's book does not stand on its own. It is one of the products of the *Multilevel Models Project*, which also produces the computer programs *ML3* and *MLn*, the manuals corresponding to these computer programs, and a stream of both theoretical and applied papers on multilevel analysis. This must be emphasized, because to some extent Goldstein's book reflects the current state and the further research program of the Multilevel Models Project. Thus it can be read both as a progress report, and as a programmatic document. In both these roles it is useful and well-executed. Taken as a whole, of course, the Multilevel Models Project is an impressive effort indeed, and it can serve very well as a model how quantitative educational and behavioural research should be organized.

But, as is perhaps obvious from this review, I have my doubts about the unrelenting expansive approach to multilevel analysis, which looks for generalizations and extensions everywhere. There are quite a few examples in the applied statistical literature of elaborate buildings that have crumbled because the foundations were not solid enough. To use a well-known statistical metaphor, we cannot go on reducing bias by defining more and more elaborate models without seriously jeopardizing the stability of our analyses. It is not clear, from the few examples presented in the book, how useful and how stable these generalizations will be. It is clear, however, that the Multilevel Models Project will provide us with a great deal of additional information about these issues in the future. (*Jan de Leeuw)*

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