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HLM 6

The columnists of my hometown newspaper are pictured every week next to their columns. One columnist, the reviewer of restaurants, is pictured wearing a hat with its large brim turned down so that you cannot see her face. That is how I felt when I made some inquiries with the distributor of the hierarchical linear modeling (HLM) software for multilevel modeling that is the subject of this review (HLM 6 software), knowing that I would be writing this review afterward.

One basis for evaluating commercial software is service, so I took note of my encounters with the distributor, Scientific Software International (SSI), when I purchased an upgrade from the previous HLM version. SSI is not Amazon; after Googling "HLM software" to make the purchase, I did not see a way to use a credit card and a secure Web form. But faxing an order form obtained from the SSI Web site seemed OK. When my software package did not turn up in my mailbox, I phoned and reached a human immediately—no interminable hold as you get with local utility companies. The service representative helped me track the order with UPS and such, and his hypothesis was right: The package was kicking around the university. A few weeks later, I thought I had found a bug, so I tried e-mailing the support address with a description. Not only did I receive a response within 24 hours, but the troubleshooter complimented me on the inclusion of screenshots in my description. In reviewer parlance, score four out of four stars for service.

The HLM software has evolved a lot over the past decade or more. It started as a DOS program, in which the user input for commands and specifications consisted of lines in a text file, each line stating a parameter followed by its value. As the Windows interface became prominent, SSI created a user interface with now-familiar pull-down menus and information entry screens or windows. Based on these entries, HLM apparently generates lines of text (in the form of parameter:value) that are still the basis of program control (telling, for example, where to find the data and the nature of the data). This approach has pros and cons. While setting up an analysis using the entry screens, it is possible to go back to the main menu and view/edit the controlling lines of text. Sometimes, variations on analyses can be set up more quickly by editing this text, and troubleshooting can be facilitated. One downside is that you must close that text file before doing anything else. This can be confusing because in most other Windows applications, you can click around from window to window, essentially multitasking. Not in HLM; if you do not close that window, when you go back to the main HLM screen, the program just hangs and you think you have encountered a bug (at least I did).

This quirk is the kind of thing that is soluble in principle with redesign and reimplementation, sweeping away the DOS legacy (e.g., implementing a text editor that is integral to

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HLM instead of using an external editor, Notepad). But SSI is not Microsoft. Presumably to do this and to make some other desirable improvements in look and feel (such as more reliable screen rewriting in certain circumstances) would require expensive programmer time, which would ultimately be reflected in the product price and viability for its specialized market. Actually, the program does so many things so well that it rates four stars for value.

While retaining the overall look and feel of earlier versions, the newest version's changes to the top-level menus are an improvement, placing options generally in a more logical order and structure (File—Basic Settings—Other Settings—Run Analysis—Help). For example, under Basic Settings, it is more prominent now that the program can estimate multilevel model parameters not only for continuous data but also for counts, dichotomies, and so forth. Under Other Settings, the user can control such things as whether the maximum likelihood estimation will be "restricted" or "full." Default choices for all necessary parameters are, of course, in place on program startup.

Like before, under the top-level menu bar, the top-level window has a right-hand pane showing equations to be estimated and a smaller, left-hand pane for displaying variables for any selected level of analysis (allowing their inclusion, or not, in equations). Another useful addition to this version is the "Mixed" button under the equations, which displays the expansion of the level-by-level equations (always displayed) as a single, mixed-level equation. For example, it can be worthwhile to examine the mixed equation to ensure that for all cross-level interactions, the individual components are also in the equation. (This requirement to include lower-order terms can be overlooked by the user when working with the default display.)

Something that has not changed, unfortunately, is the entry screen for making a new data file for use by HLM. Although HLM 6, like its predecessors, can import data from SPSS, SAS, and some others, the process of data analysis begins by creating a data file in HLM's own format (now using the suffix .mdm). This is understandable in part because identifiers must match up among levels of analysis, and the process of creating the .mdm file establishes these linkages. However, new users had better read the documentation for creating the .mdm before they "try this at home." The locations of elements on the screen do not coincide with the documentation-recommended (and often necessary) order of user actions, necessary to complete the blanks and to mark the checkboxes in this complex screen. I found it best to start by filling the blank at the top right, then jump to the left middle, and so forth.

Fortunately, the documentation (Raudenbush, Bryk, Cheong, & Congdon, 2004) is quite good. It contains a lot of useful screenshots (there—I have returned the compliment) and otherwise contains a great deal of useful information. Moreover, it dovetails nicely with the textbook treatment (Raudenbush & Bryk, 2002) of multilevel modeling by two of the developers of the software, Anthony Bryk and Stephen Raudenbush. (Another developer for some earlier versions is Richard T. Congdon, Jr.; Yuk Fai Cheong is now listed as a further author on the documentation.) For example, in using the software with count data, the documentation helped me to understand material in the text through further explanation and examples. Complete online documentation comes with the program, and a hard copy manual can be purchased separately. There is a package deal for the program, manual, and text as a complete set.

The new version goes well beyond "look-and-feel" revisions to incorporate even more forms of analysis and supporting features. Most of those forms are over my head, but I used to feel that way about multilevel modeling itself (first for continuous and then count data). For nonstatisticians like me, the incorporation of ever more complex forms of analysis provides

an opportunity at least to learn about these forms in a way that some of us cannot accomplish without hands-on experience. These forms include "cross-classified random effects models for linear models and nonlinear link functions." Enough said about that!

The program functionality has been improved first by revamping the graphing capabilities. In previous versions, graphing directly within HLM seemed more bother (and buggy) than it was worth. But the one X-Y-Z graph that I tried in the new version was a breeze to produce and even showed me I had obtained the kind of cross-level interaction that I was after. However, I am not sure yet whether I will be able to get presentation-quality graphs this way. The export format that is available is not the easiest to edit. At worst, this convenient graphing feature can tell users quickly the form taken by obtained interactions; it can also provide a check for graphs formed, for example, by using a spreadsheet program to generate predicted values of the outcome at specified values of the predictors (combined with the parameter estimates in spreadsheet equations). A lot of other uses of graphs (e.g., examining residuals) also appear to have become available or practical.

The program also has greater capability for incorporating sample design weights in more kinds of models and at more levels of analysis. This is important, for example, when data are based on probability sampling in complex designs (e.g., cluster sampling) and projection of findings from the sample to the population as a whole is of interest.

Other features, essentially for convenience, include direct saving of residual files in formats readable by standard statistical packages. This is a good timesaver and error prevention measure. Previous versions of HLM could get flummoxed by large values (e.g., millions of dollars) as the value of a variable. One hopes this fixes this.

Expansions and other changes to complex software of any kind usually mean there will be bugs or other errors someplace. SSI has done a good job over the years of providing software patches to update existing software. Registered users are notified of new patches, and the downloading and installing of patches is straightforward and is assisted by third-party tools as necessary. Some of the past errors, though very specific, sounded more than worthwhile to fix through patching. In short, if you use HLM software, you should keep up with the patches. One past problem regarding patches has been the delay between release of a new version of SPSS (a general statistical package often used for input to HLM) and release of a patch allowing HLM to read the new version's data file format. Some users have resorted to outputting data from the statistical package as text and then giving HLM instructions to read text data. An alternative is to tell one's statistical package to save the data in an older file format for that package or in another package's format (e.g., SAS transport format saved from SPSS); then HLM will be able to read it. I have addressed other, mysterious data reading failures of HLM similarly, by outputting a SAS transport file from SPSS for reading by HLM. It works for me.

In at least one respect, the new look of the version 6 interface took a step backward in clarity. The attempt was to show optional error terms in a very light font when they are omitted from a model and in the regular font when included. (Previously, an omitted error term just did not appear at all. The point of the change must be to make the user aware of the omission or optional inclusion of the term.) However, on both my laptop and desktop computer, the very light font is not light enough. Consequently, when I indicated to the software that I wanted to exclude an optional error term, I wondered why my exclusion of that term had not "taken." Actually, it had taken; I just could not see the difference between the regular and light font. Maybe brackets ([ ]) should be used for that purpose instead. Maybe a patch is coming for this?

In another respect, the interface designers were thoughtful in both senses of the word. Some three-level models involve multiple observations within individuals (e.g., across time) at level 1 and some grouping of those individuals (e.g., by classrooms) at level 2. If your models are of this kind of data, you get used to pi symbols at level 1 (e.g., capturing trends over time) and beta symbols at level 2. Previously, if you switched to a two-level model, still with multiple observations within individuals, you were stuck with beta symbols where you were accustomed to seeing pi symbols. Now you get your choice of pi or beta in a two-level model by making a selection with a radio button in one of the HLM interface's entry screens. This feature also promotes correspondence between the software output and the examples of these two kinds of models in the Raudenbush and Bryk (2002) text that was mentioned earlier.

As with the previous edition of the software, a slimmed down version is available for free as the student version. Its main limitation is in the number of effects that can be estimated, such as five effects maximum at any given level of analysis. (It also has limitations on *N* of cases.) Nevertheless, it appears to be very well suited for use in courses that teach multilevel modeling because every student can have ready access to all of the regular program capabilities. It comes with extensive examples and online documentation, just like the regular version.

Multilevel modeling can be accomplished with some other tools (such as appropriate SAS modules and MLwiN). I have not been motivated to learn to use those tools. HLM can do a lot of things and is well documented and well supported. Over time, as it incorporates more of the common and useful designs (HLM, HGLM, HMLM, and HCM2 models), there has been less need to use more flexible (but less structured and less user-friendly) approaches such as SAS modules. The main limitation of HLM may be the number of levels of analysis that it can handle (maximum of three). However, the more I learn about multilevel modeling, the more complexities I come to understand about the three-level model. For example, it may be necessary to violate convention and not trim certain nonsignificant, highest-order error terms (level 3 U-terms) when retaining related lower-order error terms (level 2 R-terms), so that the lower-order error terms are truly pertinent to their own level of analysis. I doubt I could keep track in my mind of everything going on in a four-level or higher-level model. I almost hope that a future HLM 7 does not offer a generalization to any number of levels of analysis.

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