Software Review

HyperStat: A Statistical Toolbox for the Macintosh

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HyperStat: Macintosh hypermedia for analyzing data and learning statistics (Hypermedia)

By David M. Lane. 1993, New York: Academic Press Professional. \$59.95.

Over the past 10 years, the availability of statistics programs for personal computers has greatly increased. A number of researchers have progressed from relying on statistical packages that require "batch input" of jobs necessitating arcane programming languages to far simpler packages with user-friendly interfaces. These program improvements have come about in part as a result of technological advancements of computers. At its introduction, the Apple Macintosh was not well-suited for statistical applications, but more recent models have changed the situation considerably. Programs such as Statview II (Abacus Concepts, Berkeley, CA) exemplify the coupling of statistics, technology, and human-computer interfaces that should now be expected of all statistical packages.

In light of the advancement of statistics packages, it is in some ways surprising that instructional techniques have, in general, lagged behind. In many major universities statistics courses are taught through lectures and by asking students to generate laborious computer programs to analyze data. Part of the reason for the discrepancy between teaching methods and practical applications may be tradition, but there has also been a lack of software to bridge the gap. Fortunately, change has arrived.

The Advent of Hypermedia

The use of the term *hypermedia* is becoming increasingly more common. It describes electronic media that are connected by an array of links between concepts (cf. Schneiderman, 1992). In some ways, hypermedia resemble books, but they hold far more possibilities. One key difference between hypermedia and books is that books are intended to be read in a specified sequence. In the case of textbooks, authors may arrange chapters so that they stand independently, but there is still an inher-

ent order within each chapter. Hypermedia does not impose an order, though the user may specify one. Another difference is that it is not easy to refer to related material within a book: The reader must consult an index and find appropriate entries. Hypermedia allows users to explore links among concepts more easily and thus learn, search, and organize in ways that are unique to each user.

A recent and very popular implementation of the hypermedia is HyperCard, a product produced by Apple computer and distributed with every Macintosh computer (for a discussion, see also Bingham, 1990). HyperCard uses the metaphor of a stack of cards containing information. The cards and the information that they contain are connected through invisible links that the user can activate as needed. Each card contains different information. Although HyperCard allows users to create their own programs, or "stacks," for their own needs, a variety of commercial stacks may also be used.

Hypermedia, and HyperCard in particular, are well suited for teaching purposes. Stacks that allow students to explore concepts and refresh their memories for faded definitions allow each student to progress at his/her own pace and construct his/her own "microcosm" in which to learn. Thus, unlike books in which the order of topics is prescribed and the alteration of this order is fairly effortful, hypermedia gives students the capability to roam freely through the knowledge available within the stack.

HyperStat

David Lane of Rice University, aided by Academic Press, has taken the revolutionary step of creating an all-purpose statistics "tool box," called HyperStat, which was created with HyperCard. It is difficult to provide a simple description of HyperStat because it is a multifaceted product. However, a rough, and somewhat arbitrary, division may be made between its use as a teaching tool and as an analytical package (even though the two are related). Although HyperStat is an instance of hypermedia, it is accompanied by a helpful 128-page user manual that covers the principles of use, brief descriptions of the major topics that are covered, and a guide to the statistical procedures that are implemented.

Teaching information. HyperStat provides solid coverage of the standard topics covered in general books

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on psychological statistics, including sampling and probability distributions, binomial distributions, descriptive statistics, hypothesis testing, confidence intervals, testing differences between means, between- and within-subjects analysis of variance, correlation, multiple regression, effect size measures, post hoc tests, non-parametric tests, and power analysis. Each of the 18 major sections also includes problem sets with answers and explanations to provide review.

As a teaching tool, HyperStat provides an interactive way for students to approach statistics. On the main card, HyperStat provides a table of contents of topics, as well as a list of important keywords. The user can immediately go to any of these topics or keywords by clicking on them with the mouse. For example, a starting point might be descriptive statistics. If this section is selected, introductory material will appear. At this point, other topics can be explored. Numerous graphs and examples throughout all the sections of HyperStat help clarify the information. The explanations of concepts and analytical techniques are well presented and have links to appropriate procedures that actually perform the analyses, as I will discuss below.

The analytical procedures are integrated with the didactic material through the use of simulated data in Explorations, which are provided for each of the major subject sections. To use an Exploration, one first reads the discussion of the analytical section pertaining to the Exploration. A benefit of the Explorations is that changes can be made to the data and the effects of these changes can be viewed immediately. This capability allows "hands-on" observation of how changes in data affect statistical analyses.

In itself, the ability to select a topic and see the material related to that topic is not unique to HyperStat. However, at this stage the flexibility of hypermedia also becomes apparent. Because the basic premise of hypermedia is that the user is free to explore a body of information according to his/her own needs, important terms are followed by an asterisk. To find out more information about a given term, the user merely clicks on the word; HyperStat then displays the relevant section that is linked to the word. The user can repeat this process many times, yet can still return to the starting concept. Similarly, the user can jump to appropriate procedures simply by selecting them.

Admittedly, it might appear easy to "get lost" within the information. That is, after navigating through a maze of topics, how does one remember where one was or how one got there? This problem is addressed through the implementation of electronic "bookmarks." After a bookmark, the user can find the location by clicking on the Go to Bookmark button on the main card. Another helpful navigation tool is the Find command, which facilitates searching for topics or terms. The user can click on the desired occurrence of the term or topic to view the relevant material.

As with any text, many readers may want to annotate the material. HyperStat provides a convenient way to accomplish this by providing the ability to make notes for each topic. The user's notes may be searched through a HyperStat-generated index or the Find command. The notes can also be exported to a text file or immediately printed. A small checkbox at the top of the screen indicates whether any notes have been entered for that particular screen of information.

An example of HyperStat navigation. Because HyperStat provides a unique approach to statistics, I will provide a brief example of how a user might explore the topic of power. On the main card, shown in Figure 1A, the user could click on Definition under the topic of power. The first of three cards explaining the meaning and definition of power will then be presented, as is shown in Figure 1B. To navigate through these cards, the user need only click on the arrow in the middle of the bottom portion of the screen. On any of the three cards, the user can click on words with an asterisk next to them for more information. For example, on the card shown in Figure 1B, the user could click on "Type II error" to explore this topic. Returning to the card on power is done by clicking on the curved arrow in the lower right corner of the screen. After reading the cards on power, the user could choose to proceed to an exploration that causes the power procedure to appear with sample numbers, as in Figure 1C. All of the parameters affecting power can be altered and the results immediately computed again. By graphing the power curve, the user can overlay the results of different manipulations and directly compare their effects on power across different sample sizes.

Statistical analyses. HyperStat covers and implements a fairly wide array of statistical analyses. Although many textbooks provide excellent coverage of statistical material, none provides electronic access and immediately accessible analyses. HyperStat provides analytical procedures for almost all the topics that are covered.

Statistical procedures in HyperStat are implemented on their own cards, as is shown for multiple regression in Figure 2. The procedures provide a way to analyze real data. A very nice feature of the procedure cards—one that fits nicely with educational purposes—is that each value in the field may be clicked on for further reference. For example, in Figure 2, one can click on any of the terms next to an asterisk (such as R^2 , β , s_b , t , or p) to see the card with the corresponding information.

The statistical procedures in HyperStat serve a useful purpose for education, but they also allow students to spend more time learning statistics as opposed to attempting to master more complex statistical packages such as SAS or SPSS. Because all the procedures allow users to import text files, HyperStat can serve as a statistical package that easily meets the needs of undergraduate courses and beginning graduate level courses.

Figure 1. Panel A shows the main card; panel B, the first of three cards that include a discussion of the definition of power; panel C, the power procedure card.

HyperStat Procedures

GO TO PROCEDURE | Notes | Print Results | Print Card

Multiple Regression

☐ Save predicted and residuals

Dependent is item: 3

R*	0.6837
R ² *	0.4675
R ² adjusted*	0.4522
Ssq total*	2301.0411
Ssq predicted*	1075.6271
Ssq error*	1225.4140
F(2,70)*	30.7218
p*	<.00005

Variable	β^*	Coefficient*	S _y *	t*	p*
Intercept	0	13.89101	2.21191	6.28010	<.00005
item 1	0.10441	0.14324	0.13259	1.08032	0.2837
item 2	0.63220	0.44908	0.06865	6.54159	<.00005

DATA

21.50, 13.25
20.25, 30.42
15.00, 29.28
22.50, 13.24
16.50, 8.20
16.00, 25.26
17.25, 16.24
26.00, 22.29
10.50, 8.19
20.00, 29.21
20.00, 11.21

Compute

MAIN Find Copy all Small

Figure 2. The card in which data are entered for the multiple regression procedure. After data are entered or imported, clicking the Compute button provides an estimate of the parameters.

Although HyperStat is not a substitute for a comprehensive statistical package, I should mention that it does include what is quite likely to be the most straightforward way to carry out power analyses in existence. After the estimates of the necessary population parameters and sample sizes have been entered, a power estimate is provided. In addition, HyperStat will plot the changes in power for different sample sizes from the specified parameter estimates. This feature can be extremely useful in experimental design, and especially in grant preparation.

Several analytical features of HyperStat are noteworthy. First, with respect to numerical calculations, HyperCard has sometimes been associated with less than optimal performance. HyperStat works around any performance lags by using routines known as XCMDs and XFCNs to perform many calculations. These routines are completely invisible to the user, but they greatly increase the speed of calculations through their use of machine language code. Second, HyperStat's *n*-way analysis of variance procedure allows repeated measures on more than one factor, in addition to testing simple effects in mixed designs.

Could anything in HyperStat be improved? As with the first edition of anything, hindsight tends to provide insight. For example, it would be nice to see expanded coverage of regression-related topics such as analysis of covariance and partial correlations, as well as procedures that implement these analyses. Along the same vein, discussion of analysis of variance and its relation to multiple regression would also be welcome. Finally, the coverage of post hoc tests could be expanded to pro-

vide a more comprehensive comparison of the common tests. Hopefully these issues can be addressed in future editions of HyperStat.

These points aside, HyperStat provides an excellent implementation of hypermedia on the Macintosh. It provides an approach to learning statistics at both the undergraduate and early graduate levels that is both appropriate and enjoyable. In addition, it provides analytical procedures that can import and analyze data from actual experiments.

A final question is whether HyperStat can replace a textbook. For undergraduate level courses, the answer is a resounding "yes," because no book could match HyperStat's interactive approach, which blends presentation of didactic material with the ability to perform statistical analyses. For early graduate level courses, HyperStat would be appropriate, but it does cover material that is often included in more advanced courses in research-oriented graduate programs. Regardless of whether HyperStat is used as a replacement for a textbook, it covers a broad range of topics and, especially with the advances in portable computing, provides useful analytical procedures.

Equipment

HyperStat will run under System 6 or 7, on at least a Macintosh Plus with a minimum of 4Mb of RAM. HyperStat itself will run with approximately 1Mb of RAM, but performs better with 2Mb. Macintoshes with a math coprocessor will provide increased computational speed. A hard disk is necessary, and HyperStat itself uses approximately 2.8Mb, exclusive of any added notes or data.

REFERENCES

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