Dolf Zillmann

Preface: GENERATING THE ANALYSIS OF VARIANCE FROM RULES

A long, long time ago - in 1969, to be precise - I was teaching research statistics to graduate students at the University of Pennsylvania. The advanced analysis of variance was one of the topics to be covered. Designs could become rather complex - say, a 7-factor factorial with 2 independent- and 5 repeated-measure factors, some fixed, some random - and students often were at a loss in constructing the various sources of variation together with the appropriate algebra. Text books cover the basic cases only; and so, at this time, did computer programs.

Needless to say, the algorithms that students do not see are really there, and the trick is to express them in a set of rules that students can readily comprehend. Fortunately, the teaching of Elisabeth Walther - and of Max Bense, to be sure - at what used to be the Hochschule für Gestaltung at Ulm had sensitized me to logical coherence, structural consistencies, and patterns below the surface; and I was able to detect and articulate simple rules for the analysis of variance, regardless of the complexity of the design. The rules are essentially combinatorical ones, with specific sort-out rules applied after exhaustive generations.

With these rules, students can construct any analysis of variance. What used to be the province of statistics professors - namely, to inspire awe in students and peers by filling the board with endless algebraic expressions - is now manageable by any student who follows the rules. And what used to make students shudder could now be fun. I recall, in fact, a few who gleefully invaded professorial territory by filling the board with formulas.

Well, the rules are detailed below in the original hand-out of the statistics courses.

Working with these generation rules had yet another and perhaps more significant consequence, however. Lacking computer programs that could handle complex designs, I computerized the rules. A program called GENOVAR was constructed that, in applying the same rules, generates the algebra of any analysis of variance and executes the computations. Imagine a 100-factor, a 1000-factor design! Interaction terms would be so complex that printing them out would produce miles of algebra. In even more cmplex designs, the print-out would span the globe. Surely, nobody would care to read the formulae. But somebody might be interested in the computation. And GENOVAR can handle it. It generates the appropriate algebra and executes all computations along with it. Since variance terms are complex sums, it executes and stores, goes on to the next portion, executes, sums, and stores, and so forth. This is to say that the program is capable of solving designs that are so complex that neither the algebra nor the associated arithmetic could be stored in computer memory. The program is virtually unrestricted. Neither algebra nor complex computations use up memory. All that it entails is a comparatively small set of rules that specify when to add, substract, multiply, or divide. The program knows, so to speak, the logic of the analysis of variance, and it can apply it to any given data structure.

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