—SOFTWARE ANNOUNCEMENTS—

New Software

PERM: A Double-Precision FORTRAN Routine for Obtaining Parallel Analysis Eigenvalues from Permuted Data

Parallel analysis (Horn, 1965) has been recommended as an accurate method of choosing the number of components to retain in principal components analysis, particularly for psychological item data. The researcher compares the eigenvalues from obtained data with the corresponding eigenvalues from one or more sets of random data with the same number of variables and observations, retaining only those components with observed eigenvalues greater than the corresponding eigenvalues from random data. Most implementations of parallel analysis are based on normally distributed data (e.g., Lautenschlager, 1989; Longman, Cota, Holden, & Fekken, 1989); however, individual items often have either skewed or discrete distributions. PERM is a FORTRAN computer program which overcomes this limitation by basing the comparison eigenvalues on permutations of the obtained data, thus eliminating the assumption of multivariate normality. It can perform principal components analysis of either correlation or covariance matrices, for any number of subjects or variables, and can provide any user-selected number of replications, providing both mean and specified upper-percentile eigenvalues. The program will read the data file, calculate eigenvalues for the observed correlation or covariance matrix, then calculate eigenvalues for the permuted data matrix (permuting the original data within variables). This procedure maintains the data distribution found in the sample, without assumptions about the population distribution, which is generally unknown. The number of possible permutations from even a small data set is enormous, so use of a random sample of permutations must be made. Researchers have commonly used 3 to 5 replications to obtain estimates of mean eigenvalues, and we have found that 40 replications provide good estimates of 95th percentile eigenvalues (Longman, Cota, Holden, & Fekken, 1991).

PERM is written in VS FORTRAN, with calls only to standard double-precision routines from IMSL Version 10 (International Mathematical and Statistical Libraries, 1987), although subroutines from other sources could be substituted if necessary. PERM also could be implemented on microcomputers, using either IMSL or other appropriate routines for microcomputers, but analysis of large data sets may be quite slow compared with analysis on a mainframe.

PERM, its documentation, and a trial data set are available free of charge either via Bitnet (holdenr@qucdn.queensu.ca) or as text files by mailing a formatted 5.25-in. diskette with a self-addressed stamped return mailer to Ronald R. Holden, Department of Psychology, Queen's University, Kingston, Ontario, Canada K7L 3N6.

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Dunnett-Like Multiple Comparisons Among Product-Moment Correlations

Although textbooks on experimental design in the behavioral, social, biological, and engineering sciences contain discussions of multiple comparisons, the focus is almost always on comparisons among means, and comparisons defined on other statistics, such as correlations or variances, are seldom mentioned. Perhaps because of this gap in standard textbooks, the major statistical computer packages (e.g., SAS, BMDP, SPSS, SYSTAT) usually do not include subprograms for simultaneous comparisons constructed on statistics other than the mean. A program is available for conducting "Dunnett-like" pairwise comparisons on a set of K independent sample correlations.

Levy (1973, 1975) introduced a technique for extending the Dunnett method of planned, nonorthogonal, pairwise comparisons on sample means to similar analyses on sample product-moment correlations and other statistics. In employing Dunnett's procedure in its standard form, each of the means of $K-1$ experimental groups is

compared with the mean of a control group. In using the Levy modification of the Dunnett test, each of $K-1$ independent correlations is compared with a standard correlation. Levy illustrated his method with a hypothetical example in which the product-moment correlation between age and scores on a test of abstract reasoning for a sample of North American children was compared with similar correlations for samples of children from three other cultures. Additional applications, such as those in a psychometric context involving validity coefficients or item discrimination indices, will occur to the reader.

The program elicits information regarding the number of samples, the common sample size (only equal n applications can be processed), the significance level, and the sample correlation coefficients. The monitor display of the information typed in makes it possible for the user to correct input errors. A normal deviate (z) is printed out for each of the $K-1$ comparisons, along with the z value required for statistical significance. Alpha levels of .10, .05, .02, and .01 are available for nondirectional tests of hypotheses, and these values can be halved to provide significance levels for directional tests. Joint significance levels are used for the entire set of $K-1$ comparisons. The program accommodates up to 10 independent samples, including the control or standard sample. The program is written in Microsoft QuickBASIC 4.5 and will run on IBM PC-compatible computers.

A copy of the program can be obtained by sending a 5.25- or 3.5-in. formatted diskette, together with a self-addressed, stamped mailer to Richard H. Williams, Department of Educational and Psychological Studies, P.O. Box 248065, University of Miami, Coral Gables, FL 33124.

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Tukey-Like Pairwise Comparisons Among Variances

All of the major statistical computer packages (e.g., SAS, BMDP, SPSS) contain subprograms for multiple comparisons on *means*. However, they usually exclude algorithms for comparisons defined on *statistics other than the mean*. A similar pattern is found in most of the standard textbooks in experimental design. This might lead one to conclude that the mathematical models for simultaneous comparisons among variances, product-moment correlations, or other statistics have not been developed. However, papers presenting procedures for conducting Scheffé-like, Dunnett-like, and Tukey-like comparisons

constructed on statistics other than the mean have appeared in the psychological literature (see, e.g., Levy, 1975, 1977; Marascuilo, 1966).

Spjøtvoll and Stolene (1973) introduced "extended Tukey procedures" for application to fixed effects analysis of variance when sample sizes were unequal. They recommended that these procedures be used by investigators interested in conducting pairwise comparisons among sample means. Levy (1977) showed that these "extended Tukey procedures" could be applied to pairwise comparisons defined on variances, proportions, and product-moment correlations.

Although measures of central tendency or location are usually used in connection with multiple comparisons, in some studies variability or scale may be more relevant than location.

In the behavioral sciences we sometimes expect that an experimental condition will cause some subjects to show extreme behavior in one direction while it causes others to show extreme behavior in the opposite direction. Thus we may think that economic depression and political instability will cause some people to become extremely reactionary and others to become extremely "left-wing" in their political opinions. Or we may expect environmental unrest to create extreme excitement in some mentally ill people while it creates extreme withdrawal in others. In psychological research utilizing a perceptual approach to personality, there are theoretical reasons to predict that "perceptual defense" may manifest itself in either an extremely rapid "vigilant" perceptual response or an extremely slow "repressive" perceptual response. (Siegel & Castellan, 1988, p. 156)

In research studies such as the above, analyses focusing on location rather than scale could be misleading.

The program enables the user to conduct pairwise comparisons on a set of K independent sample variances. The program prompts the user to input the number of samples, the sample sizes, the sample variances, and the significance level. The program displays the typed information so that errors can be corrected. Error trapping procedures are used so that interruptions during execution are minimized. The Studentized Q values, as described by Levy (1977), are printed, each of them representing the comparison between two independent variances. These observed Q values are then compared with a critical Q value. These tabled values, which appear in many experimental design textbooks, are included in the program. The program can accommodate alpha levels of .10, .05, .01, and .001 for nondirectional tests of hypotheses, and can handle up to 10 independent samples. Researchers requiring directional tests can halve these values. The program is applicable to analyses involving both equal and unequal sample sizes in the cells.

The program is written in Microsoft QuickBASIC 4.5 and will run on IBM PC-compatible microcomputers. A copy can be obtained free of charge by sending a 5.25- or 3.5-in. formatted diskette, together with a self-addressed, stamped mailer, to Richard H. Williams, Department of Educational and Psychological Studies, P.O. Box 248065, University of Miami, Coral Gables, FL 33124.