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All–possible–subsets for MANOVA and factorial MANOVAs: Alternative to the weekend project

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All-Possible-Subsets for MANOVA and Factorial MANOVAs:
Less than a Weekend Project

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ABSTRACT

Multivariate techniques are increasingly popular as researchers attempt to accurately model a complex world. MANOVA is a multivariate technique used to investigate the dimensions along which groups differ, and how these dimensions may be used to predict group membership. A concern in a MANOVA analysis is to determine if a smaller subset of variables may be used in the classification functions without any loss of explanatory power when precision of parameter estimates or parsimony needs to be addressed (cf. Huberty, 1984; Huberty & Olejnik, 2006). One way to address these concerns is through the use of all possible subsets. However, not all common statistical packages easily facilitate this analysis, and the analysis can be a weekend project (Huberty & Olejnik, 2006). As such, the purpose of the current paper is to examine and demonstrate R and SPSS solutions to conduct an all-possible-subsets MANOVA, including all-possible-subsets factorial MANOVA.

KEYWORDS

Descriptive Discriminant Analysis, General Linear Model, Multivariate Analysis of Variance, Weekend Project

INTRODUCTION

Multivariate techniques allow researchers to run one analysis on a set of variables and are extensions of the more popularly used univariate methods (Tabachnick & Fidell, 2013; Zientek & Thompson, 2009). By the early 1970s, the use of multivariate statistics had increased so dramatically that some claimed they would become the dominant analysis in the near future (Finn, 1974; Tatsuoka, 1973). Since that prediction, the growing complexity of contemporary psychology research resulted in an increased use of multivariate statistical methods (Tabachnick & Fidell, 2013). In education and psychology journals, implications from several reviews indicate that multivariate analyses are being applied in research studies (Elmore & Woehlke, 1998; Onwuegbuzie, 2002; Zientek, Capraro, & Capraro, 2008). We conclude that the advances in these methods will also result in an increase in the number of researchers who are conducting multivariate analysis of variances (MANOVAs).

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When conducting MANOVAs, initial model selection is important. However, when a number of variables are included in the model, parsimony may need to be addressed (Huberty & Olejnik, 2006; Thompson, 2006). A parsimonious model is a simpler model with the most explanatory power. Fortunately, the evolution of computer technology has increased the ability to address parsimony with methods once considered superior but difficult to conduct. The purpose of the current paper is to investigate and demonstrate two statistical packages that conduct a MANOVA and a factorial MANOVA with an all-possible-subset analysis. Huberty and Olejnik (2006) referred to this analysis as a weekend project because of the complexity and length of time that was required to complete the analysis. In the case of a single grouping variable, these packages are a viable alternative to problematic stepwise descriptive discriminant analyses (DDAs; cf. Huberty, 1994; Thompson, 1995).

MANOVA

Multivariate analyses are conducted when a researcher has a desire to consider group differences among several dependent variables simultaneously. A MANOVA is an extension of analysis of variance (ANOVA) in that, instead of examining if a variable depends on group membership, several theorized variables are examined simultaneously to determine if those variables depend on group membership (i.e., independent variable). Thus, a MANOVA is a multivariate analysis that allows researchers to address whether scores on a set of dependent variables differ as a function of a grouping variable (e.g., intervention, gender, race). When researchers decide to conduct a MANOVA, dependent variables are theoretically or empirically related and ideally both (Weinfurt, 1995). Advantages to conducting a MANOVA versus multiple ANOVAs is that a MANOVA (a) helps control for Type I error and (b) takes into account the pattern covariation among the dependent variables. As noted by Thompson (1991), one of the most important reasons for conducting multivariate methods, even more so than limiting the inflation of Type I error rates, is that "multivariate methods best honor the reality to which the researchers is purportedly trying to generalize" (p. 80).

Potential limitations to employing MANOVA are that MANOVA assumes multivariate normality, homogeneity of covariance matrices, and absence of outliers, which are more difficult criterions to satisfy than the univariate counterparts (cf. Tabachnick & Fidell, 2013; Weinfurt, 1995). However, MANOVA tends to be performed even when data violate the assumption of multivariate normality as MANOVA is considered to be a robust procedure (Weinfurt, 1995). When the homogeneity of covariance matrices assumption is not met, Type I and Type II error can be affected (see Stevens, 2009 for more detail). MANOVA is also highly sensitive to outliers and requires that researchers conduct a "test for univariate and multivariate outliers for each group separately, and transform or eliminate significant outliers" (Tabachnick & Fidell, 2013, p. 384). Linearity among the dependent variables is also assumed; however, Tabachnick and Fidell (2013) noted that violating the assumption is less serious and that the violations leads to reduced power. Note also that as with ANOVA, MANOVA assumes independent observations (Stevens, 2009; Weinfurt, 1995). In the case of dependent observations, researchers should consider an analysis that honors the clustered nature of the data (see Snijders & Bosker, 2012).

The popularity of ANOVA techniques in a univariate situation helped place the multivariate analysis of variance (MANOVA) in the spotlight as the multivariate extension of these methods (Bray & Maxwell, 1982). A MANOVA analysis does not, however, provide information on the nature of scores differ; for this information, researchers must turn to some type of post-hoc analysis. MANOVAs investigate multivariate effects and should be followed by a multivariate post-hoc analysis. Unfortunately, the practice of conducting multiple ANOVAs (i.e., univariate methods) as a MANOVA

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