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COMBINING INFORMATION IN LINEAR AND LOG-LINEAR ANALYSES

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In many applications of statistics the data from the current experiment or study is seldom all the information available on the quantities of interest. Often there is additional information and, although this is sometimes taken into account when designing the experiment or study, usually no attempt is made explicitly to combine the previous results with the current data. In this thesis a prior-posterior framework is used to develop a method for combining previous results with current data. This method is developed for two main classes of multivariate data: continuous responses from designed experiments and counts in multi-dimensional contingency tables.

The procedures described in this thesis use linear models for data from designed experiments and log-linear models for contingency tables. The linear model formulation which we have adopted is taken from a series of papers by Nelder. As this formulation is not widely used it is described in detail in Chapter 2 together with the associated analysis. For contingency tables we have adopted the general matrix formulation of log-linear models and an outline of this theory is given in Chapter 4. These chapters serve to introduce notation and to present the results of traditional analyses for comparison with the combined analysis procedures described in Chapters 3 and 5.

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The prior-posterior method for combining previous results with current data proceeds as follows. A statistical model is assumed for the current data and previous information concerning the parameters embodied in this model is represented by a suitable and convenient prior distribution. The posterior distribution or, more precisely, its mode and a measure of dispersion, are considered to be the combined results. Although a full prior distribution is assumed the choice of distribution is based largely on mathematical convenience and it is only the mean or mode and a measure of dispersion that is actually required. We view the method to be essentially a second order procedure.

Chapter 3 contains full details of the prior-posterior procedure for linear analyses of generally balanced designed experiments. Both the known and unknown dispersion cases are considered as well as the situation involving incomplete data. The joint and marginal posterior modes and measures of dispersion are seen to have meaningful and interpretable forms.

In Chapter 5 we describe the prior-posterior procedure for combining information in log-linear analyses of contingency tables. Results are given for tables having Poisson or (product) multinomial sampling schemes. The posterior mode is seen to be a compromise between maximum likelihood estimates under alternative log-linear models. Particular attention is given to logistic analyses of binary responses and to interaction analyses of high order tables.

The posterior summary statistics and the associated computations are discussed and compared with the traditional results. Also, full details are given of illustrative analyses using real data.