BREIMAN, L., FRIEDMAN, J. H., OLSHEN, R. A. and STONE, C. J. (1984). *Classification and Regression Trees*. Wadsworth, Belmont, Calif.

GNANADESIKAN, R. and KETTENRING, J. R. (1984). A pragmatic review of multivariate methods in applications. In *Statistics: An Appraisal* (H. A. David and H. T. David, eds). Iowa State Univ. Press, Ames.

JONES, M. C. and SIBSON, R. (1987). What is projection pursuit (with discussion)? *J. Roy. Statist. Soc. Ser. A* **150** 1–36.

KETTENRING, J. R. (1971). Canonical analysis of several sets of variables. *Biometrika* **58** 433–451.

Comment

S. James Press

I thoroughly enjoyed Mark Schervish's review of multivariate analysis, a subject that has been near and dear to me for many years. The review was written in a very light, free-flowing format that made it interesting and pleasant reading, while at the same time the points made were usually deep and insightful. I will comment generally on the Schervish review by offering my own perspectives on multivariate analysis, and then I will give a few brief specifics on his review. All comments will necessarily be brief but indicative of directions in which the field is moving.

A COMPARISON OF CLASSICAL AND MODERN MULTIVARIATE ANALYSIS

I would like to distinguish "classical" multivariate analysis (CMA) from "modern" multivariate analysis (MMA). I will do so on the basis of how they compare on various (randomly ordered) characteristics.

1. *Distribution theory.* In CMA, the theory derives largely from the multivariate normal and Wishart distributions. It also is concerned with the study of the distribution of latent roots of random matrices.

In MMA there is increasing focus on non-normal inference and distribution theory. It is based upon nonabsolutely continuous distributions, such as the mixed discrete and continuous distributions, or the mixed singular and absolutely continuous distributions, exemplified by the multivariate exponential distribution. Focus has shifted away from the latent root distributions because the models that require them have languished for lack of use.

2. *Estimation.* In CMA, the emphasis was on MLE and moment estimation. In MMA there has been a substantial shift in emphasis to Stein-type estimation, empirical Bayes estimation and Bayes estimation. This shift is natural with the improvements in multidimensional estimation achievable by using higher dimensional shrinkage estimators (for dimension greater than two) and by introducing subjective prior information into a problem in a formal way.

3. *Noncentral distributions.* In CMA, power calculations demanded the development of various noncentral distributions, such as the noncentral Student t and noncentral F distributions, the Hotelling T_0^2 distribution and the noncentral Wishart distribution, which arose in coefficient estimation for simultaneous equation systems.

In MMA a unified theory of noncentral distributions has developed around the theory of hypergeometric functions of matrix arguments, zonal polynomials and generalized distributions.

4. *Distribution theory of sample estimators.* CMA was deeply concerned with the distribution theory of sample estimators, although the introduction of the "bootstrapping" technique (Efron) and the technique of simulating complicated multivariate distributions by simulating functions of known distributions (Kass) have liberated modern multivariate analysts from their former distributional burdens of having to develop the distributional theory of complicated multivariate distributions.

5. *Discrete multivariate analysis.* CMA dealt with discrete data by means of traditional contingency table analysis, i.e., estimating cell probabilities by MLE.

MMA is more concerned with analyzing discrete data by using multivariate log-linear and logistic models; by using models involving ordered categories and by using both dimensions of a contingency table simultaneously to study categorical data, by means of "correspondence analysis."

6. *Factor analysis.* CMA was wary of the factor analysis approach and was concerned with centroid solutions, rotations, maximum likelihood factor analysis and exploratory factor analysis (rather than confirmatory).

MMA has become more accepting of the factor analysis approach. Today the emphasis has shifted to confirmatory factor analysis, Bayesian factor analysis methods and to nonparametric factor analysis

S. James Press is Professor, Department of Statistics, University of California, Riverside, California 92521.