Preface

The basic objectives that motivated the first edition of the book serve as the primary motivations for the second edition as well. While the original content of this book has been left essentially unchanged, this revision has been aimed at making the terminology used in the description of some basic mathematical concepts and operations more "up-to-date." This also makes this technical terminology more consistent with the usage now current in other fields and disciplines of study (e.g., mathematics, computer science, statistics, social and behavioral sciences, as well as marketing and business related sciences). A large number of these revisions occur in Chapter 5, "Decompositions of Matrix Transformations: Eigenstructures and Quadratic Forms," but can be found throughout the book.

The student willing to learn something about multivariate analysis will find no dearth of textbooks and monographs on the subject. From introductory to advanced, theoretical to applied, general to specific, the field has been well covered.

However, most of these books assume certain mathematical prerequisites—typically matrix algebra and introductory calculus. Single-chapter reviews of the topics are usually provided but, in turn, presuppose a fair amount of advance preparation. What appears to be needed for the student who has received less exposure is a somewhat more elementary and leisurely approach to developing the necessary mathematical foundations of applied multivariate analysis.

The present book has been prepared to help students with those aspects of transformational geometry, matrix algebra, and the calculus that seem most relevant for the study of multivariate analysis. Since the author's interest is in applications, both the material selected for inclusion and the point of view from which it is presented reflect that orientation.

The book has been prepared for students who have either taken no matrix algebra at all or, if they have, need a refresher program that is between a full-fledged matrix algebra course and the highly condensed review chapter that is often found in multivariate textbooks. The book can serve as a textbook for courses long enough to permit coverage of precursory mathematical material or as a supplement to general textbooks on multivariate analysis.

The title was chosen rather carefully and helps demarcate what the book is not as much as what it is. First, those aspects of linear algebra, geometry, and the calculus that are covered here are treated from a pragmatic viewpoint–as tools for helping the applications researcher in the behavioral and business disciplines. In particular, there are virtually no formal proofs. In some cases outlines of proofs have been sketched, but usually small numerical examples of the various concepts are presented. This decision has been deliberate and it is the author's hope that the instructor will complement the material with more formal presentations that reflect his interests and perceptions of the technical backgrounds of his students.

The book consists of six chapters and two appendices. Chapter 1 introduces the topic of multivariate analysis and presents three small problems in multiple regression, principal components analysis, and multiple discriminant analysis to motivate the mathematics that subsequent chapters are designed to supply. Chapter 2 presents a fairly standard treatment of the mechanics of matrix algebra including definitions and operations on vectors, matrices, and determinants. Chapter 3 goes through much of this same material but from a geometrically oriented viewpoint. Each of the main ideas in matrix algebra is illustrated geometrically and numerically (as well as algebraically).

Chapter 4 and 5 deal with the central topics of linear transformations and eigenstructures that are essential to the understanding of multivariate techniques. In Chapter 4, the theme of Chapter 3 receives additional attention as various matrix transformations are illustrated geometrically. This same (geometric) orientation is continued in Chapter 5 as eigenstructures and quadratic forms are described conceptually and illustrated numerically. A large number of terminological changes made in this edition of the book occur in Chapter 5.

Chapter 6 completes the cycle by returning to the three applied problems presented in Chapter 1. These problems are solved by means of the techniques developed in Chapters 2–5, and the book concludes with a further discussion of the geometric aspects of linear transformations.

Appendix A presents supporting material from the calculus for deriving various matrix equations used in the book. Appendix B provides a basic discussion on solving sets of linear equations and includes an introduction to generalized inverses. Numerical exercises appear at the end of each chapter and represent an integral part of the text. With the student's interest in mind, solutions to all numerical problems are provided. (After all, it was those *even*-numbered exercises that used to give us all the trouble!) The student is urged to work through these exercises for purposes of conceptual as well as numerical reinforcement.

Completion of the book should provide both a technical base for tackling most applications-oriented multivariate texts and, more importantly, a geometric perspective for aiding one's intuitive grasp of multivariate methods. In short, this book has been written for the student in the behavioral and administrative sciences—not the statistician or mathematician. If it can help illuminate some of the material in current multivariate textbooks that are designed for this type of reader, the author's objective will have been well satisfied.