Chapman & Hall / CRT Statistics Books: Proposal

## Proposed title

**Visualizing Multivariate Data and Models in R**

## Author

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## Contents

An in-progress outline with some description is attached.

## Subject

Data visualization methods for statistical analysis are well-developed for simple linear models for a single outcome variable. However, in applied research it is often the case that the phenomena of interest (depression, job satisfaction, academic achievement, childhood ADHD disorders) can be measured in several different ways or related aspects. For example, if academic achievement can be measured for adolescents by reading, mathematics, science and history scores, how do predictors such as parental encouragement, school environment and socioeconomic status affect all these outcomes? In the same, or different ways? In such cases, much more can be understood from a multivariate approach that takes the correlations among the outcomes into account. Yet sadly, researchers typically examine the outcomes one by one.

The statistical leap from univariate to multivariate methods is quite simple, because the classical models for ANOVA and regression:

* generalize directly to analogous models for MANOVA and multivariate regression,
* statistical multivariate tests are straightforward extensions of standard F- and t-tests,
* univariate intervals become ellipses (and ellipsoids!), showing location, covariation and precision.

This book brings together a collection of novel techniques I and others have developed over the past 15 years and implemented in mature R packages. Some key substantive features of the book are:

* Statistical data visualization is cast in a general framework by goal (see the data, visualize a model, diagnose problems), rather than a categorization by graphic types.
* Data ellipses & confidence ellipses are widely used as simple, effective summaries of data and fitted model parameters.
* These graphical tools can be used to understand or explain a wide variety of statistical concepts, phenomena and paradoxes.
* The HE (“hypothesis – error”) plot framework provides a simple way to understand the results of statistical tests and the relations among response outcomes.
* Reduced-rank methods are widely applicable to visualize a more-than-2D problem in a 2D “shadow” that squeezes the most juice out of data or a model for a particular purpose.

Some key pedagogical features are:

## Related books

There are a number of textbooks and monographs on multivariate data analysis, but there are none that focus mainly on data visualization and graphical methods. Everitt & Hothorn (2011) do use R, but not with any incisive graphics.

A few texts on multivariate methods are:

Timm, N. H. (1975). *Multivariate Analysis with Applications in Education and Psychology*. Wadsworth (Brooks/Cole)

Everitt, B., & Hothorn, T. (2011). *An Introduction to Applied Multivariate Analysis with R*. Springer New York

Tabachnick, B. G., & Fidell, L. S. (2019). *Using Multivariate Statistics* (7 ed.). Pearson.

## Audience

This book is aimed at advanced undergraduates, graduate students and researchers wishing to learn and apply multivariate techniques.

## Production

At this stage of writing, it is difficult to predict the number of pages, but I expect it to be in the range 300-400, with perhaps 100 figures. Because this is a book on data graphics, color will be essential throughout.

The book is being written using RStudio, Rmarkdown and Quarto. In writing, I’m using primarily HTML format and would like to make pre-publication drafts publicly available for comment and suggestions by colleagues. I expect to be able to have this translated to LaTeX, using the standard CRC krantz.cls, though some assistance with this might be necessary.

I expect to complete a first draft of the book in the summer of 2024.

## Reviews

John Fox, [jfox@mcmaster.ca](mailto:jfox@mcmaster.ca)

Georges Monette, [georges@yorku.ca](mailto:georges@yorku.ca)

## Marketing

Key features:

Key words:

Markets:

* STA07A-Statistics-Statistical Theory & Methods
* STA12A-Statistics-Statistics for the Social and Behavioral Sciences
* CMS08-Computer Science & Engineering-Visualization