
Contents

Preface	xi
Authors	xv
1 Multivariate Statistical Analysis—An Overview	1
1.1 An Appraisal of Statistical Analysis	1
1.2 Structure of Multivariate Problems	4
1.3 Univariate Data Description	7
1.4 Standard Error (SE) and Confidence Interval (CI)	7
1.5 Multivariate Descriptive Statistics	8
1.6 Covariance Matrix and Correlation Matrix	14
1.7 Data Visualization	16
1.8 The Multivariate Normal Distribution	23
1.9 Some Interesting Applications of Multivariate Analysis	25
Summary	26
Do it yourself	27
Suggested Reading	29
2 Comparison of Multivariate Means	31
2.1 Multivariate Comparison of Mean Vectors	31
2.2 One-sample Hotelling's T^2 Test	33
2.3 Confidence Intervals for Component Means	37
2.4 Two-Sample Hotelling's T^2 Test	39
2.5 Paired Comparison of Multivariate Mean Vectors	43
Summary	48
Do it yourself	49
Suggested Reading	50
3 Analysis of Variance with Multiple Factors	51
3.1 Review of Univariate Analysis of Variance (ANOVA)	51
3.2 Multifactor ANOVA	55
3.3 ANOVA with a General Linear Model	57
3.4 Continuous Covariates and Adjustment	61

3.5	Non-Parametric Approach to ANOVA	65
3.6	Influence of Random Effects on ANOVA	68
	Summary	69
	Do it yourself	69
	Suggested Reading	71
4	Multivariate Analysis of Variance (MANOVA)	73
4.1	Simultaneous ANOVA of Several Outcome Variables	73
4.2	Test Procedure for MANOVA	74
4.3	Interpreting the Output	78
4.4	MANOVA with Age as a Covariate	81
4.5	Using Age and BMI as Covariates	84
4.6	Theoretical Model for Prediction	86
	Summary	88
	Do it yourself	88
	Suggested Reading	90
5	Analysis of Repeated Measures Data	91
5.1	Experiments with Repeated Measures	91
5.2	RM ANOVA Using SPSS	95
5.3	RM ANOVA Using MedCalc	99
5.4	RM ANOVA with One Grouping Factor	100
5.5	Profile Analysis	107
	Summary	113
	Do it yourself	113
	Suggested Reading	114
6	Multiple Linear Regression Analysis	115
6.1	The Concept of Regression	115
6.2	Multiple Linear Regression	118
6.3	Selection of Appropriate Variables into the Model	120
6.4	Predicted Values from the Model	126
6.5	Quality of Residuals	128
6.6	Regression Model with Selected Records	129
	Summary	131
	Do it yourself	131
	Suggested Reading	134
7	Classification Problems in Medical Diagnosis	135
7.1	The Nature of Classification Problems	135
7.2	Binary Classifiers and Evaluation of Outcomes	137
7.3	Performance Measures of Classifiers	138

7.4	ROC Curve Analysis	144
7.5	Composite Classifiers	148
7.6	Biomarker Panels and Longitudinal Markers	149
	Summary	150
	Do it yourself	150
	Suggested Reading	151
8	Binary Classification with Linear Discriminant Analysis	153
8.1	The Problem of Discrimination	153
8.2	The Discriminant Score and Decision Rule	155
8.3	Understanding the Output	158
8.4	ROC Curve Analysis of Discriminant Score	161
8.5	Extension of Binary Classification	163
	Summary	164
	Do it yourself	164
	Suggested Reading	167
9	Logistic Regression for Binary Classification	169
9.1	Introduction	169
9.2	Simple Binary Logistic Regression	170
9.3	Binary Logistic Regression with Multiple Predictors	175
9.4	Assessment of the Model and Relative Effectiveness of Markers	179
9.5	Logistic Regression with Interaction Terms	180
	Summary	182
	Do it yourself	182
	Suggested Reading	184
10	Survival Analysis and Cox Regression	185
10.1	Introduction	185
10.2	Data Requirements for Survival Analysis	186
10.3	Estimation of Survival Time with Complete Data (No Censoring)	187
10.4	The Kaplan–Meier Method for Censored Data	190
10.5	Cox Regression Model	193
	Summary	199
	Do it yourself	200
	Suggested Reading	203

11 Poisson Regression Analysis	205
11.1 Introduction	205
11.2 General Form of Poisson Regression	206
11.3 Selection of Variables and Subset Regression	211
11.4 Poisson Regression Using SPSS	213
11.5 Applications of the Poisson Regression model	216
Summary	217
Do it yourself	217
Suggested Reading	218
12 Cluster Analysis and Its Applications	219
12.1 Data Complexity and the Need for Clustering	219
12.2 Measures of Similarity and General Approach to Clustering	221
12.3 Hierarchical Clustering and Dendrograms	224
12.4 The Impact of Clustering Methods on the Results	229
12.5 K-Means Clustering	232
Summary	235
Do it yourself	235
Suggested Reading	237
Index	239