

4.4	The Parametric Bootstrap	511
5.5	Influence Functions and Influence Curves	520
6.6	Notes	524
6.1	The Multinomial Distribution	524
6.2	Exponential Families	525
6.3	Neyman's Construction	526
6.4	The Percentile Method	528
6.5	Bias-Corrected Confidence Intervals	531
6.6	Second-Order Methods	533
6.7	Bootstrap Intervals	535
6.8	Objective Bayes Intervals and the Confidence Interval	537
	Preface	xv
	Acknowledgments	xviii
	Notation	xix
	Part I Classic Statistical Inference	1
1	Algorithms and Inference	3
1.1	A Regression Example	4
1.2	Hypothesis Testing	8
1.3	Notes	11
2	Frequentist Inference	12
2.1	Frequentism in Practice	14
2.2	Frequentist Optimality	18
2.3	Notes and Details	20
3	Bayesian Inference	22
3.1	Two Examples	24
3.2	Uninformative Prior Distributions	28
3.3	Flaws in Frequentist Inference	30
3.4	A Bayesian/Frequentist Comparison List	33
3.5	Notes and Details	36
4	Fisherian Inference and Maximum Likelihood Estimation	38
4.1	Likelihood and Maximum Likelihood	38
4.2	Fisher Information and the MLE	41
4.3	Conditional Inference	45
4.4	Permutation and Randomization	49
4.5	Notes and Details	51
5	Parametric Models and Exponential Families	53

5.1	Univariate Families	54
5.2	The Multivariate Normal Distribution	55
5.3	Fisher's Information Bound for Multiparameter Families	59
5.4	The Multinomial Distribution	61
5.5	Exponential Families	64
5.6	Notes and Details	69
Part II Early Computer-Age Methods		73
6	Empirical Bayes	75
6.1	Robbins' Formula	75
6.2	The Missing-Species Problem	78
6.3	A Medical Example	84
6.4	Indirect Evidence 1	88
6.5	Notes and Details	88
7	James–Stein Estimation and Ridge Regression	91
7.1	The James–Stein Estimator	91
7.2	The Baseball Players	94
7.3	Ridge Regression	97
7.4	Indirect Evidence 2	102
7.5	Notes and Details	104
8	Generalized Linear Models and Regression Trees	108
8.1	Logistic Regression	109
8.2	Generalized Linear Models	116
8.3	Poisson Regression	120
8.4	Regression Trees	124
8.5	Notes and Details	128
9	Survival Analysis and the EM Algorithm	131
9.1	Life Tables and Hazard Rates	131
9.2	Censored Data and the Kaplan–Meier Estimate	134
9.3	The Log-Rank Test	139
9.4	The Proportional Hazards Model	143
9.5	Missing Data and the EM Algorithm	146
9.6	Notes and Details	150
10	The Jackknife and the Bootstrap	155
10.1	The Jackknife Estimate of Standard Error	156
10.2	The Nonparametric Bootstrap	159
10.3	Resampling Plans	162

10.4	The Parametric Bootstrap	169
10.5	Influence Functions and Robust Estimation	174
10.6	Notes and Details	177
11	Bootstrap Confidence Intervals	181
11.1	Neyman's Construction for One-Parameter Problems	181
11.2	The Percentile Method	185
11.3	Bias-Corrected Confidence Intervals	190
11.4	Second-Order Accuracy	192
11.5	Bootstrap- t Intervals	195
11.6	Objective Bayes Intervals and the Confidence Distribution	198
11.7	Notes and Details	204
12	Cross-Validation and C_p Estimates of Prediction Error	208
12.1	Prediction Rules	208
12.2	Cross-Validation	213
12.3	Covariance Penalties	218
12.4	Training, Validation, and Ephemeral Predictors	227
12.5	Notes and Details	230
13	Objective Bayes Inference and MCMC	233
13.1	Objective Prior Distributions	234
13.2	Conjugate Prior Distributions	237
13.3	Model Selection and the Bayesian Information Criterion	243
13.4	Gibbs Sampling and MCMC	251
13.5	Example: Modeling Population Admixture	256
13.6	Notes and Details	261
14	Postwar Statistical Inference and Methodology	264
Part III Twenty-First-Century Topics		269
15	Large-Scale Hypothesis Testing and FDRs	271
15.1	Large-Scale Testing	272
15.2	False-Discovery Rates	275
15.3	Empirical Bayes Large-Scale Testing	278
15.4	Local False-Discovery Rates	282
15.5	Choice of the Null Distribution	286
15.6	Relevance	290
15.7	Notes and Details	294
16	Sparse Modeling and the Lasso	298

16.1	Forward Stepwise Regression	299
16.2	The Lasso	303
16.3	Fitting Lasso Models	308
16.4	Least-Angle Regression	309
16.5	Fitting Generalized Lasso Models	313
16.6	Post-Selection Inference for the Lasso	317
16.7	Connections and Extensions	319
16.8	Notes and Details	321
17	Random Forests and Boosting	324
17.1	Random Forests	325
17.2	Boosting with Squared-Error Loss	333
17.3	Gradient Boosting	338
17.4	Adaboost: the Original Boosting Algorithm	341
17.5	Connections and Extensions	345
17.6	Notes and Details	347
18	Neural Networks and Deep Learning	351
18.1	Neural Networks and the Handwritten Digit Problem	353
18.2	Fitting a Neural Network	356
18.3	Autoencoders	362
18.4	Deep Learning	364
18.5	Learning a Deep Network	368
18.6	Notes and Details	371
19	Support-Vector Machines and Kernel Methods	375
19.1	Optimal Separating Hyperplane	376
19.2	Soft-Margin Classifier	378
19.3	SVM Criterion as Loss Plus Penalty	379
19.4	Computations and the Kernel Trick	381
19.5	Function Fitting Using Kernels	384
19.6	Example: String Kernels for Protein Classification	385
19.7	SVMs: Concluding Remarks	387
19.8	Kernel Smoothing and Local Regression	387
19.9	Notes and Details	390
20	Inference After Model Selection	394
20.1	Simultaneous Confidence Intervals	395
20.2	Accuracy After Model Selection	402
20.3	Selection Bias	408
20.4	Combined Bayes–Frequentist Estimation	412
20.5	Notes and Details	417

21	Empirical Bayes Estimation Strategies	421
21.1	Bayes Deconvolution	421
21.2	g -Modeling and Estimation	424
21.3	Likelihood, Regularization, and Accuracy	427
21.4	Two Examples	432
21.5	Generalized Linear Mixed Models	437
21.6	Deconvolution and f -Modeling	440
21.7	Notes and Details	444
 <i>Epilogue</i>		446
<i>References</i>		453
<i>Author Index</i>		463
<i>Subject Index</i>		467

The book is an examination of how statistics has evolved over the past sixty years—an aerial view of a vast subject, but seen from the height of a small plane, not a jetliner or satellite. The individual chapters take up a series of influential topics—generalized linear models, survival analysis, the jackknife and bootstrap, false-discovery rates, empirical Bayes, MCMC, neural nets, and a dozen more—describing for each the key methodological developments and their inferential justification.

Needless to say, the role of electronic computation is central to our story. This doesn't mean that every advance was computer-related. A land bridge had opened to a new continent but not all were eager to cross. Topics such as empirical Bayes and James–Stein estimation could have emerged just as well under the constraints of mechanical computation. Others, like the bootstrap and proportional hazards, were pureborn children of the computer age. Almost all topics in twenty-first-century statistics are now computer-dependent, but it will take our small plane a while to reach the new millennium.

Dictionary definitions of statistical inference tend to equate it with the entire discipline. This has become less satisfactory in the “big-data” era of immense computer-based processing algorithms. Here we will attempt, not always consistently, to separate the two aspects of the statistical enterprise: algorithmic developments aimed at specific problem areas, for instance