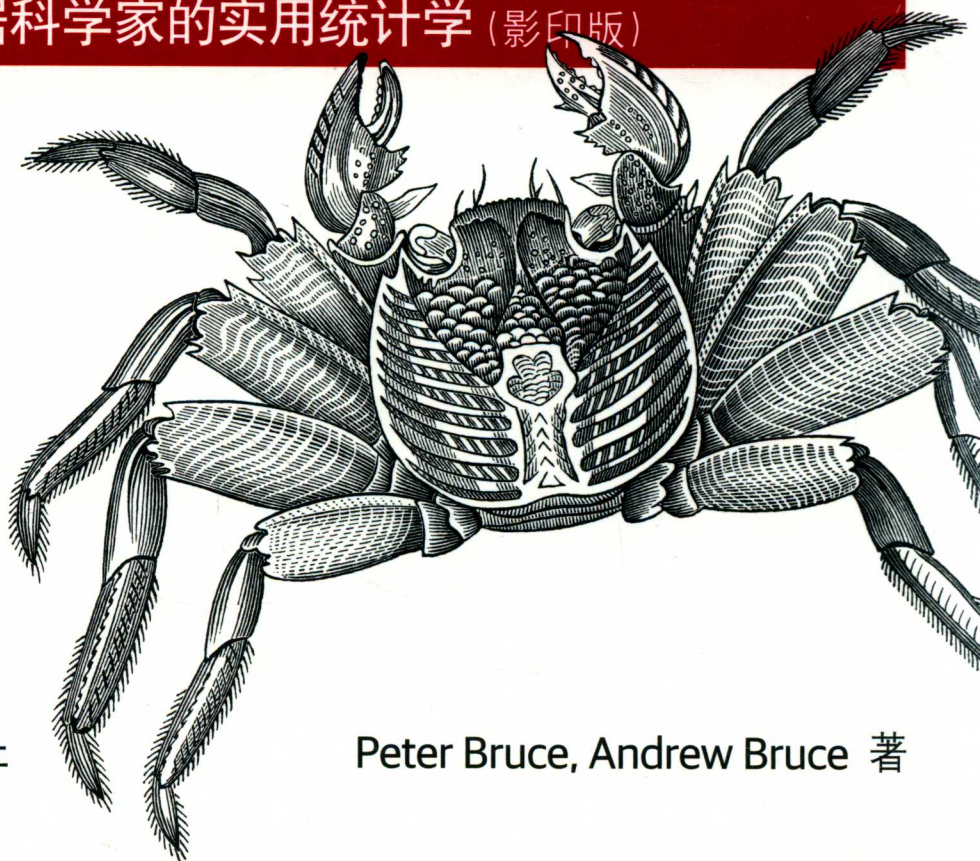


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Practical Statistics for Data Scientists

面向数据科学家的实用统计学 (影印版)



東南大學出版社

Peter Bruce, Andrew Bruce 著

Practical Statistics for Data Scientists

with applications using Python and R



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Practical Statistics for Data Scientists

Peter Bruce, Andrew Bruce 著

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Table of Contents

We would like to dedicate this book to the memories of our parents Victor G. Bruce and Nancy C. Bruce, who cultivated a passion for math and science; and to our early mentors John W. Tukey and Julian Simon, and our lifelong friend Geoff Watson, who helped inspire us to pursue a career in statistics.

Preface

This book is aimed at the data scientist with some familiarity with the R programming language, and with some prior (perhaps spotty or ephemeral) exposure to statistics. Both of us came to the world of data science from the world of statistics, so we have some appreciation of the contribution that statistics can make to the art of data science. At the same time, we are well aware of the limitations of traditional statistics instruction: statistics as a discipline is a century and a half old, and most statistics textbooks and courses are laden with the momentum and inertia of an ocean liner.

Two goals underlie this book:

- To lay out, in digestible, navigable, and easily referenced form, key concepts from statistics that are relevant to data science.
- To explain which concepts are important and useful from a data science perspective, which are less so, and why.

What to Expect

Key Terms

Data science is a fusion of multiple disciplines, including statistics, computer science, information technology, and domain-specific fields. As a result, several different terms could be used to reference a given concept. Key terms and their synonyms will be highlighted throughout the book in a sidebar such as this.

Conventions Used in This Book

The following typographical conventions are used in this book:

Italic

Indicates new terms, URLs, email addresses, filenames, and file extensions.

Constant width

Used for program listings, as well as within paragraphs to refer to program elements such as variable or function names, databases, data types, environment variables, statements, and keywords.

Constant width bold

Shows commands or other text that should be typed literally by the user.

Constant width italic

Shows text that should be replaced with user-supplied values or by values determined by context.



This element signifies a tip or suggestion.



This element signifies a general note.



This element indicates a warning or caution.

Using Code Examples

Supplemental material (code examples, exercises, etc.) is available for download at <https://github.com/andrewgbruce/statistics-for-data-scientists>.


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Table of Contents

Preface.....	xiii
1. Exploratory Data Analysis.....	1
Elements of Structured Data	2
Further Reading	4
Rectangular Data	5
Data Frames and Indexes	6
Nonrectangular Data Structures	7
Further Reading	8
Estimates of Location	8
Mean	9
Median and Robust Estimates	10
Example: Location Estimates of Population and Murder Rates	12
Further Reading	13
Estimates of Variability	13
Standard Deviation and Related Estimates	15
Estimates Based on Percentiles	17
Example: Variability Estimates of State Population	18
Further Reading	19
Exploring the Data Distribution	19
Percentiles and Boxplots	20
Frequency Table and Histograms	21
Density Estimates	24
Further Reading	26
Exploring Binary and Categorical Data	26
Mode	28
Expected Value	28
Further Reading	29

Weibull Distribution	76
Further Reading	77
Summary	77
3. Statistical Experiments and Significance Testing.....	79
A/B Testing	80
Why Have a Control Group?	82
Why Just A/B? Why Not C, D...?	83
For Further Reading	84
Hypothesis Tests	85
The Null Hypothesis	86
Alternative Hypothesis	86
One-Way, Two-Way Hypothesis Test	87
Further Reading	88
Resampling	88
Permutation Test	88
Example: Web Stickiness	89
Exhaustive and Bootstrap Permutation Test	92
Permutation Tests: The Bottom Line for Data Science	93
For Further Reading	93
Statistical Significance and P-Values	93
P-Value	96
Alpha	96
Type 1 and Type 2 Errors	98
Data Science and P-Values	98
Further Reading	99
t-Tests	99
Further Reading	101
Multiple Testing	101
Further Reading	104
Degrees of Freedom	104
Further Reading	106
ANOVA	106
F-Statistic	109
Two-Way ANOVA	110
Further Reading	111
Chi-Square Test	111
Chi-Square Test: A Resampling Approach	112
Chi-Squared Test: Statistical Theory	114
Fisher's Exact Test	115
Relevance for Data Science	117
Further Reading	118

Multi-Arm Bandit Algorithm	119
Further Reading	122
Power and Sample Size	122
Sample Size	123
Further Reading	125
Summary	125
4. Regression and Prediction.....	127
Simple Linear Regression	127
The Regression Equation	129
Fitted Values and Residuals	131
Least Squares	132
Prediction versus Explanation (Profiling)	133
Further Reading	134
Multiple Linear Regression	134
Example: King County Housing Data	135
Assessing the Model	136
Cross-Validation	138
Model Selection and Stepwise Regression	139
Weighted Regression	141
Prediction Using Regression	142
The Dangers of Extrapolation	143
Confidence and Prediction Intervals	143
Factor Variables in Regression	145
Dummy Variables Representation	145
Factor Variables with Many Levels	147
Ordered Factor Variables	149
Interpreting the Regression Equation	150
Correlated Predictors	150
Multicollinearity	151
Confounding Variables	152
Interactions and Main Effects	153
Testing the Assumptions: Regression Diagnostics	155
Outliers	156
Influential Values	158
Heteroskedasticity, Non-Normality and Correlated Errors	161
Partial Residual Plots and Nonlinearity	164
Polynomial and Spline Regression	166
Polynomial	167
Splines	168
Generalized Additive Models	170
Further Reading	172

Summary	172
5. Classification	173
Naive Bayes	174
Why Exact Bayesian Classification Is Impractical	175
The Naive Solution	176
Numeric Predictor Variables	178
Further Reading	178
Discriminant Analysis	179
Covariance Matrix	180
Fisher's Linear Discriminant	180
A Simple Example	181
Further Reading	183
Logistic Regression	184
Logistic Response Function and Logit	184
Logistic Regression and the GLM	186
Generalized Linear Models	187
Predicted Values from Logistic Regression	188
Interpreting the Coefficients and Odds Ratios	188
Linear and Logistic Regression: Similarities and Differences	190
Assessing the Model	191
Further Reading	194
Evaluating Classification Models	194
Confusion Matrix	195
The Rare Class Problem	196
Precision, Recall, and Specificity	197
ROC Curve	198
AUC	200
Lift	201
Further Reading	202
Strategies for Imbalanced Data	203
Undersampling	204
Oversampling and Up/Down Weighting	204
Data Generation	205
Cost-Based Classification	206
Exploring the Predictions	206
Further Reading	208
Summary	208
6. Statistical Machine Learning	209
K-Nearest Neighbors	210
A Small Example: Predicting Loan Default	211

Distance Metrics	213
One Hot Encoder	214
Standardization (Normalization, Z-Scores)	215
Choosing K	217
KNN as a Feature Engine	218
Tree Models	219
A Simple Example	221
The Recursive Partitioning Algorithm	222
Measuring Homogeneity or Impurity	224
Stopping the Tree from Growing	225
Predicting a Continuous Value	227
How Trees Are Used	227
Further Reading	228
Bagging and the Random Forest	228
Bagging	230
Random Forest	230
Variable Importance	233
Hyperparameters	236
Boosting	237
The Boosting Algorithm	238
XGBoost	239
Regularization: Avoiding Overfitting	241
Hyperparameters and Cross-Validation	245
Summary	247
7. Unsupervised Learning	249
Principal Components Analysis	250
A Simple Example	251
Computing the Principal Components	254
Interpreting Principal Components	254
Further Reading	257
K-Means Clustering	257
A Simple Example	258
K-Means Algorithm	260
Interpreting the Clusters	261
Selecting the Number of Clusters	263
Hierarchical Clustering	265
A Simple Example	266
The Dendrogram	266
The Agglomerative Algorithm	268
Measures of Dissimilarity	268
Model-Based Clustering	270

Multivariate Normal Distribution	270
Mixtures of Normals	272
Selecting the Number of Clusters	274
Further Reading	276
Scaling and Categorical Variables	276
Scaling the Variables	277
Dominant Variables	278
Categorical Data and Gower's Distance	280
Problems with Clustering Mixed Data	283
Summary	284
Bibliography.....	285
Index.....	287

Exploratory Data Analysis

As a discipline, statistics has mostly developed in the past century. Probability theory—the mathematical foundation for statistics—was developed in the 17th to 19th centuries based on work by Thomas Bayes, Pierre-Simon Laplace, and Carl Gauss. In contrast to the purely theoretical nature of probability, statistics is an applied science concerned with analysis and modeling of data. Modern statistics as a rigorous scientific discipline traces its roots back to the late 1800s and Francis Galton and Karl Pearson. R. A. Fisher, in the early 20th century, was a leading pioneer of modern statistics, introducing key ideas of *experimental design* and *maximum likelihood estimation*. These and many other statistical concepts live largely in the recesses of data science. The main goal of this book is to help illuminate these concepts and clarify their importance—or lack thereof—in the context of data science and big data.

This chapter focuses on the first step in any data science project: exploring the data. *Exploratory data analysis*, or EDA, is a comparatively new area of statistics. Classical statistics focused almost exclusively on *inference*, a sometimes complex set of procedures for drawing conclusions about large populations based on small samples. In 1962, John W. Tukey (https://en.wikipedia.org/wiki/John_Tukey) (Figure 1-1) called for a reformation of statistics in his seminal paper “The Future of Data Analysis” [Tukey-1962]. He proposed a new scientific discipline called *data analysis* that included statistical inference as just one component. Tukey forged links to the engineering and computer science communities (he coined the terms *bit*, short for binary digit, and *software*), and his original tenets are surprisingly durable and form part of the foundation for data science. The field of exploratory data analysis was established with Tukey’s 1977 now-classic book *Exploratory Data Analysis* [Tukey-1977].



Figure 1-1. John Tukey, the eminent statistician whose ideas developed over 50 years ago form the foundation of data science.

With the ready availability of computing power and expressive data analysis software, exploratory data analysis has evolved well beyond its original scope. Key drivers of this discipline have been the rapid development of new technology, access to more and bigger data, and the greater use of quantitative analysis in a variety of disciplines. David Donoho, professor of statistics at Stanford University and former undergraduate student of Tukey's, authored an excellent article based on his presentation at the Tukey Centennial workshop in Princeton, New Jersey [Donoho-2015]. Donoho traces the genesis of data science back to Tukey's pioneering work in data analysis.

Elements of Structured Data

Data comes from many sources: sensor measurements, events, text, images, and videos. The *Internet of Things* (IoT) is spewing out streams of information. Much of this data is unstructured: images are a collection of pixels with each pixel containing RGB (red, green, blue) color information. Texts are sequences of words and nonword characters, often organized by sections, subsections, and so on. Clickstreams are sequences of actions by a user interacting with an app or web page. In fact, a major challenge of data science is to harness this torrent of raw data into actionable information. To apply the statistical concepts covered in this book, unstructured raw data must be processed and manipulated into a structured form—as it might emerge from a relational database—or be collected for a study.