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Basic Statistics

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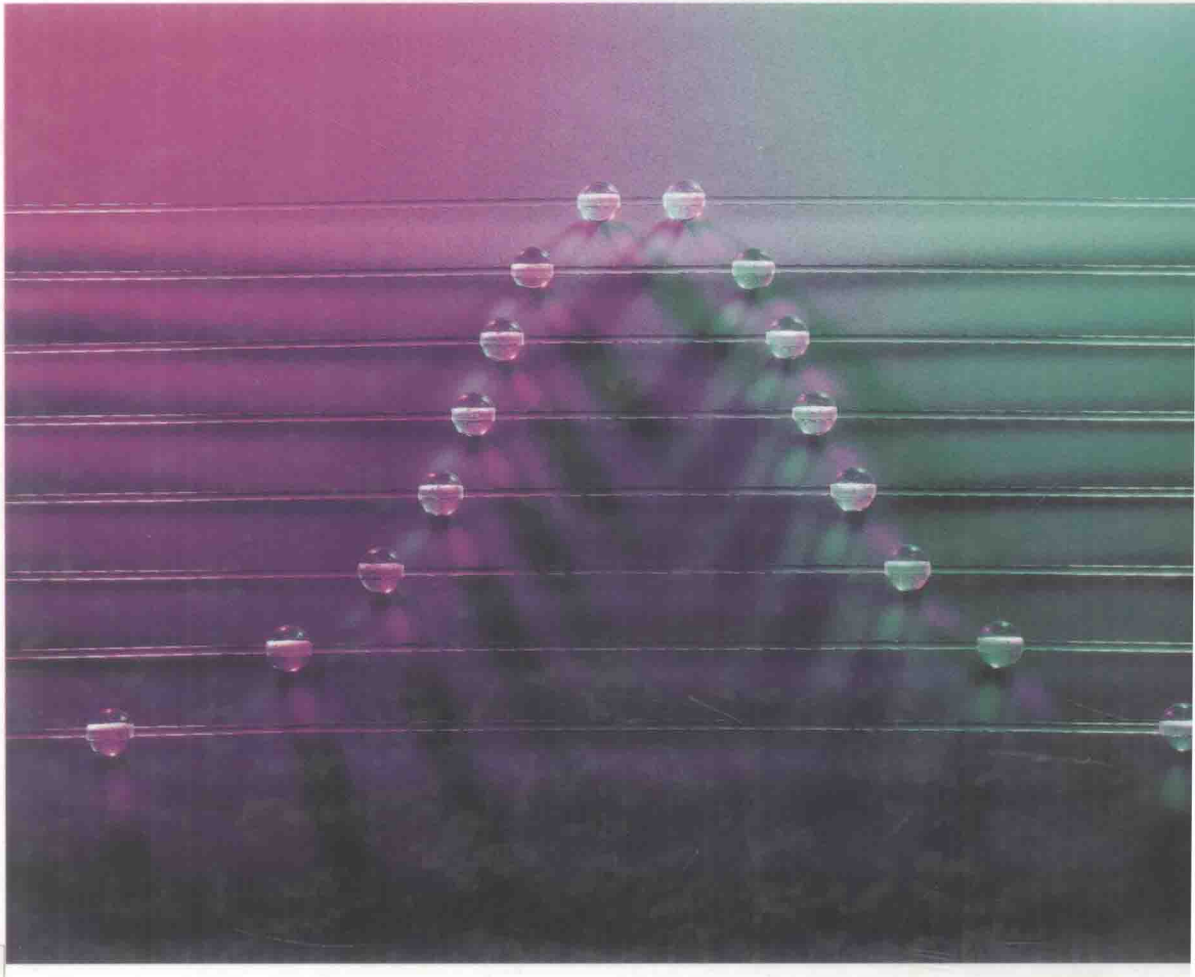

CHRIS SPATZ

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Chris Spatz

Hendrix College

Brooks/Cole Publishing Company

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GLOSSARY OF SYMBOLS

GREEK LETTER SYMBOLS

α	The probability of a Type I error
β	The probability of a Type II error
μ	The mean of a population
ρ	Population correlation coefficient
Σ	The sum; an instruction to add
σ	Standard deviation of a population
σ^2	Variance of a population
$\sigma_{\bar{X}}$	Standard error of the mean (population σ known)
χ^2	The chi square statistic

MATHEMATICAL AND LATIN LETTER SYMBOLS

∞	Infinity
$>$	More than
$<$	Less than
a	Point where the regression line intersects the Y axis
b	The slope of the regression line
D	The difference between two correlated scores
$\bar{D}$	The mean of a set of difference scores
d	Effect size for one-sample and two-sample experiments
df	Degrees of freedom
E	In chi square, the expected frequency
$E(\bar{X})$	The expected value of the mean; the mean of a sampling distribution
F	The F statistic in ANOVA
f	Frequency; the number of times a score occurs
f	Effect size for ANOVA
H_0	The null hypothesis
H_1	A hypothesis that is an alternative to the null hypothesis
HSD	Tukey honestly significant difference; makes pairwise comparisons
i	The interval size; the number of score points in a class interval

K	The number of levels of the independent variable
LL	Lower limit of a confidence interval
MS	Mean square; ANOVA term for the variance
N	The number of scores or observations
O	In chi square, the observed frequency
r	Pearson product-moment correlation coefficient
r_s	A correlation coefficient for ranked data; named for Spearman
r^2	The coefficient of determination
S	The standard deviation of a sample; describes the sample
$\hat{s}$	The standard deviation of a sample; estimates σ
s^2	Variance of a sample; estimates σ^2
s_D	Standard deviation of a distribution of differences between correlated scores
$s_{\bar{D}}$	Standard error of the difference between correlated means
$s_{\bar{X}_1 - \bar{X}_2}$	Standard error of a difference between means
$s_{\bar{X}}$	Standard error of the mean (population σ estimated from sample)
SS	Sum of squares; the sum of the squared deviations from the mean
T	Wilcoxon matched-pairs signed-ranks T statistic for correlated samples
t	t test statistic
t_α	Critical value of t; level of significance $= \alpha$
U	Mann-Whitney U statistic for independent samples
UL	Upper limit of a confidence interval
X	A score
x	A deviation score
$\bar{X}$	The mean of a sample
$\bar{\bar{X}}$	The mean of a set of means
X_H	The upper limit of the highest score in a distribution
X_L	The lower limit of the lowest score in a distribution
Y'	The Y value predicted for some X value
$\bar{Y}$	The mean of the Y variable
z	A score expressed in standard deviation units; a standard score
z	Test statistic when sampling distribution is normal
z_X	A z value for a score on variable X
z_Y	A z value for a score on variable Y

6

Basic Statistics

TALES OF DISTRIBUTIONS

For Thea

Even if our statistical appetite is far from keen, we all of us should like to know enough to understand, or to withstand, the statistics that are constantly being thrown at us in print or conversation—much of it pretty bad statistics. The only cure for bad statistics is apparently more and better statistics. All in all, it certainly appears that the rudiments of sound statistical sense are coming to be an essential of a liberal education.

Robert Sessions Woodworth

PREFACE

Basic Statistics: Tales of Distributions, Sixth Edition, is designed for a one-term, introductory course in statistics. In addition to traditional statistical topics, some experimental design terms and issues are covered. My goal has been to produce a book that is comprehensible and complete for students who take only one statistics course and comprehensible and preparatory for students who will take additional courses.

Although detailed directions and examples are given for each statistical procedure, this book concentrates heavily on conceptualization and interpretation of statistical results. In many places the reader is invited to stop and think, or stop and do an exercise. Some problems simply ask the student to decide which statistical technique is appropriate. Because of this book's emphasis and style, I am confident that it will reinforce an instructor's efforts to promote critical thinking.

My expectation for students who work through this book is that they will be able to:

- solve statistical problems
- understand statistical reasoning
- write explanations that are congruent with statistical analyses
- choose proper statistical techniques to analyze data from simple experimental designs

Students who meet these expectations will be able to understand the statistical concepts in many journal articles as well as be able to analyze data from their own research. I also expect they will use this statistical knowledge in the years that follow.

I think you will like this book. Most students find it relatively engaging because it is written in an informal, personal style. There are examples and problems from many fields, including some that have been worked on by the pioneers in statistics.

In addition to the writing style and the varied problems, this book has a number of features that are designed to make statistics easier to learn. For example, the problems are an integral part of the text. The answers, complete with all necessary steps or explanations, are in Appendix E. Concepts that will be important in later chapters are

identified as "Clues to the Future" and set off in boxes. The "Error Detection" boxes note ways to detect or prevent mistakes. At the beginning of each chapter, a list of objectives provides orientation. This same list also serves as a review exercise for the chapter. Three glossaries are provided: the Glossary of Words and the Glossary of Formulas are Appendixes C and D, respectively; the Glossary of Symbols is printed on the inside covers of the book.

Two ancillary publications supplement this textbook. For students, there is a softcover Study Guide that provides additional explanations, problems, and answers. For professors, there is an Instructor's Manual that contains teaching suggestions and test items. Test items are also available in electronic format.

This sixth edition differs in a number of ways from the last edition. I added an *effect size index* to the analyses of the one-sample t test, both two-sample t tests, and the one-way ANOVA. An emphasis on effect size was also incorporated into other statistical descriptions. The section on confidence intervals about a mean difference was eliminated from the chapter on two-sample t tests. All three basic ANOVA designs are covered now that a new chapter has been added, Analysis of Variance: One-Factor Correlated Measures (Chapter 11). I rewrote all of Chapter 6, Samples, Sampling Distributions, and Confidence Intervals; most of Chapter 7, Hypothesis Testing and Effect Size: One-Sample Tests; and many other paragraphs and sections. My aim was clarity, especially on the topics of sampling distributions and hypothesis testing. Responding to the recommendations of teachers and reviewers, the sample estimator of σ was changed from s to $\hat{s}$, which will distinguish it easily from S (sample standard deviation). Chapter 14, Choosing Tests and Writing Interpretations, was modified to encourage students to create overall summaries of elementary statistics. My answers are given in table form (Table 14.1) and as decision trees (Figure 14.1 and Figure 14.2). I brought all contemporary data sets up to date.

I am pleased to acknowledge all the help I have received from students, colleagues, and Hendrix College. Students identified some 42 errors in the previous two editions. (I pay $2.00 to the first to report an error.) Colleagues at Hendrix and elsewhere have made many useful suggestions. Bob Eslinger produced accurate graphs of the F, t, χ^2, and normal distributions. Rob Nichols wrote a sampling program for me. Hendrix librarians JoAnn McMillen and Delores Thompson provided enthusiastic and competent help for all six editions of this book. Roger E. Kirk of Baylor University, my consulting editor for all six editions, deserves a special thanks. Over the years he has saved me from several errors, taught me some statistics, and always had a note of encouragement for me. Jim Brace-Thompson, Nancy Shammas, and the staff at Brooks/Cole contributed in many ways.

I also want to acknowledge the help of reviewers for this edition: Eugene Chao, Berea College; David Chattin, St. Joseph's College; Dennis Cogan, Texas Tech University; Anupa K. Doraiswami, Morris Brown College; James Overton, Coker College; Joel Royalty, Murray State University; Anthony Santucci, Manhattanville College; Randolph Smith, Ouachita Baptist University; Boyd Spencer, Eastern Illinois University; Philip Tolin, Central Washington University; Mahlon Wagner, State University of New York—Oswego; and Donald Walter, University of Wisconsin—Parkside.

I am grateful to the Longman Group UK Ltd., on behalf of the Literary Executor of the late Sir Ronald A. Fisher, F.R.S. and Dr. Frank Yates, F.R.S., for permission to

reproduce Tables III, IV, and VII from their book *Statistical Tables for Biological, Agricultural, and Medical Research*, Sixth Edition, (1974).

I especially want to acknowledge James O. Johnston, my good friend and former co-author, who contributed to the first three editions of this book. Without his efforts, there never would have been a first edition.

My most important acknowledgment goes to my wife and family, who have helped and supported me in many ways during the almost 25 years of this project.

I've been a teacher for much of my life—first as an older sibling, then as a parent, and now as a professor. Education is a task of the first order, in my opinion. I hope that my writing conveys both my enthusiasm for this task and my philosophy of teaching. (By the way, if you are a student who is thoroughly reading the *whole* preface, you should know that in a number of places in this book I included phrases or examples with *your kind* in mind.)

Chris Spatz

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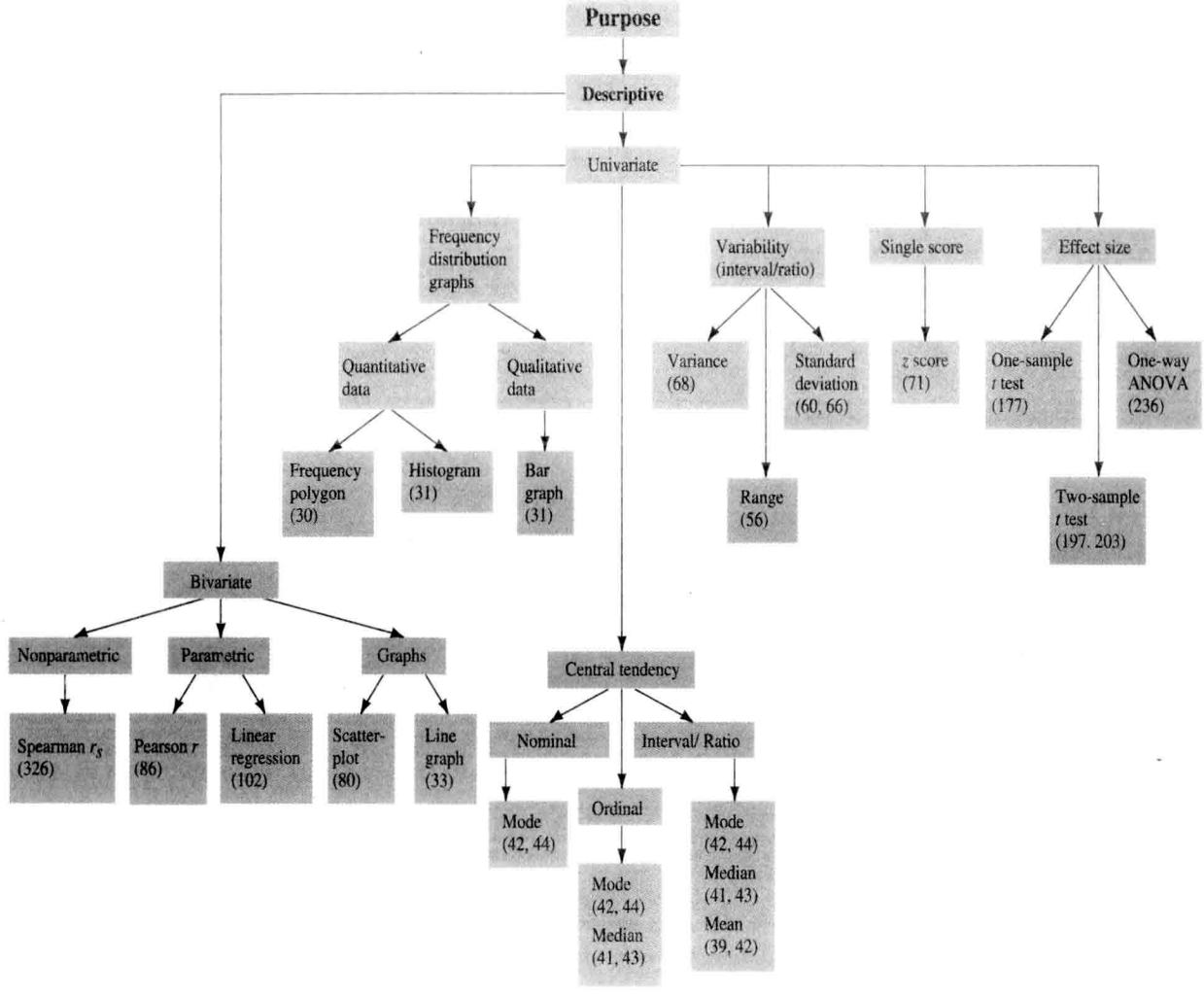

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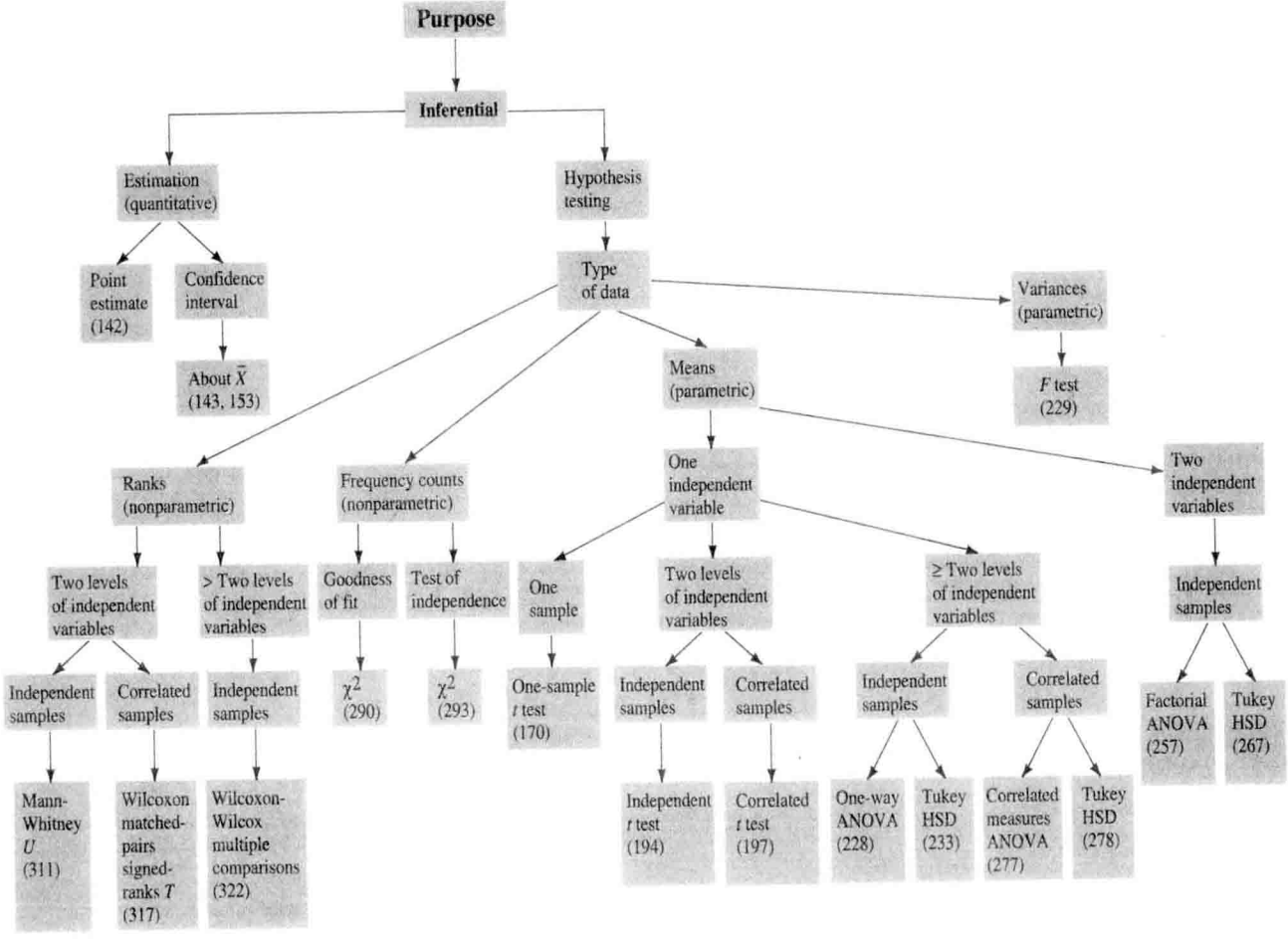

BRIEF CONTENTS

CONTENTS