

Contents

Preface xiii

To the Student xv

1

The Logic of Statistical Analysis 1

THINKING STATISTICALLY 3

REVIEW: HOW THE STUDIES WORK 4

A Word of Caution 5

The ASARCO Smelter Debate: Another Example 6

The Outcome 7

Statistics as Language 8

Learning Statistics as a New Language 8

A Statistical Culture 10

Opinion Polls 10

2

Variables and Hypotheses 12

CASES AND VARIABLES 12

KINDS OF VARIABLES: LEVELS OF MEASUREMENT 14

DATA SETS 16

Social Indicators: Countries Data Set 16

A Social Psychology Experiment: A Two-Part Data Set 17

Hospital Costs Data Set 19

STATISTICS AS DATA REDUCTION	21
HYPOTHESES	22
KEY CONCEPTS IN THIS CHAPTER	24
EXERCISES	25

3

Frequency Distributions 29

A BEGINNING EXAMPLE	30
Dice	34
EXPLORATORY DATA ANALYSIS	40
PER CAPITA INCOME: AN EXAMPLE	40
NECESSARY INFORMATION	44
KEY CONCEPTS IN THIS CHAPTER	46
EXERCISES	47

4

Describing Distributions: Measures of Central Tendency and Dispersion 53

THE AVERAGE, OR MEAN	54
Examples	56
THREE OTHER MEASURES OF CENTRAL TENDENCY	58
The Median	58
The Trimean	59
The Mode	60
Choosing a Measure of Central Tendency	61
SUMMARY	61
MEASURES OF DISPERSION	62
The Range	63
The Semi-interquartile Range	64
Box-and-Whisker Plots	66
The Variance	67
A "Calculation Formula" for the Variance	70
Standard Deviation	72
COEFFICIENT OF VARIATION	73
SUMMARY: COMPARING DISTRIBUTIONS	74
READING COMPUTER OUTPUT	76
KEY CONCEPTS IN THIS CHAPTER	78
EXERCISES	80

Interlude A

Suicide: Individual Will or Social Regularity 86

5

Probability 92

PROBABILITY DEFINED	94
Essential Prior Definitions	95
Definition of Probability	96
Theoretical Probability	98
Diagrammatic Approaches to Probability	99
Probability When Outcomes Are Equiprobable	101
PROPERTIES OF PROBABILITIES	101
Simple Addition Rule	102
Simple Multiplication Rule	105
General Multiplication Rule	107
General Addition Rule	109
USING THE PROPERTIES OF PROBABILITY	110
KEY CONCEPTS IN THIS CHAPTER	114
EXERCISES	115

6

Probability Distributions 123

RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS	124
PROBABILITY DISTRIBUTIONS FOR DISCRETE RANDOM VARIABLES	126
Mean and Variance of Discrete Random Variables	128
BINOMIAL DISTRIBUTION	132
Mean and Variance of a Binomial Random Variable	138
Using a Binomial Table	139
PROBABILITY DISTRIBUTIONS FOR CONTINUOUS RANDOM VARIABLES	140
NORMAL DISTRIBUTION	143
Applications	148
NORMAL APPROXIMATION OF THE BINOMIAL DISTRIBUTION	151
KEY CONCEPTS IN THIS CHAPTER	154
EXERCISES	155

7

Sampling and an Introduction to Decision Making 163

RANDOM SAMPLES	164
Using a Random Number Table	167

Sampling in Practice	170
SAMPLING DISTRIBUTIONS	171
CENTRAL-LIMIT THEOREM	175
Applications: Introduction to Decision Making	180
KEY CONCEPTS IN THIS CHAPTER	182
EXERCISES	183

Interlude B

Probability and Culture 190

8

Hypothesis Testing and Decision Making 193

HYPOTHESIS TESTING	194
LARGE-SAMPLE HYPOTHESIS TESTING ABOUT A POPULATION MEAN	196
Region of Rejection and Test Statistics	199
Statistical Significance	202
One-Tailed and Two-Tailed Tests	203
Setting a Level to Reject: Type I and Type II Errors	207
Summary: Rephrasing the Steps in Hypothesis Testing	209
SMALL-SAMPLE HYPOTHESIS TESTS ABOUT A POPULATION MEAN	210
Unknown Population Standard Deviation σ	214
HYPOTHESIS TESTING ABOUT A POPULATION PROPORTION	215
HYPOTHESIS TESTS ABOUT TWO POPULATION MEANS	218
Small Samples	220
Paired Samples	224
CAUTION: THE SIGNIFICANCE OF "SIGNIFICANCE"	226
KEY CONCEPTS IN THIS CHAPTER	228
EXERCISES	228

9

Point and Interval Estimation 234

POINT ESTIMATES	235
Bias and Efficiency	236
INTERVAL ESTIMATES	238
Interval Estimates of the Population Mean	239
Constructing Intervals	243
ESTIMATING THE POPULATION MEAN	244
Unknown Population Standard Deviation σ	245
Small Samples	245

INTERVAL ESTIMATES OF A POPULATION PROPORTION	246
INTERVAL ESTIMATES OF THE DIFFERENCE BETWEEN MEANS	247
RELATIONSHIP BETWEEN HYPOTHESIS TESTING AND CONFIDENCE INTERVALS	249
DETERMINING SAMPLE SIZE	249
KEY CONCEPTS IN THIS CHAPTER	251
EXERCISES	252

10

Introduction to Association and Statistical Independence 256

ASSOCIATION AND STATISTICAL INDEPENDENCE	258
MEASURING STRENGTH OF ASSOCIATION	262
ASSOCIATION AND CAUSATION	265
AN INFERENCEAL TEST ABOUT ASSOCIATION: CHI SQUARED	268
Degrees of Freedom	274
A Quicker Example	277
A TEST ABOUT TWO POPULATION PROPORTIONS	279
KEY CONCEPTS IN THIS CHAPTER	280
EXERCISES	281

11

Measures of Association for Discrete Variables 287

NOMINAL VARIABLES: LAMBDA	288
TWO-BY-TWO TABLES: YULE'S Q	292
ORDINAL VARIABLES IN TABLES THAT ARE LARGER THAN TWO-BY-TWO: GOODMAN AND KRUSKAL'S GAMMA	297
INFERENCEAL TESTS ABOUT G, THE POPULATION PARAMETER CORRESPONDING TO THE SAMPLE STATISTIC GAMMA	303
SUMMARY	305
KEY CONCEPTS IN THIS CHAPTER	305
EXERCISES	306

Interlude C

Statistical Doubletalk? 317

PERCENTAGE CHANGE AND PERCENTAGE POINTS	317
DIFFERENT BASES	318
COMPOUNDING AND ANNUALIZING	320
CHARTING CHANGES	321
CAUTION	324

12

Measures of Association for Continuous Variables 325

BACKGROUND	329
DESCRIBING DATA WITH A LINE	331
STRAIGHT-LINE MODEL	336
ESTIMATING A AND B : THE REGRESSION LINE	338
A PRACTICAL EXAMPLE	344
ASSUMPTIONS OF LINEAR REGRESSION MODELS	347
A TEST ABOUT COEFFICIENTS A AND B	350
Reprise: Urbanization and Per Capita Income	354
CORRELATION	356
Interval Estimates of the Correlation Coefficient, ρ	362
A CONCLUDING EXAMPLE	362
KEY CONCEPTS IN THIS CHAPTER	370
SUPPLEMENT 12.1: USING THE CALCULUS TO OBTAIN THE REGRESSION LINE	371
SUPPLEMENT 12.2: THE COMPUTATIONAL AND THE BASIC FORMULAS FOR b ARE EQUAL	372
SUPPLEMENT 12.3: RELATIONSHIP BETWEEN THE REGRESSION COEFFICIENT AND THE CORRELATION COEFFICIENT	373
EXERCISES	375

Interlude D**Political History of Correlation 383**

13

Analysis of Variance: The Case of Multiple Means 386

ANALYSIS OF VARIANCE: BASICS	388
ONE-WAY ANALYSIS OF VARIANCE	392
Narrative Summary	397
EXAMINING THE EFFECTS IN ONE-WAY ANOVA	399
Using Interval Estimates of μ_j	400
Tukey's Honestly Significant Difference	401
TWO-WAY ANALYSIS OF VARIANCE: AN INTRODUCTION	402
Main Effects and Interaction Effects	406
Restatement of the Three Null Hypotheses	411
Sums of Squares and Degrees of Freedom	412

<i>F</i> Test for Significance	415
Another Example	418
KEY CONCEPTS IN THIS CHAPTER	421
EXERCISES	422
Appendix A: Data Sets	428
Appendix B: Statistical Tables	443
Answers to Selected Exercises	466
Index	520