

RAND R. WILCOX

**FUNDAMENTALS
OF MODERN
STATISTICAL
METHODS**

**SUBSTANTIALLY IMPROVING
POWER AND ACCURACY**



Springer

CONTENTS

PREFACE

vii

1 • INTRODUCTION

<i>A Brief History of the Normal Curve</i>	3
<i>Empirical Studies Regarding Normality</i>	5
<i>Inferential Methods</i>	7

P A R T I

2 • GETTING STARTED

<i>Probability Curves</i>	12
<i>The Mean</i>	14
<i>The Median</i>	17
<i>A Weighted Mean</i>	19

<i>Variance</i>	20
<i>Measuring Error</i>	22
<i>Fitting a Straight Line to Data</i>	24
<i>A Summary of Key Points</i>	30

3 • THE NORMAL CURVE AND OUTLIER DETECTION

<i>The Normal Curve</i>	32
<i>Detecting Outliers</i>	33
<i>The Central Limit Theorem</i>	38
<i>Normality and the Median</i>	44
<i>A Summary of Key Points</i>	47

4 • ACCURACY AND INFERENCE

<i>Some Optimal Properties of the Mean</i>	50
<i>The Median Versus the Mean</i>	52
<i>Regression</i>	55
<i>Confidence Intervals</i>	58
<i>Confidence Interval for the Population Mean</i>	60
<i>Confidence Interval for the Slope</i>	62
<i>A Summary of Key Points</i>	65

5 • HYPOTHESIS TESTING AND SMALL SAMPLE SIZES

<i>Hypothesis Testing</i>	68
<i>The One-Sample T Test</i>	72
<i>Some Practical Problems with Student's T</i>	78
<i>The Two-Sample Case</i>	82
<i>The Good News About Student's T</i>	84
<i>The Bad News about Student's T</i>	85
<i>What Does Rejecting with Student's T Tell Us?</i>	87
<i>Comparing Multiple Groups</i>	89
<i>A Summary of Key Points</i>	89
<i>Bibliographic Notes</i>	90

6 • THE BOOTSTRAP

<i>Two Bootstrap Methods for Means</i>	94
<i>Testing Hypotheses</i>	104
<i>Why Does the Percentile t Bootstrap Beat Student's T</i>	104
<i>Comparing Two Independent Groups</i>	105
<i>Regression</i>	107
<i>Correlation and Tests of Independence</i>	109
<i>A Summary of Key Points</i>	115
<i>Bibliographic Notes</i>	115

7 • A FUNDAMENTAL PROBLEM

<i>Power</i>	120
<i>Another Look at Accuracy</i>	123
<i>The Graphical Interpretation of Variance</i>	124
<i>Outlier Detection</i>	126
<i>Measuring Effect Size</i>	127
<i>How Extreme Can the Mean Be?</i>	127
<i>Regression</i>	129
<i>Pearson's Correlation</i>	132
<i>More About Outlier Detection</i>	134
<i>A Summary of Key Points</i>	134
<i>Bibliographic Notes</i>	135

P A R T I I**8 • ROBUST MEASURES OF LOCATION**

<i>The Trimmed Mean</i>	141
<i>The Population Trimmed Mean</i>	147
<i>M-Estimators</i>	149
<i>Computing a One-Step M-Estimator of Location</i>	153
<i>A Summary of Key Points</i>	157
<i>Bibliographic Notes</i>	157

9 • INFERENCES ABOUT ROBUST MEASURES OF LOCATION

<i>Estimating the Variance of the Trimmed Mean</i>	159
<i>Inferences About the Population Trimmed Mean</i>	166
<i>The Relative Merits of Using a Trimmed Mean Versus a Mean</i>	169
<i>The Two-Sample Case</i>	170
<i>Power Using Trimmed Means Versus Means</i>	172
<i>Inferences about M-Estimators</i>	174
<i>The Two-Sample Case Using an M-Estimator</i>	175
<i>Some Remaining Issues</i>	175
<i>A Summary of Key Points</i>	177
<i>Bibliographic Notes</i>	178

10 • MEASURES OF ASSOCIATION

<i>What Does Pearson's Correlation Tell Us?</i>	179
<i>A Comment on Curvature</i>	183
<i>Other Ways Pearson's Correlation Is Used</i>	184
<i>The Winsorized Correlation</i>	187
<i>Spearman's Rho</i>	190
<i>Kendall's Tau</i>	191
<i>Methods Related to M-Estimators</i>	193
<i>A Possible Problem</i>	193
<i>Global Measures of Association</i>	196
<i>More Comments on Curvature</i>	200
<i>A Summary of Key Points</i>	202
<i>Bibliographic Notes</i>	203

11 • ROBUST REGRESSION

<i>Theil-Sen Estimator</i>	207
<i>Regression via Robust Correlation and Variances</i>	210
<i>L_1 Regression</i>	211
<i>Least Trimmed Squares</i>	212
<i>Least Trimmed Absolute Value</i>	216
<i>Least Median of Squares</i>	217
<i>Regression Outliers and Leverage Points</i>	217
<i>M-Estimators</i>	220
<i>The Deepest Regression Line</i>	223

<i>Relative Merits and Extensions to Multiple Predictors</i>	223
<i>Correlation Coefficients Based on Regression Estimators</i>	224
<i>A Summary of Key Points</i>	225
<i>Bibliographic Notes</i>	227
12 • ALTERNATE STRATEGIES	
<i>Ranked-Based Methods for Comparing Two Groups</i>	229
<i>Permutation Tests</i>	235
<i>Extension to Other Experimental Designs</i>	236
<i>Regression Based on Ranked Residuals</i>	240
<i>Software</i>	241
<i>A Summary of Key Points</i>	242
<i>Bibliographic Notes</i>	243
APPENDIX A	245
REFERENCES	249
INDEX	253