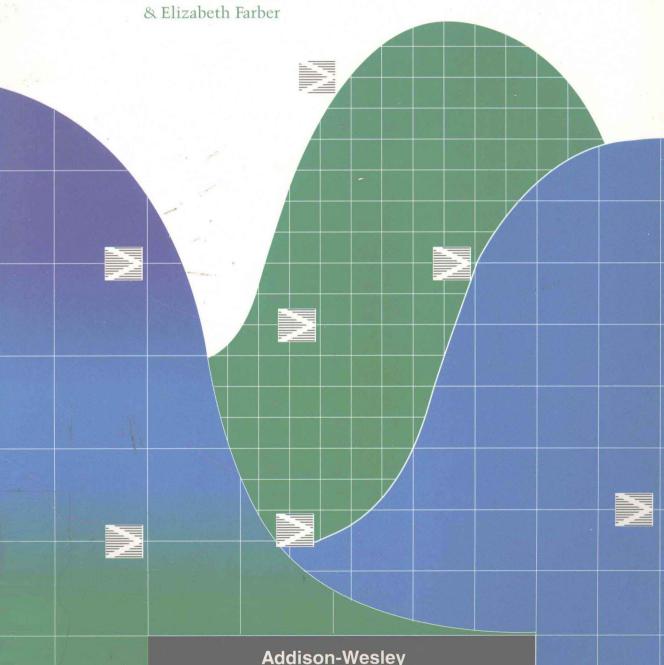
THE STUDENT EDITION OF

# MINITAB® 8

Statistical software...adapted for education

User's Manual by Robert-L. Schaefer





# THE STUDENT EDITION OF MINITAB® Release 8 Statistical software...adapted for education

Robert L. Schaefer Miami University at Oxford

Elizabeth Farber Bucks County Community College





Addison-Wesley Publishing Company, Inc. Benjamin/Cummings Publishing Company, Inc.

Reading, Massachusetts · Redwood City, California · New York Don Mills, Ontario · Wokingham, England · Amsterdam · Bonn Sydney · Singapore · Tokyo · Madrid · San Juan · Milan · Paris The Student Edition of MINITAB is published by Addison-Wesley Publishing Company, Inc. and Benjamin/Cummings Publishing Company, Inc. Contributors included:

Betsy Burr, Sponsoring Editor
Kristen Duerr, Project Coordinator
Barbara Clemens, Project Manager
Joan Carey, Developmental Editor
Mary Coffey, Production Manager
Nancy Benjamin, Production Supervisor
Susan Marsh, Text Designer
Linda Enrico, Cover and Package Designer
Joeth Barlas, Copy Editor
Patricia Gordon, Manufacturing Media Supervisor
TSI Graphics, Inc., Compositor

Photo and Minitab at Work credits appear on p. 604, which constitutes an extension of the copyright page.

Trademarks: MINITAB/Minitab is a registered trademark of Minitab Inc. Excel and Word are products of Microsoft Corporation. Microsoft and MS-DOS are registered trademarks, and Windows is a trademark of Microsoft Corporation. Epson is a registered trademark of Seiko Epson Corporation. HALO is a registered trademark of Media Cybernetics, Inc. Hercules is a registered trademark of Hercules Computer Technology, Inc. Hewlett-Packard, HP, and LaserJet are registered trademarks of Hewlett-Packard Corporation. IBM is a registered trademark, and PC-DOS is a trademark of International Business Machines Corporation. 80286 is a registered trademark of Intel Corporation. 1-2-3 and Symphony are registered trademarks of Lotus Development Corporation. Mac and Macintosh are registered trademarks of Apple Computer, Inc. PostScript is a registered trademark of Adobe Systems, Inc. Quattro is a registered trademark of Borland International, Inc. WordPerfect is a trademark of WordPerfect Corporation.

General Notice: Some of the product names used herein have been used for identification purposes only and may be trademarks of their respective companies.

The Student Edition of MINITAB User's Manual Copyright © 1992, Addison-Wesley Publishing Company, Inc.

The Student Edition of MINITAB Software Copyright © 1991, Minitab Inc. All rights reserved. Certain portions of this software are copyrighted by Language Systems Corp. © 1988, 1989.

It is a violation of copyright law to make a copy of the accompanying software except for backup purposes to guard against accidental loss or damage. Addison-Wesley assumes no responsibility for errors arising from duplication of the original programs.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher. Printed in the United States.

Reprinted July, 1994. ISBN 0-201-50649-1 (DOS 5 1/4" format) ISBN 0-201-50650-5 (DOS 3 1/2" format)

ISBN 0-201-82048-X (User's Manual)

Note: This product is also available in Macintosh format.

# THE STUDENT EDITION OF MINITAB® 8 Statistical software...adapted for education

### **Limited Warranty**

Addison-Wesley warrants that The Student Edition of Minitab ("the program") will substantially conform to the published specifications and to the documentation during the period of 90 days from the date of original purchase, provided that it is used on the computer hardware and with the operating system for which it was designed. Addison-Wesley also warrants that the magnetic media on which the program is distributed and the documentation are free from defects in materials and workmanship during the period of 90 days from the date of original purchase. Addison-Wesley will replace defective media or documentation or correct substantial program errors at no charge, provided you return the item with dated proof of purchase to Addison-Wesley within 90 days of the date of original purchase. If Addison-Wesley is unable to replace defective media or documentation or correct substantial program errors, your license fee will be refunded. These are your sole remedies for any breach of warranty.

Except as specifically provided above, Addison-Wesley makes no warranty or representation, either express or implied, with respect to this program, documentation, or media, including their quality, performance, merchantability, or fitness for a particular purpose.

Because programs are inherently complex and may not be completely free of errors, you are advised to verify your work. In no event will Addison-Wesley or Minitab be liable for direct, indirect, special, incidental, or consequential damages arising out of the use of or inability to use the program, documentation, or media, even if advised of the possibility of such damages. Specifically, neither Addison-Wesley nor Minitab is responsible for any costs including, but not limited to, those incurred as a result of lost profits or revenue (in any case, the program must be used only for educational purposes, as required by your license), loss of use of the computer program, loss of data, the costs of recovering such programs or data, the cost of any substitute program, claims by third parties, or for other similar costs. In no case shall the liability of Addison-Wesley or Minitab exceed the amount of the license fee.

The waltanty and remedies set forth above are exclusive and in lieu of all others, brail or written, express or implied. No Addison-Wesley dealer, distributor, agent, or employee is authorized to make any modification or addition to this warranty.

Some states do not allow the exclusion of implied warranties; if any implied warranties are found to exist, they are hereby limited in duration to the 90-day life of the express warranties given above. Some states do not allow the exclusion or limitation of incidental or consequential damages, nor any limitation on how long implied warranties last, so these limitations may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

To obtain performance of this warranty, return the item with dated proof of purchase within 90 days of the purchase date to: Addison-Wesley Publishing Company, Inc., Educational Software Division, Jacob Way, Reading, MA 01867.

# PREFACE

Welcome to The Student Edition of Minitab.

Minitab is a powerful tool originally developed at The Pennsylvania State University as a teaching aid for introductory statistics courses. Minitab is one of the most widely accepted statistical analysis packages for college instruction, and is currently used at over 2,000 schools. Minitab has also proven itself as an established research tool and is installed on mainframe, mini-, and microcomputers at over 3,000 sites in 51 countries worldwide, and is used by three-quarters of the companies listed in *Fortune* magazine's listing of the top 50 companies. Except for a few features, The Student Edition of Minitab is an identical version of this program and is designed to provide students with a tool for describing, analyzing, and displaying data.

The Student Edition of Minitab includes the following:

- a menu-driven interface providing easy access to all Minitab's statistical, graphical, and data management capabilities
- a data window permitting data entry, editing, and browsing in a spreadsheet-like display
- an on-screen help window that displays information on Minitab menus, commands, and options
- the ability to import and export data
- Lotus<sub>®</sub> 1-2-3<sub>®</sub> compatibility

- statistical process control charts
- similar interface, commands, and output across Macintosh and DOS platforms

# **Objectives**

The Student Edition of Minitab is designed to introduce students to a powerful statistical analysis program they can use to analyze and describe data. The primary objectives of the package are:

- to provide a complete educational environment for learning Minitab
- to provide students with a powerful and versatile tool that will enhance their learning experience
- to teach students the basics of Minitab in the context of case studies and data from business, life sciences, engineering, and the social sciences
- to provide teachers with a flexible means of integrating technology into their classrooms

# What's in This Edition?

The Student Edition of Minitab for the IBM features the same functionality as the previous IBM PC Student Edition, with the following new or enhanced features.

### Software

- larger worksheets that allow up to 3,500 data points and up to 100 columns
- new menu-driven interface with menus, dialog boxes, and improved access to help information
- the Minitab command language is still available
- the ability to scroll and to copy and paste in the Session window
- data editor that allows data entry and editing in a spreadsheet format
- high-resolution graphics for histograms, boxplots, scatter plots, multiple scatter plots, and control charts

PREFACE vii

titles, footnotes, axis labels on both low- and high-resolution plots

- multiple comparison procedures including Tukey. Fisher. Dunnet. and MCB with one-way analysis of variance
- SORT of multiple columns with BY and DESCENDING
- alpha data up to 80 characters long supported in COPY, DELETE, INFO, READ, INSERT, SORT, STACK, UNSTACK, and WRITE
- various additional commands, i.e., INDICATOR, YESNO, SAMPLE, MTSPLOT, COVARIANCE, CENTER, ONEWAY, ANOVA
- eleven statistical process control charts, including XBARCHART. RCHART, PCHART, and ICHART

### Manual

- new tutorials, including a tutorial on statistical process control charts, and an expanded tutorial on macros
- completely new examples, case studies, and exercises
- new data sets throughout with an emphasis on real-world data
- "Minitab at Work" boxes that show how Minitab is used in organizations throughout the United States
- Exploring Data section that describes all data sets, including five larger data sets with suggestions for analysis

# Manual

**Organization of This** The manual is organized into four sections. Part I, Getting Started, begins by detailing the contents of the Student Edition package. Chapter 1 includes a concise explanation of the conventions used throughout the manual, an introduction to the fundamentals of DOS, and information regarding technical support. Chapters 2 and 3 include complete, easy-to-follow instructions for installing, starting, and exiting Minitab. Chapter 4 consists of a comprehensive sample session, designed to give students an overview of the program and to interest them in its capabilities.

> Part II, Tutorials, is the heart of the manual. It contains fourteen interactive tutorials that teach students how to use Minitab by working with case studies from business, engineering, life sciences, and the social sciences.

Each tutorial begins with a list of objectives, and includes case studies that introduce students to Minitab commands. As students perform steps in the tutorial, screen views are shown in the manual to keep students on track and illustrate Minitab concepts and features. Each tutorial requires approximately 45 minutes to complete (not including practice problems).

Each tutorial ends with a summary and review section that includes a list of menu items that were introduced in or related to that tutorial. A set of practice problems follows, using the data sets from the tutorials as well as introducing new data sets. In selected tutorials, a "Minitab at Work" section illustrates how Minitab is used in organizations throughout the United States.

For those students unfamiliar with Minitab, the first four tutorials, dealing with data entry, manipulation, description, and summary, should be completed in order. The remaining tutorials can be completed in any sequence; however, the student should note that some tutorials are based on case studies introduced in earlier tutorials. The experienced Minitab user could proceed with any tutorial.

Part III, Exploring Data, contains descriptions of all the data sets used in the tutorials and practice problems. It also includes additional data sets, as well as larger data sets with suggestions for analysis.

Part IV, Reference, describes all of Minitab's features. It contains comprehensive descriptions of the Minitab commands, menus, functions, and Minitab basics. It also contains a discussion of selected Minitab topics, such as file types, importing and exporting data, and working with menus, dialog boxes, and the keyboard. In addition, it features chapters on more advanced topics: the data editor, the Minitab command language, and macros. Menu commands are cross-referenced to their corresponding Session window commands and the tutorials.

# The Differences Between the Student Edition and the Standard Version

The Student Edition is completely compatible with the commercial program but has the following limitations:

- the worksheet is limited to 3,500 data points and 100 columns
- matrix functions are not included
- selected commands have not been included (see Appendix E for a complete listing)

PREFACE

### **Acknowledgments**

The completion of this revision of The Student Edition of Minitab took over seven months and demanded a diverse team. At this time, we could not possibly list the complete team, since we had limited, if any, interaction with most of its members. Long before we wrote our first sentence, there were those who outlined what this manual would look like. Long after we wrote our last word, others took over to edit, produce, distribute, and market the final product. Everyone on the team, and their contributions, was crucial to the success of the revision. In particular, we would like to recognize those individuals with whom we worked on a regular basis.

Betsy Burr was instrumental in getting this project started. From her preliminary contact meeting to recruiting the final team, her organizational skill is attested to by the fact that this manuscript was completed well within schedule and incorporates her vision of what The Student Edition of Minitab would be. Many of the innovative features of this edition are due to her.

On a day-to-day basis we operated most closely and most frequently with Barbara Clemens and Kristen Duerr. The ambitious schedule, which seemed impossible at times, was easily met through their efforts. To successfully coordinate activities spanning three seasons of the year, four states, two time zones, and three word processing systems on two different computer platforms demanded extraordinary patience, a never-ending sense of humor, and exceptional managerial skills. We could not have done it without both of them.

Joan Carey's developmental editing improved the manuscript with each reading. Her merger of the new user interface and the Minitab command language in the reference section was a stroke of genius. To do all of this so professionally and competently and on schedule, while caring for twin one-year-olds, still amazes us.

Our thanks to the staff and programmers of Minitab, Inc., especially to Mike McCormick, Gwen Stimely, Bob Graf, Denny Huber, and Emil Hrivnak, who provided us with their technical expertise and created the software for this package.

Alan Jacobs provided valuable, and much appreciated, insight and solutions to particularly annoying problems.

Finally, we are grateful to the many reviewers who took time to find many of the typos, misspellings, and non sequiturs that somehow find their way into every manuscript. Your questions, comments, and suggestions have significantly improved this manual. ×

We would also like to thank the many reviewers and class testers whose diligent reading and thoughtful comments strengthened this work immeasurably.

### Reviewers

William Hannum, Syracuse University, New York Richard S. Lehman, Franklin and Marshall, Pennsylvania Don Myers, University of Arizona, Arizona Alex Olsen, University of Lowell, Massachusetts Calvin Williams, Clemson University, South Carolina

### **Class Testers**

University of Lowell, Massachusetts
Coordinator: Alex Olsen
Student Testers: Joyce Elder, David Hedison, Joseph Misserville,
Lyn Ann Misserville, Danielle White

Clemson University, South Carolina Coordinator: Calvin Williams Student Testers: Juliette Atkins, Wendy Cullen, Christopher Custodio, Amy Dickerson, Raymond Griffith

> Robert L. Schaefer Elizabeth Farber

# **CONTENTS**

# Part I Getting Started

# Chapter 1: Before You Begin 5

Checking Your Package 5
What's in This Book? 6
Required Computer System 7
Typographical Conventions 7
Technical Support 8
Using DOS 9
Formatting Disks 9
Copying the Sample Files Disk 11
Checking Disk Space 12

# Chapter 2: Installing Minitab

Before Installation 14
Installing Minitab 15
Setting Up Drivers 16
Setting Up Extended Memory 17

14

# Chapter 3: Starting and Stopping Minitab 19

Opening Minitab 19
Windows and Screens 20
The Session Window 20
Session Window Menus 21
Choosing Commands: Using the Help
Menu 22
Scrolling 23
Key Combinations 24
The Data Worksheet 24
The Data Screen Menu 25
Using the Mouse 26
Mouse Techniques 27
Exiting from Minitab 29

# Chapter 4: Sample Session 30

Case Study: Faculty Survey 31
Exploring an Existing Worksheet 31
Creating a New Variable 35
Describing a Variable Using Basic Statistics 37
Creating High-Resolution Graphs 39
Correlating Two Variables 43
Exiting from Minitab 44

## Part II Tutorials

# Tutorial 1: Working with Data 49

Case Study: Nutrition 50 Using Minitab Menus 51 Viewing the Data Worksheet 52 Moving Around the Data Worksheet 53 Using the Data Screen Menu 54 Entering Data 56 Alpha Data 59 Naming Columns 59 Saving Data 60 Retrieving Data 63 Manipulating Data with the General Expressions Command 66 Copying a Column 70 Getting Help 72 Case Study: Consultant 74 Deleting and Inserting Rows 75 Deleting Columns 78 Copying Parts of a Column Case Study: Teaching 82 Importing a Data File Created with a Word Processor 82 Using the Session Window 85 Minitab Command Summary 88 Review and Practice 90

# Tutorial 2: Summarizing, Transforming, and Manipulating Data 94

Mean, Median, and Round 95
Summarizing Columns 99
Listing Columns in the Session Window 100
Combining Data with the Stack
Command 101
Coding Data 103
Ranking Data 105

Sorting Data 106
Separating Data with Unstack 108
Standardizing Data 110
Getting Worksheet Information 111
Printing the Record of Your Session 112
Creating an Outfile 114
Minitab Command Summary 116
Review and Practice 118

# Tutorial 3: Graphical Methods for Describing Data 121

Graphics Modes 122
Graphing Single Variables 122
Creating Histograms 123
Creating a Dotplot 127
Creating a Stem-and-Leaf Plot 130
Creating a Boxplot 133
Plotting One Variable Against Another 135
Minitab at Work: Forestry 136
Creating a Scatter Plot 136
Using Tags in Scatter Plots 140
Creating a Multiple Scatter Plot 142
Printing Graphs 143
Saving Graphs 145
Minitab Command Summary 146
Review and Practice 147

# Tutorial 4: Numerical Methods for Describing Data 150

Describing Data 151
Other Descriptive Statistics 153
Converting Alpha Data to Numeric 155
Describing Data Separately for Each Value of a
By Variable 158
Calculating Frequencies 159
Covariance 163
Correlation 165
Minitab Command Summary 166
Review and Practice 167

CONTENTS xiii

# Tutorial 5: Distributions and Random Data 170

Case Study: Blood Types 171

Discrete Probability Functions 171

Cumulative Probability Distributions for
Discrete Variables 176

Case Study: Genetics 178

Generating Random Data from Discrete
Distributions 178

Case Study: Heights 181

Generating Random Data from a Continuous
Distribution 181

Obtaining the Normal Probability Plot Using
Normal Scores 183

Minitab at Work: Public Safety 184

Inverse Cumulative Functions for Continuous
Distributions 187

# Tutorial 6: Inference from One Sample 195

Minitab Command Summary 191

Sampling from a Column 189

Review and Practice 192

Case Study: Crowdedness 196
Testing μ When σ Is Known 197
Computing a Confidence Interval for μ When σ
Is Known 200

Case Study: Revenues 201 Testing  $\mu$  When  $\sigma$  Is Unknown 201 Minitab at Work: Retailing 203 Computing a Confidence Interval for  $\mu$  When  $\sigma$  Is Unknown 203

Case Study: Election 204
Testing and Obtaining a Confidence Interval for a Population Proportion 204
Minitab Command Summary 208
Review and Practice 208

# Tutorial 7: Inference from Two Samples 211

Testing the Difference Between Two

Samples in Separate Columns 212
Case Study: Blood Pressure 214
Testing the Difference Between Two
Population Means Using Two Independent
Samples Stacked in a Single Column 214
Testing the Difference Between Two
Population Means Using Paired
Samples 217

Population Means Using Two Independent

Case Study: Blood Clotting 218

Minitab at Work: Scientific Research 219

Calculating a Confidence Interval for the

Difference Between Two Population Means
Using Paired Samples 221

Minitab Command Summary 222

Review and Practice 223

# Tutorial 8: Comparing Population Means: Analysis of Variance 226

Case Study: Electronics 227
Comparing the Means of Several
Populations 228
Fitted and Residual Values 229
NScores and a Check for Normality 230
Checking for Constant Variance 232
Tukey Multiple Comparison Test 233
Comparing the Means of Several Populations with Responses in Separate Columns 234
Assessing the Effects of Two Factors on a Response 236

Case Study: Marketing 236
Minitab Command Summary 245
Review and Practice 246

# Tutorial 9: Examining Linear Relationships Between Variables: Regression 248

Finding a Straight Line Fit to Data: Simple
Linear Regression 249
Polynomial Regression Models 256
Multiple Linear Regression 258
Stepwise Multiple Regression 261
Minitab at Work: Ecology 262
Stepwise Selection 263
Forward Selection 265
Backward Elimination 266
Minitab Command Summary 268
Review and Practice 269

# **Tutorial 10:**

## **Analyzing Categorical Data** 272

Comparing an Observed Distribution to a
Hypothesized Distribution 273
Case Study: Transistors 277
Testing the Relationship Between Two
Categorical Variables in a Contingency
Table 277
Testing the Relationship Between Two
Categorical Variables Using Raw Data 279
Minitab at Work: Education 282
Minitab Command Summary 285
Review and Practice 286

# Tutorial 11:

# Analyzing Data with Nonparametric Methods 288

Checking a Sampling Process for Randomness with the Runs Test 289

Testing the Population Median 291

Comparing the Medians of Two
Populations 293

Case Study: Banking 293

Case Study: Banking 293
Minitab at Work: Medical Diagnostics 294

Comparing the Centers of K Populations 296 Minitab Command Summary 299 Review and Practice 300

# Tutorial 12:

Statistical Process Control 303

Constructing an Xbar Chart 304
Constructing a Range Chart 307
Constructing an Individuals Chart 308
Constructing a Moving Range Chart 312
Constructing a Proportion Chart 313
Minitab Command Summary 316
Review and Practice 317

# Tutorial 13: Time Series Analysis 320

Case Study: Environment 321
Plotting a Time Series 321
Checking the Autocorrelation and Partial Autocorrelation Plots 323
Transforming a Time Series 326
Box-Jenkins (ARIMA) Analysis of a Time Series 329
Minitab at Work: Stock Market 330
Forecasting Using ARIMA 333
Minitab Command Summary 336
Review and Practice 337

# Tutorial 14: Macros 340

Menu Commands and the Minitab Command
Language 341
Executing a Macro Several Times 347
Creating a Macro Using a Word Processor 349
Generalizing a Macro 353
Other Enhancements to Macros 356
Minitab Command Summary 362
Review and Practice 362

CONTENTS XV

# Part III **Exploring Data**

Exploring Data: Other Data Sets Exploring Data: Larger Data Sets 375

Data Sets Used in Tutorials and Exercises 384

# Part IV Reference

# Chapter 1: **Special Topics** 409

Working with Menus, Dialog Boxes, and the Keyboard 409 Alpha Data 417 File Types 417 Importing and Exporting Data 419

# Chapter 2: Session Window Menu Reference 428

Using the Session Window 428 The File Menu 433 The Edit Menu 443 The Calc Menu 448 The Stat Menu 472 The Graph Menu 525 The Help Menu 539

# Chapter 3:

**Data Editor Menu Reference** 542

Using the Data Editor 542 Data Editor Ouick Reference 543 The Data Screen Menu Reference 545 The Data Screen Help Menu 548

# Chapter 4:

Minitab Command Language 549

Session Commands 549

Subcommands 549 Syntax Rules for Session Commands 550 Using Symbols 550 Session Commands Not Available Through the Menus 551

# Chapter 5: Macros 553

A Simple Example 553 How to Create Macros 554 Looping Through Commands 554 Looping Through Columns 555 Conditional Execution and Nesting Macros 555 Interactive Macros 556 Using YESNO 556 Using NOECHO and ECHO 557

# Appendix A: Session Command / Menu Command Equivalents 559

# Appendix B: Additional Installation and System Notes 567

Appendix C: **High-Resolution Graphics** 576

Appendix D: Error Messages 581

# Appendix E: Student Edition Limits and Drivers 589

# Appendix F: Statistical Reference Texts and Companion Textbooks 593

Index 605

DEPT NUM		CE Z. 2. 2. 3.
ACC	321	3.42
ACC ACC AER	344 181 426	3.25 3.29 2.47 3.00
E ARC ART B ART B ART ATH	111 111 211 485	3.17 3.60 2.50
A STATE OF THE PARTY OF THE PAR	155 212	2.92
12 ATH 12 CHI 13 CHI 14 CHI 14 CHI	141	1.36
CLASTICLASTICS OF THE PROPERTY	M 59	