STATISTICS

An Introduction

Robert D. Mason
Douglas A. Lind
William G. Marchal

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Robert D. Mason
Douglas A. Lind
William G. Marchal
The University of Toledo

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To Dorothy, Jane, and Andrea

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Preface

This text has been designed for use in introductory statistics courses. Principles of both descriptive and inferential statistics are discussed, illustrated, and applied in situations close to most students' own experience. The mathematics can be handled easily by students with a limited background.

We have written and organized the material to provide the greatest possible flexibility of use in both content and format. The book's content is appropriate for any general statistics course. Illustrations and exercises are drawn from disciplines as varied as sociology, education, politics, demography, meteorology, sports, and mathematics. Considerable latitude has also been built into the organization of the chapter topics, so that the text can easily be adapted for use in one-semester, one-quarter, or two-quarter courses. A one-semester course, for example, might include Chapters 1–10, 13, and 14. Time permitting, Chapter 16 would be a logical addition.

A number of special features set this text apart in motivating and assisting students as they progress through the material:

- Each chapter begins with a set of performance objectives—what the reader should be able to do on completion of that chapter. The objectives serve the dual function of advance organizers and motivators.
- A brief chapter introduction reviews important concepts presented in the previous chapter and explains how they are linked to the present chapter. The introduction is followed by a chapter overview.
- The discussion of each concept is followed by a realistic statistical problem and its solution.

- A number of self-reviews are interspersed in each chapter. Each self-review is closely patterned after the chapter problems that preceded it. Answers and methods of solution are always shown in the margin. These self-reviews help students to monitor their own progress and provide them with constant reinforcement.
- Many interesting real-world exercises are incorporated in the body and at the end of each chapter. The answers and methods of solution for all even-numbered exercises are supplied in the book's appendix.
- Every important new term and formula is defined and placed in a box for easy reference.
- Both a summary and a chapter outline are included in every chapter. They are a valuable aid to students in pulling together a chapter's main ideas.
- An end-of-chapter achievement test covers all the material in that chapter, helping students to evaluate their own overall comprehension of the subject matter. Answers and methods of solution are provided in the appendix.
- A set of chapter highlights is included after each of six major groups of chapters. They include a brief review, key concepts, key terms, key symbols, review problems, and two ongoing cases (one dealing with a grocery store chain, and the other with a hospital) to be analyzed by the students.
- Throughout the book, a number of computer applications using the Statistical Package for the Social Sciences, MINITAB, and the BASIC programming language illustrate the computer's potential for problem solving.
- A complete glossary of terms and a set of standard statistical tables are also included in the book's appendix.
- The normal and t distributions are repeated inside the front cover for easy reference.
- In addition, a simple flowchart inside the back cover aids students in selecting the appropriate formula for computing the mean and the standard deviation.

A complete ancillary package accompanies the text. It includes a Study Guide, a Solutions Manual, and a set of suggested test questions for each chapter. The Study Guide is comprehensive, with an organization similar to that of the main text. Each chapter includes chapter objectives, an extensive summary, solved problems, student exercises with answers and methods of solution in the appen-

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dix, and tear-out chapter assignments to be graded by the instructor. Ample space is provided for computations. The Solutions Manual contains the full solutions to all exercises in the textbook and to all chapter assignments in the Study Guide.

Finally, we wish to acknowledge the valuable contribution made to this book by friends, students, colleagues, and collaborators throughout its various stages of development. In particular, we would like to express our thanks and appreciation to Richard J. Beres, John J. Bodner, Patricia S. DeJarnette, and Toni M. Somers at the University of Toledo, and Jerry Bergman, Spring Arbor College, for their helpful suggestions and assistance in class testing portions of the manuscript. Special thanks to Patricia E. Hetrick, who proofread the manuscript and checked the solutions, and to Dolores A. Lucitte and Jean K. Schaefer for typing some of the material.

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ROBERT D. MASON

DOUGLAS A. LIND

WILLIAM G. MARCHAL

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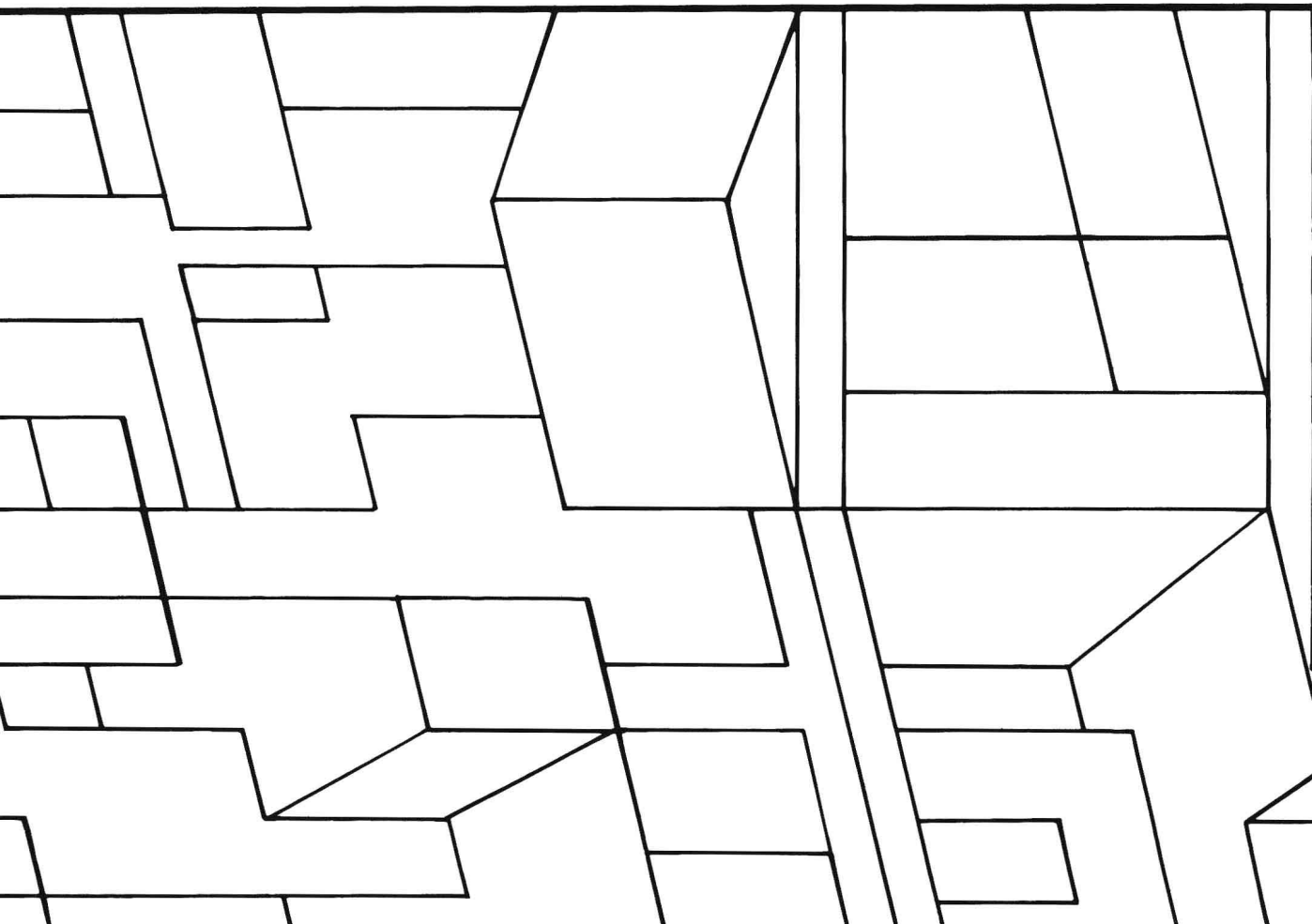
1
What Is Statistics?



Introduction

Whenever we watch television, listen to the radio, or read a newspaper or magazine, all of us are exposed to—and sometimes overwhelmed by—assorted facts and figures commonly labelled "statistics." We may read or hear that

- The Consumer Price Index increased 0.8% last month.
- More than 97% of all households in the United States have television sets.
- One violent crime is committed every 27 seconds.
- The Dallas Cowboys defeated the Los Angeles Rams 29 to 17. The Cowboys had 24 first downs, the Rams 22. The passing yards were 275 for Dallas, 203 for Los Angeles. Dallas was penalized 108 yards, Los Angeles 78 yards.

As a result, you may envision a statistician as someone who sits in the press box and collects numerical data on passing yardage, punt returns, and so on and releases statistics like these:

Rams - Cowboys

October 18

Score by Periods

Los Angeles . .	0	10	7	0—17
Dallas	12	14	0	3—29

Scoring

Dallas—Springs 1 run (Septien kick).
Dallas—Field goal Septien 40.
Dallas—Safety, Haden tackled in end zone.
Dallas—Dorsett 44 run (Septien kick).
Los Angeles—Tyler 2 run (Corral kick).
Los Angeles—Field goal Corral 40.
Dallas—Hill 63 pass from D. White (Septien kick).
Los Angeles—D. Hill 43 pass from Haden (Corral kick).
Dallas—Field goal Septien 39.

Team Statistics

	Los Angeles	Dallas
First downs . .	22	24
Rushes - Yards . . .	34 - 171	42 - 221

Individual Statistics

Rushing—Dallas, Dorsett 27 - 159, Springs 12 - 41, D. White 3 - 21; Los Angeles, Tyler 16 - 90, Bryant 14 - 53, Haden 2 - 17, Guman 2 - 11.

Passing—Dallas, D. White 15 - 33 - 2 —277; Los Angeles, Haden 13 - 30 - 3 —237.

Receiving—Dallas, Hill 4 - 97, Pearson 4 - 78, Saldi 2 - 17, Cosbie 1 - 28, Dorsett 1 - 22, DuPree 1 - 15, Johnson 1 - 15, Springs 1 - 5; Los Angeles, Miller 4 - 51, Moore 3 - 53, D. Hill 2 - 88, Bryant 2 - 13, Childs 1 - 19, Arnold 1 - 13.

Kickoff Returns—Los Angeles, D. Hill 6 - 95; Dallas, J. Jones 2 - 40, Fellows 1 - 14.

Punt Returns—Los Angeles, Irvin 3 - 13; Dallas, J. Jones 1 - 9, Fellows 2 - 6.

Interceptions—Los Angeles, Cromwell 2 - 0; Dallas, Walls 2 - 0, Thurman 1 - 0.

Punting—Los Angeles, Corral 5 - 48.0; Dallas, D. White 5 - 42.6.

Such sports data *are,* in fact, one variety of statistics—a collection of numerical data. However, statistics also has a broader meaning. The boxed definition that follows is the one we will consider throughout.

> **Statistics** The body of techniques used to facilitate the collection, organization, presentation, analysis, and interpretation of data for the purpose of making better decisions.

Types of Statistics

Descriptive Statistics

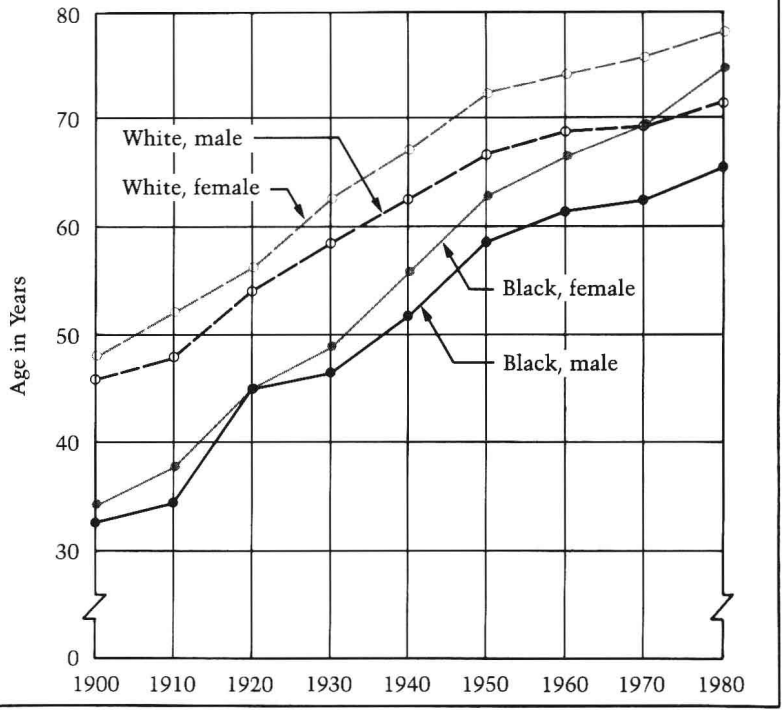
As stated in the definition, statistics involves, among other things, the collection, organization, and presentation of numerical data. Masses of unorganized data stored in a computer, or collected by Gallup-type polls with respect to the preference of voters, are usually of little value. Techniques are available, however, to organize such data into some meaningful form. These aids in organizing, analyzing, and describing (or summarizing) a large collection of numbers are collectively referred to as **descriptive statistics.**

> **Descriptive Statistics** Methods used to describe the data that have been collected.

We will discuss one such summary technique, called a frequency distribution, in Chapter 2. In that chapter, we will also examine how data can be presented graphically. For example, over 300 separate figures were needed to create a chart of a population's life expectancy at birth, by ethnic background and sex, since 1900 (see Figure 1-1). At a single glance, this chart reveals that the life expectancy for all groups has risen dramatically since 1900—with the life expectancy for blacks having increased over 100%.

Figure 1-1

Life Expectancy at Birth, by Ethnic Background and Sex: U.S. 1900-1980



In Chapter 3 we will study the tendency of numerical data to cluster about a central value. An analysis of the spread or variation in the data using measures such as the standard deviation and the variance will be found in Chapter 4.

Inferential Statistics

Descriptive statistics is only one facet of the science of statistics. Another is **inferential statistics** or **inductive statistics.** Inferential statistical methods are concerned with finding out something about a **population.** Gallup, Harris, and other pollsters do just that when they are hired before an election to find out how voters (the population) plan to vote on election day.

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