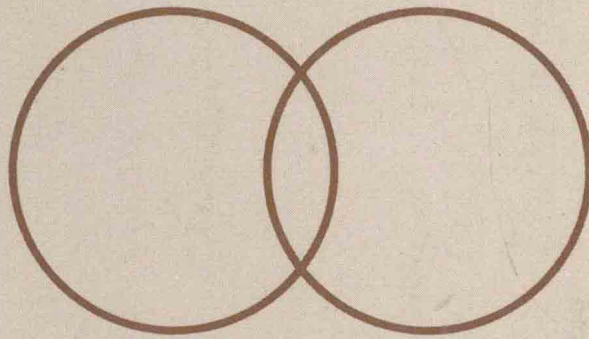


STUDY GUIDE
TO ACCOMPANY
DANIEL • TERRELL
**BUSINESS
STATISTICS**



SECOND EDITION

STUDY GUIDE TO ACCOMPANY
**BUSINESS
STATISTICS**
BASIC CONCEPTS AND METHODOLOGY

WAYNE W. DANIEL · JAMES C. TERRELL
SECOND EDITION

HOUGHTON MIFFLIN COMPANY BOSTON

Dallas Geneva, Illinois Hopewell, New Jersey Palo Alto London

Copyright © 1979 by Houghton Mifflin Company. All rights reserved.
No part of this work may be reproduced or transmitted in any form
or by any means, electronic or mechanical, including photocopying
and recording, or by any information storage or retrieval system,
without permission in writing from the publisher.

Printed in the U.S.A.

Library of Congress Catalog Card Number: 78-69607

ISBN: 0-395-26764-1

PREFACE

The purpose of this study guide is to help you, the student, learn the concepts and techniques of statistics. It is designed for use as a supplementary learning aid to accompany our textbook, *Business Statistics: Basic Concepts and Methodology*, second edition.

The chapters of this study guide correspond, section by section, to the chapters in *Business Statistics*. Before you try to answer the questions in the study guide, you should carefully study the corresponding explanatory material found in the text.

We cover both the concepts and the arithmetic and algebraic techniques necessary for an understanding of basic statistical methodology. The study guide uses a programmed approach. The questions are designed for fill-in-the-blank type responses and either blanks or blank spaces are provided for your use in responding directly on the page before you. Cover the answers with a strip of cardboard (provided for your convenience just inside the back cover of the book) until you have written down your answers.

We provide you with many computational problems which are broken down into the basic steps of their solution. You can therefore check, step-by-step, your knowledge of the computations involved in arriving at a solution. This procedure allows you to correct mistakes and learn the right procedures before arriving at the final answer.

We would like to express our appreciation to Mary Daniel, who typed the manuscript for this study guide, and to Professor Hilbert Schultz, University of Wisconsin-Oshkosh, and Mr. Jeff David, former graduate student at Iowa State University (now employed with American Telephone and Telegraph Company). They read the manuscript in detail, made many suggestions for improvement, and uncovered some errors.

Wayne W. Daniel
James C. Terrell

CONTENTS

Preface	viii	4 Some important probability distributions	43
1 The role of statistics in the decision-making process	1	4.1 Introduction	44
1.1 Introduction	2	4.2 Probability distributions of discrete random variables	44
1.2 The role of statistics in decision making	2	4.3 The binomial distribution	46
1.3 Basic principles and concepts of special studies	3	4.4 The Poisson distribution	48
1.4 Steps involved in planning and conducting special studies	3	4.5 The hypergeometric distribution	52
		4.6 Probability distributions of continuous random variables	53
		4.7 The normal distribution	55
		Review questions	63
2 Organizing and summarizing data	5	5 Some important sampling distributions	67
2.1 Introduction	6	5.2 Simple random sampling	68
2.2 Some basic vocabulary	6	5.3 Sampling distributions	69
2.3 Summarizing data: the ordered array	7	5.4 Distribution of the sample mean	70
2.4 Summarizing data: the frequency distribution	8	5.5 Distribution of the difference between two sample means	74
2.5 Summarizing data: the histogram and frequency polygon	11	5.6 Distribution of the sample proportion	76
2.6 Summarizing data: descriptive measures	12	5.7 Distribution of the difference between two sample proportions	78
2.7 Descriptive measures computed from grouped data	15	Review questions	80
Review questions	19	6 Statistical inference I: estimation	85
3 Some elementary probability concepts	23	6.1 Introduction	86
3.1 Introduction	24	6.2 Properties of good estimators	86
3.2 Set concepts and notation (basic notions)	24	6.3 The population mean—known population variance	88
3.3 Counting techniques—permutations and combinations	30	6.4 The population mean—unknown population variance	93
3.4 Different views of probability	33	6.5 The difference between two population means—known population variances	97
3.5 Elementary properties of probability	34	6.6 The difference between two population means—unknown population variances	98
3.6 Calculating the probability of an event	35	6.7 The population proportion	100
3.7 Bayes' Theorem	37	6.8 The difference between two population proportions	102
Review questions	38		

6.9	Determination of sample size for estimating means	103	8.3	Testing for significant differences between individual pairs of means	152
6.10	Determination of sample size for estimating proportions	105	8.4	The randomized complete block design	153
6.11	Confidence interval for the variance of a normally distributed population	106	8.5	The Latin square design	157
6.12	Ratio of the variances of two normally distributed populations	108	8.6	The factorial experiment	162
	Review questions	109		Review questions	166
7	Statistical inference II: hypothesis testing	115	9	Simple linear regression and correlation	174
7.1	Introduction	116	9.1	Introduction	175
7.2	Hypothesis testing—some general considerations	116	9.2	The simple linear regression model	175
7.3	The mean of a normally distributed population—known population variance	122	9.3	The assumptions underlying simple linear regression	176
7.4	The mean of a normally distributed population—unknown population variance	124	9.4	Obtaining the sample regression equation	177
7.5	The mean of a population that is not normally distributed	127	9.5	Evaluating the sample regression equation	178
7.6	The difference between the means of two normally distributed populations	130	9.6	Using the sample regression equation	183
7.7	The difference between the means of two populations not normally distributed	131	9.7	The correlation model	184
7.8	Testing a hypothesis about a population proportion	132	9.8	The correlation coefficient	185
7.9	The difference between two population proportions	134		Review questions	186
7.10	Testing a hypothesis about the variance of a normally distributed population	135	10	Multiple regression and correlation	193
7.11	The ratio of the variances of two normally distributed populations	136	10.1	Introduction	194
7.12	The type II error and the power of a test	137	10.2	The multiple-regression model and its underlying assumptions	194
7.13	Determining sample size to control both type I and type II errors	140	10.3	Obtaining the sample multiple-regression equation	195
	Review questions	142	10.4	Evaluating the regression equation	199
8	Analysis of variance	147	10.5	Using the sample multiple-regression equation	202
8.1	Introduction	148	10.6	The multiple-correlation model	204
8.2	The completely randomized design	149	10.7	Choosing the independent variables for the regression equation	206
				Review questions	206
			11	The chi-square distribution and the analysis of frequencies	214
			11.2	The mathematical properties of the chi-square distribution	215
			11.3	Tests of goodness of fit	215
			11.4	Tests of independence	220
			11.5	Tests of homogeneity	223
				Review questions	226

12	Nonparametric statistics	231	14.3	Basic theory	272
12.1	Introduction	232	14.4	Additional concepts	273
12.2	When to use nonparametric statistics	232	14.5	Steps involved in a sample survey	274
12.3	Measurement and measurement scales	233	14.6	Stratified random sampling	274
12.4	Advantages and disadvantages of nonparametric statistics	233	14.7	Cluster sampling	276
12.5	The one-sample runs test	234	14.8	Systematic sampling	278
12.6	The median test	235	14.9	Costs, efficiency, and sample size	279
12.7	The sign test	236	14.10	Nonprobability sampling procedures	284
12.8	The Kruskal-Wallis one-way analysis of variance by ranks	237		Review questions	284
12.9	The Friedman two-way analysis of variance by ranks	239	15	Statistical decision theory	288
12.10	The Spearman rank correlation coefficient	241	15.1	Introduction	289
	Review questions	242	15.2	Some basic ideas	289
13	Time series analysis and index numbers	250	15.3	Application of the Bayes criterion	293
13.1	Introduction	251	15.4	Utility theory	294
13.2	Secular trend	252	15.5	Bayesian decision theory and classical statistical inference	295
13.3	The moving average	255		Review questions	295
13.4	Measuring seasonal variation	257	16	Some statistical applications in quality control	302
13.5	Measuring cyclical variation	261	16.1	Introduction	303
13.6	Forecasting	263	16.2	Control charts—variables	303
13.7	Index numbers	265	16.3	Control charts—attributes	305
13.8	Aggregative price indexes	266	16.4	Acceptance sampling for attributes	306
	Review questions	268	16.5	Acceptance sampling by variables	307
14	Elementary survey sampling	271		Review questions	308
14.1	Introduction	272			
14.2	Applications	272			

1

THE ROLE OF STATISTICS IN THE DECISION-MAKING PROCESS

Chapter Objectives

This chapter is concerned with the increasing complexity confronting the manager or business decision maker in today's world. It discusses the role that statistics can play in the decision-making process. It also covers the basic principles and steps that are involved in planning and conducting special statistical studies. After studying this chapter, you should be able to do the following.

1. Explain the major reasons for the increasing use of the scientific method and management-information systems by business decision makers and researchers
2. Describe how statistics relates to business decision making
3. Discuss the basic principles involved in conducting statistical studies
4. List a set of steps that can help ensure that statistical studies are properly planned and conducted

1.1

objectivity, inductive

examination

measurement

concepts, hypotheses

theory

data

decisions

INTRODUCTION

1. The scientific method is characterized by _____, _____ reasoning, and a systematic _____ and _____ of facts.
2. The accumulation of facts is followed by the formulation of _____, _____, and _____, all of which may be modified later as additional facts are collected.
3. The ultimate objective of the manager and the researcher is to assemble _____ of sufficient quantity and quality to provide a basis for making sound _____.

1.2

scientific

decisions

uncertainty

aid

THE ROLE OF STATISTICS IN DECISION MAKING

1. Statistics may be described as the technology of the _____ method. It consists of a set of tools that are used to facilitate the making of _____ whenever conditions of _____ prevail.
2. The proper use of statistics is to _____ in decision making.

1.3

**BASIC PRINCIPLES AND CONCEPTS
OF SPECIAL STUDIES**

value

feasible

objectives

data

resources

value

1. When proposing a study, one should determine whether the study is of _____ and whether it is _____.
2. In determining the feasibility of a study, you should answer the following questions.
 - (a) Can the _____ be achieved?
 - (b) Are required _____ readily available?
 - (c) Will needed _____ be available?
 - (d) Will the study be of sufficient _____ to warrant the expenditure of resources?

1.4

**STEPS INVOLVED IN PLANNING AND
CONDUCTING SPECIAL STUDIES**

purpose

objectives

analyses

data

1. The five steps of the planning phase of a study are as follows.
 - (a) Prepare a clear and concise statement of _____.
 - (b) Develop a set of meaningful and measurable specific _____.
 - (c) Determine the _____ necessary to achieve the objectives.
 - (d) Determine what _____ are required in order for the analyses to be performed.

data collection	(e) Specify in detail the _____ plans.
	2. The five steps in the accomplishment phase of a study are as follows.
Collect	(a) _____ the data.
Edit, organize	(b) _____ and _____ the data.
Perform	(c) _____ the planned analyses of the data.
Achieve analyses	(d) _____ each specific objective based on the planned _____.
Evaluate	(e) _____ the general study objectives based on the results of the efforts to achieve the specific objectives.

2

ORGANIZING AND SUMMARIZING DATA

Chapter Objectives

This chapter teaches you some of the basic techniques used in describing and summarizing important characteristics of a set of data. In addition, this chapter helps you to understand and use these techniques. These skills are essential for handling much of the material in the remainder of the text. After studying this chapter and working the exercises, you should be able to do the following.

1. Use some basic vocabulary necessary for understanding statistics
2. Organize and summarize data so that they can be better understood
3. Effectively communicate the important information contained in a set of data by means of graphs
4. Compute numerical quantities that measure the central tendency and dispersion of a set of data

2.1

INTRODUCTION

descriptive statistics

inferential statistics

descriptive statistics

Inferential statistics

1. Applied statistics can be considered to consist of

and _____.

2. Methods of organizing, summarizing, and presenting statistical data are known as _____

_____.

3. _____ is concerned with reaching conclusions (making inferences) about a body of data by examining only a part of the data.

2.2

SOME BASIC VOCABULARY

entity

variable

constant

random variable

1. The unit on which we take a measurement or make an observation is referred to as an _____.
2. If a characteristic assumes different values for different entities, then that characteristic is called a _____.
3. A characteristic that retains the same value from entity to entity is called a _____.
4. If you cannot predict the exact value that a particular variable will assume, but you know the different values that the variable can assume and the relative frequency with which each of these values will occur, then that variable is known as a _____.

variate

5. The term _____ is used frequently as a synonym for random variable.

quantitative

6. Measurements and counts, such as weights or numbers of items sold, are examples of _____ variables.

qualitative

7. Color of paint, sex, and nationality are examples of _____ variables.

discrete

8. The number of students attending class is an example of a _____ variable.

continuous

9. A variable—such as height, weight, or temperature—that can theoretically take on any value in an interval is a _____ variable.

population

10. The largest group or collection of values in which one has an interest is the _____.

sample

11. A portion or fraction of a population is a _____.

random

12. A sample selected in such a manner that the results of its analysis allow inferences to be made about the population is a _____ sample.

2.3

SUMMARIZING DATA: THE ORDERED ARRAY

ordered array

1. When a group of observations is arranged in order of increasing magnitude of the values, we have an _____.

pencil, paper, and calculator

computer

2. An ordered array can be very useful when the tools used in the analysis are _____.
3. An ordered array may be of no real value when all calculations are made by a _____.

2.4

class intervals

upper limit

lower limit

6

15

 $1 + 3.322(\log_{10} n)$

SUMMARIZING DATA: THE FREQUENCY DISTRIBUTION

1. Contiguous and nonoverlapping categories that are used for classifying a set of data are called _____.
2. Each class interval is clearly specified by its _____ and _____.
3. There is no generally accepted procedure for determining the number of class intervals needed for a frequency distribution. Usually the number of intervals should be no fewer than _____ nor more than _____. According to Sturges' rule, the number of intervals k should be approximately equal to _____, where n is the number of observations.

4. The range of scores and number of observations in each of four sets of data are shown below. Use Sturges' rule to find a suggested number of class intervals for each, and compute an approximate interval width.

Range of scores	No. of observations	No. of intervals	Approximate interval width
16-38	100	_____	_____
21-87	50	_____	_____
5-34	150	_____	_____
1-20	40	_____	_____

5. It is usually best to have class intervals of equal

width

_____. The width used should be

convenient

_____ to work with.

6. Each observation in a set of data should be classified

into one and only one of the _____

class intervals

_____.

7. After you select class intervals and classify each observation into one of the intervals, you should make a count of the number (frequency) of observations falling into each interval. The result is a

frequency distribution

_____.

8. We usually show a frequency distribution as a

table, graph

_____ or _____.

9. If the values of a given set of observations range from 10 through 44, an acceptable set of class intervals

7	might be _____ intervals with widths of
5	_____ units each.
	10. From the data in the preceding exercise, compute true class limits.
-14.5	9.5-_____
14.5-19.5	_____
19.5-24.5	_____
24.5-29.5	_____
29.5-34.5	_____
34.5-39.5	_____
39.5	_____ -44.5
	11. You can convert a frequency distribution for a set of
relative frequency	observations to a _____
frequency	distribution by dividing the _____
	(number of observations) in each class interval by the
	total number of observations. The resulting
relative	_____ frequency for each interval is the
proportion	_____ of the total
	number of observations that fall into that interval.
	12. You can convert a frequency distribution for a set of
cumulative	observations to a _____
	frequency distribution by adding the frequency of each
preceding	class interval to the total frequency of all
	_____ intervals.