

STATISTICS

THEORY AND PRACTICE

8e

A comprehensive and easy to understand text, *Statistics – Theory and Practice* discusses fundamental theoretical concepts with emphasis on practical applicability. The book begins with the explanation of statistical fundamentals and progresses to discussion of representation and presentation techniques, measures of central tendency, dispersion, skewness, correlation and regression. It further initiates the study of index numbers and analysis of time series, interpolation and extrapolation, association of attributes, probability, theoretical distribution, sampling theory and chi square and concludes with logarithm and its uses.

The book successfully integrates theory and practice. It has ample illustrations with solutions to help students understand the topics discussed and gain a solid foundation in statistics. The book is an ideal choice for undergraduate and postgraduate students of statistics, and also caters to the needs of students of varied disciplines.

Features:

- A perfect balance of theory and practice with abundant diagrams and tables to reinforce understanding
- Over 550 solved illustrations interspersed throughout the text
- More than 400 objective type questions with answers; 300 theoretical questions and 1000 practical problems with detailed answers

S. CHAND PUBLISHING

A division of S Chand And Company Limited
(ISO 9001 Certified Company)

Website: www.schandpublishing.com

E-mail: helpdesk@schandpublishing.com

Customer care (toll free) No.: 1800-30702850



₹ 550.00

V18F33UA17PS



S. CHAND
HIGHER
ACADEMIC

PILLAI
BAGAVATHI

8e

STATISTICS
THEORY AND PRACTICE



S. CHAND

8e

STATISTICS
THEORY AND PRACTICE

**R S N PILLAI
BAGAVATHI**

STATISTICS

THEORY AND PRACTICE

For B.Com., M.Com., BA, MA (Eco),
CA, ICWA and other Courses

R.S.N. PILLAI

MA, M.Com., LLB
Prof. and HOD of Commerce
Arignar Anna College
Aramboly, Kanyakumari 629 301

BAGAVATHI

MA, M.Com.
240, Chidambaranagar
Nagercoil, 629 002



S. CHAND
PUBLISHING
empowering minds

S Chand And Company Limited

(ISO 9001 Certified Company)

RAM NAGAR, NEW DELHI - 110 055



S Chand And Company Limited (ISO 9001 Certified Company)

Head Office: 7361, RAM NAGAR, QUTAB ROAD, NEW DELHI - 110 055

Phone: 23672080-81-82, 66672000 Fax: 91-11-23677446

www.schandpublishing.com; e-mail: helpdesk@schandpublishing.com

Branches:

Ahmedabad	Ph: 27541965, 27542369, ahmedabad@schandpublishing.com
Bengaluru	Ph: 22268048, 22354008, bangalore@schandpublishing.com
Bhopal	Ph: 4209587, bhopal@schandpublishing.com
Chandigarh	Ph: 2625356, 2625546, 4025418, chandigarh@schandpublishing.com
Chennai	Ph: 28410027, 28410058, chennai@schandpublishing.com
Coimbatore	Ph: 2323620, 4217136, coimbatore@schandpublishing.com (Marketing Office)
Cuttack	Ph: 2332580, 2332581, cuttack@schandpublishing.com
Dehradun	Ph: 2711101, 2710861, dehradun@schandpublishing.com
Guwahati	Ph: 2738811, 2735640, guwahati@schandpublishing.com
Hyderabad	Ph: 27550194, 27550195, hyderabad@schandpublishing.com
Jaipur	Ph: 2219175, 2219176, jaipur@schandpublishing.com
Jalandhar	Ph: 2401630, jalandhar@schandpublishing.com
Kochi	Ph: 2809208, 2808207, cochin@schandpublishing.com
Kolkata	Ph: 23353914, 23357458, kolkata@schandpublishing.com
Lucknow	Ph: 4065646, lucknow@schandpublishing.com
Mumbai	Ph: 22690881, 22610885, 22610886, mumbai@schandpublishing.com
Nagpur	Ph: 2720523, 2777666, nagpur@schandpublishing.com
Patna	Ph: 2300489, 2260011, patna@schandpublishing.com
Pune	Ph: 64017298, pune@schandpublishing.com
Raipur	Ph: 2443142, raipur@schandpublishing.com (Marketing Office)
Ranchi	Ph: 2361178, ranchi@schandpublishing.com
Sahibabad	Ph: 2771235, 2771238, delhibr-sahibabad@schandpublishing.com

© 1984, R.S.N. Pillai & Bagavathi

All rights reserved. No part of this publication may be reproduced or copied in any material form (including photocopying or storing it in any medium in form of graphics, electronic or mechanical means and whether or not transient or incidental to some other use of this publication) without written permission of the copyright owner. Any breach of this will entail legal action and prosecution without further notice.

Jurisdiction: All disputes with respect to this publication shall be subject to the jurisdiction of the Courts, Tribunals and Forums of New Delhi, India only.

First Edition 1984

Subsequent Editions and Reprints 1986, 87, 89, 91, 93, 94, 95, 97, 98, 99, 2000-2006, 2008-2010, 2012, 2013 (Twice), 2014, 2015

Eighth Edition 2016

Reprints 2016, 2017

Reprint 2018

ISBN : 978-93-525-3309-1

PRINTED IN INDIA

By Vikas Publishing House Pvt. Ltd., Plot 20/4, Site-IV, Industrial Area Sahibabad, Ghaziabad-201010 and Published by S Chand And Company Limited, 7361, Ram Nagar, New Delhi-110 055.

PREFACE TO THE EIGHTH REVISED EDITION

Statistical methods are playing an ever-increasing role in framing suitable policies in a large number of diversified fields covering natural, physical and social sciences. Formerly, statistics dealt only with the affairs of the state. Statistics today has become indispensable in all phases of human endeavour. The science of statistics has assumed great importance in recent years. It was once known as the 'science of kings' and its scope was extremely limited, but today statistics has become a very important science without which no other science can progress. In fact, economic planning cannot be imagined in the absence of statistical data. Statistics is now taught in almost all the universities of the country and there are a number of statistical institutes which impart special training in the subject.

We are extremely happy to place before the readers the enlarged edition of Statistics - Theory and Practice. Many topics of this book have been re-written and restructured. Almost all the topics have been thoroughly analysed, presented lucidly and briefly, avoiding lengthy discussion without sacrificing the theme of theories. The main aim of this book is to facilitate easy understanding of the matter avoiding any tediousness in grasping the theories and illustrations.

We have incorporated maximum number of new problems selected from examinations of different Indian universities and professional institutions to acquaint students with the trend of examinations. Our endeavour has been to make this book more student-oriented and learner-friendly. We have taken sufficient care to ensure that the book meets the needs of a variety of students.

The book contains 555 solved illustrations, 444 objective type questions with answers, 300 theoretical questions and 1000 practical problems with detailed answers. It is our earnest hope that the students and teachers will find the new revised edition immensely useful.

I take this opportunity to thank all those readers who spared their valuable time in making suggestions for improving the quality of the text.

We sincerely thank our Publishers S. Chand Private Limited particularly, Ms Nirmala Gupta Chairperson and Managing Director for bring out this book well in time. The authors can be reached at 9994045593; 9566367303.

Authors

Disclaimer: While the authors of this book have made every effort to avoid any mistake or omission and have used their skill, expertise and knowledge to the best of their capacity to provide accurate and updated information. The author and S. Chand does not give any representation or warranty with respect to the accuracy or completeness of the contents of this publication and are selling this publication on the condition and understanding that they shall not be made liable in any manner whatsoever. S.Chand and the author expressly disclaim all and any liability/responsibility to any person, whether a purchaser or reader of this publication or not, in respect of anything and everything forming part of the contents of this publication. S. Chand shall not be responsible for any errors, omissions or damages arising out of the use of the information contained in this publication. Further, the appearance of the personal name, location, place and incidence, if any; in the illustrations used herein is purely coincidental and work of imagination. Thus the same should in no manner be termed as defamatory to any individual.

PREFACE TO THE FIRST EDITION

Statistics has been given an important place in our courses of studies in various social sciences. No student of commerce, economics, management and other social studies can attain the goal without studying statistics. The study of statistics is very engaging and it has become a part of every human activity.

The book covers the theoretical, practical and applied aspects of statistics as far as possible in a clear and exhaustive manner. Every effort has been made to give illustrations for lucidity. Every chapter in this book explains the principles through appropriate illustrations, and at the end of each chapter, enough exercises selected from different university papers have been given alongwith answers.

This book is meant for B.Com. and B.A. (Ecos.) degrees of Indian universities. Particularly it is complete in respect of the syllabus for B.Com. and B.A. (Ecos.) degrees (Semester and Non-semester) of Madurai Kamaraj University.

We are grateful to our fellow teachers who have given suggestions on the subject. We also thank M/s S. Chand and Company for their effort in bringing out the book in an elegant form and at a reasonable price, in time.

Valuable suggestions and criticisms from the readers will be appreciated and included in the subsequent editions.

Nagercoil (T.N.)

R.S.N. Pillai
Bagavathi

CONTENTS

<i>Chapter's</i>	<i>Pages</i>
1. INTRODUCTION	1 – 11
Origin, Growth, Meaning, Definition, Statistics as Data, Statistics as Methods, Nature, Object, Science or Art, Statistical Thinking, Objective Type Questions, Theoretical Questions.	
2. IMPORTANCE, FUNCTIONS, LIMITATIONS	12 – 21
Importance, Statistics in States, Statistics in Economics, Statistics in Business, Statistics in Astronomy, Statistics in Education, Statistics in Accounting, Statistics in Research, Statistics in Planning, Statistics in Mathematics, Statistics and the Common Man, Functions of Statistics, Limitations of Statistics, Distrust of Statistics, Fallacies in Statistics, Objective Type Questions, Theoretical Questions.	
3. STATISTICAL SURVEY	22 – 26
Planning and Design of Enquiry, Object, Scope, Statistical Unit, Sources of Data, method of Data Collection, The Frame, Standard of Accuracy, Type of Enquiry, Executing the Survey, Setting up of Administrative Team, Design of Forms and Questionnaire, Selection and Training of Field Investigators, Supervision of Field Work, Follow-up of Non-response, Processing and Analysing of Data, Preparation of Report, Theoretical Questions.	
4. COLLECTION OF DATA	27 – 37
Primary and Secondary Data, Choice of Methods, Direct Personal Observation, Indirect Oral Interview, Information through Agencies, Mailed Questionnaire, Schedules sent through Enumerators, Sources of Secondary data, Precautions in the use of Secondary Data, Framing a Questionnaire, Sample Questionnaire, Editing the Data, Questions Objective Type Questions, Theoretical Questions.	
5. SAMPLING DESIGN	38 – 49
Finite and Infinite Population, Hypothetical and Existent Population, Census Method, Sample Method, Essentials of Sampling, Method of Sampling, Random Sampling method, Non-Random Sampling, Simple Random Sampling, Restricted Random Sampling, Stratified Sampling, Systematic Sampling, Cluster Sampling, Judgement Sampling, Quota Sampling, Convenience or Chunk Sampling, Statistical Laws, The Law of Statistical Regularity, The Law of Inertia of Large Numbers, Statistical Error, Measurement of Errors, Absolute Error, Relative Error, Reducing Sampling Errors, Test of Reliability of Samples, Questions, Objective Type Questions, Theoretical Questions.	
6. CLASSIFICATION AND TABULATION	50 – 80
Introduction, Meaning of Classification, Chief Characteristics of Classification, Objects of Classification, Rules of Classification, Types of classifications, Geographical Classification, Chronological Classification, Qualitative Classification, Quantitative Classification, Statistical Series, Types of Series, Frequency Distribution, Individual Observation, Discrete (Ungrouped) Frequency Distribution, Continuous or Grouped Frequency Distribution Class Frequency, Magnitude of Class Intervals, Cumulative Frequency Distribution, Two-Way Frequency Distribution (Bivariate) Tabulation of Data, Meaning, Objects, Difference between Classification	

and Tabulation, Parts of Tabulation, Structure of Tabulation, Rules for Tabulation, Types of Tables, On the Basis of Coverage, On the Basis of Objective (Purpose), On the Basis of Originality.

7. DIAGRAMMATIC REPRESENTATION 81 – 99

Introduction, Advantages, Limitations of a Diagram, Rules for Making a Diagram, Types of Diagram, One-Dimensional Diagram, Two-Dimensional diagram (Area or Surface diagram), Three-Dimensional Diagram, Pictogram, Cartogram, Selection of a Diagram, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.

8. GRAPHIC PRESENTATION 100 – 123

Advantages of Graphic Presentation, Construction of a Graph, General Rules, Difference between Diagram and Graph, Graph of Frequency Distribution: Histogram, Frequency Polygon, Frequency curve, Ogive or Cumulative Frequency Curves, More than Ogive, Graphs of Time Series: Horizontal Line Graph or Historigram, False Base Lines, Silhouette (Net Balance Graph) Range of Variation Graph, Component or Band Graph, Z Curve, Questions, Objective Type Questions Theoretical Questions, Practical Problems.

9. MEASURES OF CENTRAL TENDENCY (AVERAGES) 124 – 240

Meaning, Definition, functions of an Average, Characteristics of a Typical Average, Arithmetic Mean, Mathematical Characteristics, Weighted Arithmetic Mean, Discrete Series, continuous Series, Charlier's Accuracy Check, Open End Classes, Cumulative Series, Merits of mean, Demerits (Limitations) of Arithmetic Mean, Uses of mean, Correcting Incorrect Mean, Combined Arithmetic Mean, Algebraic Properties of Arithmetic Mean, Median, Calculation of Median, Individual Series, Under Even Numbers, Graphic Location of median, Merits of Median, Demerits, characteristics of Median, Further Partitioned Value, Quartiles, Calculation of Quartiles, (Individual and discrete Series), Continuous Series, Deciles, Percentile, Mode, Method of Calculation of Mode, Discrete Series, Graphic Location of Mode, Relationship Between Different Averages, Merits, Demerits, Uses, Geometric mean, Uses, Merits, Demerits, Harmonic Mean, Calculation of Harmonic mean, Individual Series, Calculation of H-M, Discrete Series, merits of Harmonic Mean, Relationship between Mean, Geometric Mean and harmonic Mean, Demerits, Appropriateness of an average, Comparison of Averages, List of Formulae, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.

10. DISPERSION 241 – 337

Introduction, Definition, Concept of Variation, Purpose of Measuring, Variation, Properties of a good Measure of Variation, Methods of Measuring Dispersion, Range, Meaning, Merits, Demerits, Uses, Inter Quartile Range, Quartile Deviation, Merits of Quartile Deviation, Demerits, Mean Deviation or Average Deviation, Co-efficient of Mean Deviation, Computation of Mean Deviation, Discrete Series, Short-cut Method of Computation, Continuous Series, Merits, Demerits, Uses Standard Deviation, Calculation of Standard Deviation, Individual, Observation, Discrete Series, Continuous Series, Charlier's Check of Accuracy, Combined Standard Deviation, Merits, Demerits, Uses, Comparison between Mean Deviation and Standard Deviation, Coefficient of Variations, List of Formula, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.

11. SKEWNESS, KURTOSIS, MOMENTS 338 – 395

Introduction, Meaning, Skewness, Test of Skewness, Dispersion and Skewness, Measures,

Objective, Karl Pearson's Coefficient of Skewness, Bowley's coefficient of skewness, Kelly's Coefficient of Skewness, Moments, Meaning, Kurtosis, Meaning, List of Formulae, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.

12. CORRELATION 396 – 464

Introduction, Definitions, Significance of the Study of Correlation, Correlation and Causation, Types of Correlation, Method of Studying Correlation, Graphic, Karl Pearson's Coefficient of Correlation, Properties, Assumptions, Merits and Demerits, Interpretation of Correlation, Correlation and Probable Error, Function of Probable Error, Conditions for Probable Error, Standard Error, Coefficient of Determination, Rank Coefficient of Correlation, Concurrent Deviation, Lag and Lead, Correlation of Time Series, List of Formula, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.

13. REGRESSION 465 – 525

Introduction, Definition, Uses, Significance of Regression Study, Correlation and Regression, Difference between the Two, Method of Studying Regression, Graphic Method, Algebraic Method, Regression Line, Regression Equation, Mathematical properties, Standard Error of Estimate, List of Formulae, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.

14. INDEX NUMBERS 526 – 590

Introduction, Meaning, Definition, Characteristics, Uses, Types of Index Number, Interpretation of Index Numbers, Problems of Construction, Choice of Formula, Method of construction, Laspeyre's Method, Paasche's Method, Dorbish and Bowley's Method, Fisher's Ideal method, Marshall-Edgeworth method, Kelly's Method, Walsch's Method, Quantity Index Numbers, Value Index Numbers, Time Reversal Test, Factor Reversal Test, circular Test, Chain base, Fixed Base, Base Shifting, Deflating of Index Numbers, Consumer Price Index, Family Budget, Limitation of Index Numbers, List of Formulae, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.

15. ANALYSIS OF TIME SERIES 591 – 646

Meaning, Definition, Uses, Time Series, Models, Secular Trend, Seasonal Variation, cyclical Variation, Irregular Variation, Preparation of Data for analysis, Measurement of Secular Trend, Graphic Method, Semi-average Method, Moving Average Method, Method of Least Squares, Parabola Curve, Selecting the Type of Trend, Choice, Conversion, Shifting of Origin, Measurement of Seasonal Variation, Method of Simple Average, Ratio to Trend Method, Ratio to Moving Average Method, Link Relative Method, List of Formulae, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.

16. INTERPOLATION AND EXTRAPOLATION 647 – 689

Meaning, Significance of Interpolation, Assumptions, Method of Interpolation, Graphic, Algebraic, Binomial Expansion Method, Newton's Method of Advancing Differences, Newton Gauss (Forward) Method, Newton Gauss (Backward) Method, Newton's Method of Backward Differences, Newton's Divided Difference Method, Lagrange's method and Parabolic Curve Fitting, Miscellaneous Illustrations, List of Formula, Questions, Objective Types Questions, Theoretical Questions, Practical Problems.

17. ASSOCIATION OF ATTRIBUTES	690 – 725
Introduction, Classification, Correlation and Association, Uses of Terms and Notation, Positive and Negative Classes, Number of Classes, Ultimate Class Frequencies, Order of classes, Relationship, Determination of Frequencies, Consistency of Data, Types of Association, comparison of Observed and Expected Frequencies, Comparison of Proportion, Yule's coefficient of Association, Yule's coefficient of Colligation, Pearson's Coefficient of Contingency, Partial Association, List of Formulae, Questions, Objective Type Questions, Theoretical Questions, Practical Problems,	
18. PROBABILITY	726 – 768
A Brief History, meaning, Usefulness, Mathematical properties, Permutation, Combination, Trial, Event, Sample Space, Mutually Exclusive Cases, Exhaustive Events, Independent Events, Dependent Events, Simple and Compound Events; Measurement: Classical, Relative Frequency Theory of Probability, Limitations, Personalistic View of Probability and Axiomatic Approach of Probability, Addition and Multiplication theorem, Odds, Miscellaneous Illustrations Questions, Objective Type Questions, Theoretical Questions, Practical Problems.	
19. THEORETICAL DISTRIBUTION	769 – 809
Binomial Distribution, Obtaining Binomial coefficient, Properties of Binomial Distribution, Poisson Distribution, Normal distribution, Importance of Normal Curve, Characteristics, Computation, List of Formulae, Questions, Objective Type Questions, Theoretical questions Practical Problems.	
20. SAMPLING THEORY AND TEST OF SIGNIFICANCE	810 – 846
Introduction, Estimation, Hypothesis, Standard Error, Tests of Significance for Attributes, Tests of Significance for Large Sample, Tests of significance for Small Samples, Student's Distribution, List of Formulae, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.	
21. CHI SQUARE TEST	847 – 870
Introduction, Characteristics, Assumptions, Uses χ^2 Test of Goodness of Fit, χ^2 Test of Independence, Yates' Correction, χ^2 Test of Homogeneity, Additive Property, Questions, Objective Type Questions, Theoretical Questions, Practical Problems.	
22. LOGARITHM AND THEIR USES	871 – 875
Characteristic, Mantissa, Explanation, Antilogarithm, Statistical Tables.	

CHAPTER

1

INTRODUCTION

The word 'statistics' seems to have been derived from the Latin word 'Status' or Italian word 'Statista' or the German word 'Statistik' or the French word 'Statistique', each of which means a political state. It is not a new discipline, but is as old as the human society. In good old days, the term statistics was applied to a branch of statecraft—science of statecraft. As such, the term statistics was applied to mean facts and figures which were needed by the State in its day to day life. Statistics was regarded as a by-product of administrative activities of the State. Now statistics is usually not studied for its own sake (as a separate branch), but statistics is employed as a tool in solving or analysing the problems of the State.

Origin

In ancient times the scope of statistics was primarily limited in keeping the records of the population in regard to age and sex-wise, birth, death, property, wealth, etc., of a country. This knowledge was used as a tool to know the man-power and also to fix taxes and levies. Statistics in the past was a by-product of administrative activity of the State. The State or the Government collected statistics for administrative purposes, and as such statistics was regarded as 'the Science of Kings' or 'the Science of Statecraft'. Many people contributed to the development of statistics.

Sixteenth century astronomy contributed to the growth of statistics. Tycho Brave (1554 to 1661) discovered valuable facts regarding the movements of stars and planets and compiled records to make predictions of eclipses and positions. J. Kepler made a detailed study of the information collected by Brave, analysed and thus found three laws relating to the planetary movements. These laws gave a basis to Newton for the discovery of the Law of Gravitation.

Seventeenth century Captain John Graunt of London (1620-1674) known as "the father of the vital statistics", made a systematic study of the births and deaths. During this period, Edmund Halley prepared the first life-table from the data collected by Sir William Petty (1623-1687). He also prepared mortality tables and analysed them. This led to the idea of life insurance and the first Life Insurance Institution was founded in London in 1698.

Eighteenth century, Sussmilch (1707-1767) found out the natural order of physiocratic School; i.e., "ratio of births and deaths remains constant" and gave statistical explanations to the theory. J. Bernoulli (1654-1705) discovered the law of large numbers. Laplace (1749-1827) published the monumental work on the "theory of probability" in 1782. Later on prominent mathematicians like Lagrange, Gauss, Lexis, Charlier, Quetlet and others further contributed to the theory of probability.

Francis Galton (1822-1921) pioneered the study of "Regression Analysis". S. Jevons (1835-1882) who is known as "the father of index numbers" developed the technique of analysis of time series. Karl Pearson (1857-1936) pioneered the study of Correlation Analysis. His Chi-square