# Chapter – 9

# STATISTICS

Statistics deals with the collection, classification, presentation, analysis and interpretation of numeric data (quantitative data).

The simplest form of numerical data is a series of values of a certain variable. Such values can be given as individual numbers. Therefore, such data is called an individual series of raw data.

In such a series, some numbers could occur repeatedly. In such cases, it would be convenient to group these numbers. This grouping can be done in two ways. The numbers can be arranged in ascending (or descending) order and the number of times each number occurs (its frequency) can be specified. This results in a discrete series. Alternately, we may choose to ignore the actual number and record only the fact that it lies between certain limits. Such grouping results in a continuous series. The values between the limits are called intervals. For example, consider the marks obtained by the students of a class. This data has been represented in each of the ways below.

Individual series
60, 55, 70, 60, 70
65, 75, 65, 70, 55
58, 74, 67, 68, 73

Discrete series

| Frequency | 2 | 1 | 2 | 2 | 1 | 1 | 3 | 1 | 1 | 1 |
|-----------|----|----|----|----|----|----|----|----|----|----|
| Number | 55 | 58 | 60 | 65 | 67 | 68 | 70 | 73 | 74 | 75 |

Continuous series
We denote the marks obtained by the students as

| Intervals | Frequency |
|-----------|-----------|
| $x \leq 55$ | 2 |
| $55 < x \leq 60$ | 3 |
| $60 < x \leq 65$ | 2 |
| $65 < x \leq 70$ | 5 |
| $70 < x \leq 75$ | 3 |

Collection of data, especially on a large scale, is typically an expensive process and requires big teams of field workers. Therefore it needs careful planning. The primary consideration is the purpose for which the collected data will be used

After data has been collected, classified and presented, it has to be analysed and interpreted. To analyse data, the important features of the data have to be identified and relations between quantities (variables) have to be studied. Two important features of any data are the central tendency and dispersion. Instead of thinking of all the numbers in a set, we would like to think of a typical number, the 'central' value. Two sets of numbers, which may have the same 'central' value, may differ in terms of the variation of all the numbers in the set, i.e. the extent to which the numbers 'disperse' from this central value.

Various quantitative measures can be defined to measure these two properties, ie central tendency and dispersion.

In this chapter, we shall limit ourselves to an individual series and study such properties.

## I. Measures of Central Tendencies

The measures we discuss here are
(A) Arithmetic Mean,
(B) Geometric Mean,
(C) Harmonic Mean,
(D) Median and
(5) Mode.

### 1. Arithmetic Mean (A.M.) ($\bar{x}$)

Given $x_1, x_2, \ldots\ldots, x_n$ (n individual items)

$$\text{A.M.} = \bar{x} = \frac{x_1 + x_2 + \ldots + x_n}{n}$$

or $\bar{x} = \dfrac{\text{Sum of the observations}}{\text{The number of observations}}$

#### Examples

(i) The arithmetic mean of (5, 8, 9, 14, −16) is
$$= \frac{5 + 8 + 9 + 14 - 16}{5} = \frac{20}{5} = 4$$

(ii) The arithmetic mean of (3, 4, 5, 6, 7, 8, 9, 10) is
$$= \frac{3 + 4 + 5 + 6 + 7 + 8 + 9 + 10}{8} = \frac{52}{10} = 5.2$$

**Note:**
(a) The algebraic sum of deviations about the mean is 0 or $\Sigma(x - \bar{x}) = 0$.
(b) The arithmetic mean of two numbers a, b is $\dfrac{a + b}{2}$.
(c) If b = AM of (a, c), then a, b and c are in arithmetic progression.

### 2. Geometric Mean (G.M.)

Given $x_1, x_2, \ldots\ldots, x_n$ (n individual items all being positive)

$$\text{G.M.} = (x_1 \cdot x_2 \cdot \ldots\ldots, x_n)^{1/n}$$

or G.M. = $n^{th}$ root of the product of the numbers.

#### Examples

(i) The geometric mean of (10, 30, 90) is
$$= (10 \times 30 \times 90)^{1/3}$$
$$= (10 \times 30 \times 3 \times 30)^{1/3}$$
$$= (30 \times 30 \times 30)^{1/3} = 30$$

(ii) The geometric mean of (24, 20, 15, 45, 75) is
$$= (8 \times 3 \times 5 \times 4 \times 3 \times 5 \times 3^2 \times 5 \times 3 \times 5^2)^{1/5}$$
$$= (2^6 \times 3^5 \times 5^5)^{1/5}$$
$$= 2 \times 3 \times 5 = 30$$

# Mathematics Course 3 Chapter 9 Statistics And Matrices

**Dennis S. Bernstein**

**Mathematics Course 3 Chapter 9 Statistics And Matrices:**

  **Matrix Mathematics** Dennis S. Bernstein,2009-07-06 When first published in 2005 Matrix Mathematics quickly became the essential reference book for users of matrices in all branches of engineering science and applied mathematics In this fully updated and expanded edition the author brings together the latest results on matrix theory to make this the most complete current and easy to use book on matrices Each chapter describes relevant background theory followed by specialized results Hundreds of identities inequalities and matrix facts are stated clearly and rigorously with cross references citations to the literature and illuminating remarks Beginning with preliminaries on sets functions and relations Matrix Mathematics covers all of the major topics in matrix theory including matrix transformations polynomial matrices matrix decompositions generalized inverses Kronecker and Schur algebra positive semidefinite matrices vector and matrix norms the matrix exponential and stability theory and linear systems and control theory Also included are a detailed list of symbols a summary of notation and conventions an extensive bibliography and author index with page references and an exhaustive subject index This significantly expanded edition of Matrix Mathematics features a wealth of new material on graphs scalar identities and inequalities alternative partial orderings matrix pencils finite groups zeros of multivariable transfer functions roots of polynomials convex functions and matrix norms Covers hundreds of important and useful results on matrix theory many never before available in any book Provides a list of symbols and a summary of conventions for easy use Includes an extensive collection of scalar identities and inequalities Features a detailed bibliography and author index with page references Includes an exhaustive subject index with cross referencing     Research in Education ,1971     Resources in Education ,1992     **Unified Modern Mathematics, Course 1-3** Secondary School Mathematics Curriculum Improvement Study,1968     Mathematics Michael Sullivan,Abe Mizrahi,2004-06-01 Looking for a textbook to help you motivate your students Sullivan Mizrahi s Mathematics An Applied Approach 8 e continues its rich tradition of engaging students and demonstrating how mathematics applies to various fields of study The text is packed with real data and real life applications to business economics social and life sciences The new Eighth Edition also features a new full color design and improved goal oriented pedagogy to further help student understanding     **Numerical Linear Algebra** SUNDARAPANDIAN, V.,2008-04-23 This well organized text provides a clear analysis of the fundamental concepts of numerical linear algebra It presents various numerical methods for the basic topics of linear algebra with a detailed discussion on theory algorithms and MATLAB implementation The book provides a review of matrix algebra and its important results in the opening chapter and examines these results in the subsequent chapters With clear explanations the book analyzes different kinds of numerical algorithms for solving linear algebra such as the elimination and iterative methods for linear systems the condition number of a matrix singular value decomposition SVD of a matrix and linear least squares problem In addition it describes the Householder and Givens matrices and their applications and the basic numerical methods for solving the matrix eigenvalue

problem Finally the text reviews the numerical methods for systems and control Key Features Includes numerous worked out examples to help students grasp the concepts easily Provides chapter end exercises to enable students to check their comprehension of the topics discussed Gives answers to exercises with hints at the end of the book Uses MATLAB software for problem solving Primarily designed as a textbook for postgraduate students of Mathematics this book would also serve as a handbook on matrix computations for scientists and engineers    *Statistics of Directional Data* K. V. Mardia,2014-07-03 Probability and Mathematical Statistics A Series of Monographs and Textbooks Statistics of Directional Data aims to provide a systematic account of statistical theory and methodology for observations which are directions The publication first elaborates on angular data and frequency distributions descriptive measures and basic concepts and theoretical models Discussions focus on moments and measures of location and dispersion distribution function corrections for grouping calculation of the mean direction and the circular variance interrelations between different units of angular measurement and diagrammatical representation The book then examines fundamental theorems and distribution theory point estimation and tests for samples from von Mises populations The text takes a look at non parametric tests distributions on spheres and inference problems on the sphere Topics include tests for axial data point estimation distribution theory moments and limiting distributions and tests of goodness of fit and tests of uniformity The publication is a dependable reference for researchers interested in probability and mathematical statistics    3D Math Primer for Graphics and Game Development Fletcher Dunn,Ian Parberry,2002 Presents an introduction to the fundamental concepts of 3D math explaining vectors coordinate spaces matrices Euler angles geometric primitives representation techniques and more    *Math for Deep Learning* Ronald T. Kneusel,2021-12-07 Math for Deep Learning provides the essential math you need to understand deep learning discussions explore more complex implementations and better use the deep learning toolkits With Math for Deep Learning you ll learn the essential mathematics used by and as a background for deep learning You ll work through Python examples to learn key deep learning related topics in probability statistics linear algebra differential calculus and matrix calculus as well as how to implement data flow in a neural network backpropagation and gradient descent You ll also use Python to work through the mathematics that underlies those algorithms and even build a fully functional neural network In addition you ll find coverage of gradient descent including variations commonly used by the deep learning community SGD Adam RMSprop and Adagrad Adadelta    **Symbolic Mathematics for Chemists** Fred Senese,2018-11-05 An essential guide to using Maxima a popular open source symbolic mathematics engine to solve problems build models analyze data and explore fundamental concepts Symbolic Mathematics for Chemists offers students of chemistry a guide to Maxima a popular open source symbolic mathematics engine that can be used to solve problems build models analyze data and explore fundamental chemistry concepts The author a noted expert in the field focuses on the analysis of experimental data obtained in a laboratory setting and the fitting of data and modeling experiments The text contains a wide variety of illustrative

examples and applications in physical chemistry quantitative analysis and instrumental techniques Designed as a practical resource the book is organized around a series of worksheets that are provided in a companion website Each worksheet has clearly defined goals and learning objectives and a detailed abstract that provides motivation and context for the material This important resource Offers an text that shows how to use popular symbolic mathematics engines to solve problems Includes a series of worksheet that are prepared in Maxima Contains step by step instructions written in clear terms and includes illustrative examples to enhance critical thinking creative problem solving and the ability to connect concepts in chemistry Offers hints and case studies that help to master the basics while proficient users are offered more advanced avenues for exploration Written for advanced undergraduate and graduate students in chemistry and instructors looking to enhance their lecture or lab course with symbolic mathematics materials Symbolic Mathematics for Chemists A Guide for Maxima Users is an essential resource for solving and exploring quantitative problems in chemistry      *Scalar, Vector, and Matrix Mathematics* Dennis S. Bernstein,2018-02-27 The essential reference book on matrices now fully updated and expanded with new material on scalar and vector mathematics Since its initial publication this book has become the essential reference for users of matrices in all branches of engineering science and applied mathematics In this revised and expanded edition Dennis Bernstein combines extensive material on scalar and vector mathematics with the latest results in matrix theory to make this the most comprehensive current and easy to use book on the subject Each chapter describes relevant theoretical background followed by specialized results Hundreds of identities inequalities and facts are stated clearly and rigorously with cross references citations to the literature and helpful comments Beginning with preliminaries on sets logic relations and functions this unique compendium covers all the major topics in matrix theory such as transformations and decompositions polynomial matrices generalized inverses and norms Additional topics include graphs groups convex functions polynomials and linear systems The book also features a wealth of new material on scalar inequalities geometry combinatorics series integrals and more Now more comprehensive than ever Scalar Vector and Matrix Mathematics includes a detailed list of symbols a summary of notation and conventions an extensive bibliography and author index with page references and an exhaustive subject index Fully updated and expanded with new material on scalar and vector mathematics Covers the latest results in matrix theory Provides a list of symbols and a summary of conventions for easy and precise use Includes an extensive bibliography with back referencing plus an author index      **Linear Algebra, Data Science, and Machine Learning** Jeff Calder,Peter J. Olver,2025-08-25 This text provides a mathematically rigorous introduction to modern methods of machine learning and data analysis at the advanced undergraduate beginning graduate level The book is self contained and requires minimal mathematical prerequisites There is a strong focus on learning how and why algorithms work as well as developing facility with their practical applications Apart from basic calculus the underlying mathematics linear algebra optimization elementary probability graph theory and statistics is developed from scratch in a form best suited

to the overall goals In particular the wide ranging linear algebra components are unique in their ordering and choice of topics emphasizing those parts of the theory and techniques that are used in contemporary machine learning and data analysis The book will provide a firm foundation to the reader whose goal is to work on applications of machine learning and or research into the further development of this highly active field of contemporary applied mathematics To introduce the reader to a broad range of machine learning algorithms and how they are used in real world applications the programming language Python is employed and offers a platform for many of the computational exercises Python notebooks complementing various topics in the book are available on a companion GitHub site specified in the Preface and can be easily accessed by scanning the QR codes or clicking on the links provided within the text Exercises appear at the end of each section including basic ones designed to test comprehension and computational skills while others range over proofs not supplied in the text practical computations additional theoretical results and further developments in the subject The Students Solutions Manual may be accessed from GitHub Instructors may apply for access to the Instructors Solutions Manual from the link supplied on the text s Springer website The book can be used in a junior or senior level course for students majoring in mathematics with a focus on applications as well as students from other disciplines who desire to learn the tools of modern applied linear algebra and optimization It may also be used as an introduction to fundamental techniques in data science and machine learning for advanced undergraduate and graduate students or researchers from other areas including statistics computer science engineering biology economics and finance and so on **Cryptology** Richard Klima,Richard E. Klima,Neil Sigmon,Neil P. Sigmon,2018-12-07 Cryptology Classical and Modern Second Edition proficiently introduces readers to the fascinating field of cryptology The book covers classical methods including substitution transposition Playfair ADFGVX Alberti Vigene re and Hill ciphers It also includes coverage of the Enigma machine Turing bombe and Navajo code Additionally the book presents modern methods like RSA ElGamal and stream ciphers as well as the Diffie Hellman key exchange and Advanced Encryption Standard When possible the book details methods for breaking both classical and modern methods The new edition expands upon the material from the first edition which was oriented for students in non technical fields At the same time the second edition supplements this material with new content that serves students in more technical fields as well Thus the second edition can be fully utilized by both technical and non technical students at all levels of study The authors include a wealth of material for a one semester cryptology course and research exercises that can be used for supplemental projects Hints and answers to selected exercises are found at the end of the book

*Mathematics of Big Data* Jeremy Kepner,Hayden Jananthan,2018-07-17 The first book to present the common mathematical foundations of big data analysis across a range of applications and technologies Today the volume velocity and variety of data are increasing rapidly across a range of fields including Internet search healthcare finance social media wireless devices and cybersecurity Indeed these data are growing at a rate beyond our capacity to analyze them The tools

including spreadsheets databases matrices and graphs developed to address this challenge all reflect the need to store and operate on data as whole sets rather than as individual elements This book presents the common mathematical foundations of these data sets that apply across many applications and technologies Associative arrays unify and simplify data allowing readers to look past the differences among the various tools and leverage their mathematical similarities in order to solve the hardest big data challenges The book first introduces the concept of the associative array in practical terms presents the associative array manipulation system D4M Dynamic Distributed Dimensional Data Model and describes the application of associative arrays to graph analysis and machine learning It provides a mathematically rigorous definition of associative arrays and describes the properties of associative arrays that arise from this definition Finally the book shows how concepts of linearity can be extended to encompass associative arrays Mathematics of Big Data can be used as a textbook or reference by engineers scientists mathematicians computer scientists and software engineers who analyze big data **Stochastic Processes** Pierre Del Moral,Spiridon Penev,2017-02-24 Unlike traditional books presenting stochastic processes in an academic way this book includes concrete applications that students will find interesting such as gambling finance physics signal processing statistics fractals and biology Written with an important illustrated guide in the beginning it contains many illustrations photos and pictures along with several website links Computational tools such as simulation and Monte Carlo methods are included as well as complete toolboxes for both traditional and new computational techniques **Linear Algebra for Data Science, Machine Learning, and Signal Processing** Jeffrey A. Fessler,Raj Rao Nadakuditi,2024-05-16 Master matrix methods via engaging data driven applications aided by classroom tested quizzes homework exercises and online Julia demos Finite Mathematics Carla C. Morris,Robert M. Stark,2015-08-24 Features step by step examples based on actual data and connects fundamental mathematical modeling skills and decision making concepts to everyday applicability Featuring key linear programming matrix and probability concepts Finite Mathematics Models and Applications emphasizes cross disciplinary applications that relate mathematics to everyday life The book provides a unique combination of practical mathematical applications to illustrate the wide use of mathematics in fields ranging from business economics finance management operations research and the life and social sciences In order to emphasize the main concepts of each chapter Finite Mathematics Models and Applications features plentiful pedagogical elements throughout such as special exercises end notes hints select solutions biographies of key mathematicians boxed key principles a glossary of important terms and topics and an overview of use of technology The book encourages the modeling of linear programs and their solutions and uses common computer software programs such as LINDO In addition to extensive chapters on probability and statistics principles and applications of matrices are included as well as topics for enrichment such as the Monte Carlo method game theory kinship matrices and dynamic programming Supplemented with online instructional support materials the book features coverage including Algebra Skills Mathematics of Finance Matrix Algebra Geometric Solutions Simplex

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