ON THE CONVERGENCE RATE IN THE CENTRAL LIMIT THEOREM FOR WEAKLY DEPENDENT RANDOM VARIABLES

A. N. TIKHOMIROV

(Translated by B. Seckler)

1. Introduction

Let X_1, X_2, \cdots be a narrow-sense stationary sequence of random variables, which are assumed to have zero means and finite variances. Put $\sigma_n^2 = \mathbf{E}(\sum_{j=1}^n X_j)^2$ and form the sum

$$S_n = \frac{1}{\sigma_n} \sum_{j=1}^n X_j$$
.

Many publications have been devoted to investigating conditions under which this sum is asymptotically normal, i.e., when

$$F_n(Z) = \mathbf{P}\{S_n < Z\} \to \Phi(Z)$$

as $n \to \infty$, where

$$\Phi(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z} e^{-y^2/2} dy$$

(for instance, see [3], Chapter 18). Set

$$\Delta_n = \sup_{z} |F_n(z) - \Phi(z)|.$$

This paper investigates the rate with which Δ_n tends to zero when n goes to infinity.

This problem has been studied in detail for independent summands (for example, see [5], Chapter 5). Some very interesting results were obtained for dependent variables X_i by V. A. Statulyavichus in [6] and C. Stein in [10].

To a considerable extent, this paper was written under the influence of the article of Stein just mentioned. However, in contrast to Stein, we make use of the apparatus of characteristic functions, whereas Stein in general questioned the advantage of using this apparatus when investigating the rate of decay for weakly dependent variables.

Limit Theory For Mixing Dependent Random Variables

M. B. Rajarshi

Limit Theory For Mixing Dependent Random Variables:

Limit Theory for Mixing Dependent Random Variables Lin Zhengyan, Lu Chuanrong, 1997-07-31 For many practical problems observations are not independent In this book limit behaviour of an important kind of dependent random variables the so called mixing random variables is studied Many profound results are given which cover recent developments in this subject such as basic properties of mixing variables powerful probability and moment inequalities weak convergence and strong convergence approximation limit behaviour of some statistics with a mixing sample and many useful tools are provided Audience This volume will be of interest to researchers and graduate students in the field of probability and statistics whose work involves dependent data variables Limit Theorems of Probability Theory Yu.V. Prokhorov, V. Statulevicius, 2013-03-14 This book consists of five parts written by different authors devoted to various problems dealing with probability limit theorems The first part Classical Type Limit Theorems for Sums ofIndependent Random Variables V v Petrov presents a number of classical limit theorems for sums of independent random variables as well as newer related results The presentation dwells on three basic topics the central limit theorem laws of large numbers and the law of the iterated logarithm for sequences of real valued random variables. The second part The Accuracy of Gaussian Approximation in Banach Spaces V Bentkus F G6tze V Paulauskas and A Rackauskas reviews various results and methods used to estimate the convergence rate in the central limit theorem and to construct asymptotic expansions in infinite dimensional spaces The authors con fine themselves to independent and identically distributed random variables. They do not strive to be exhaustive or to obtain the most general results their aim is merely to point out the differences from the finite dimensional case and to explain certain new phenomena related to the more complex structure of Banach spaces Also reflected here is the growing tendency in recent years to apply results obtained for Banach spaces to asymptotic problems of statistics *Asymptotic* Theory of Weakly Dependent Random Processes Emmanuel Rio, 2017-04-13 Ces notes sont consacr es aux in galit s et aux th or mes limites classiques pour les suites de variables al atoires absolument r guli res ou fortement m langeantes au sens de Rosenblatt Le but poursuivi est de donner des outils techniques pour l tude des processus faiblement d pendants aux statisticiens ou aux probabilistes travaillant sur ces processus Martingale Limit Theory and Its Application P. Hall, C. C. Heyde, 2014-07-10 Martingale Limit Theory and Its Application discusses the asymptotic properties of martingales particularly as regards key prototype of probabilistic behavior that has wide applications The book explains the thesis that martingale theory is central to probability theory and also examines the relationships between martingales and processes embeddable in or approximated by Brownian motion The text reviews the martingale convergence theorem the classical limit theory and analogs and the martingale limit theorems viewed as the rate of convergence results in the martingale convergence theorem The book explains the square function inequalities weak law of large numbers as well as the strong law of large numbers The text discusses the reverse martingales martingale tail sums the invariance principles in the central

limit theorem and also the law of the iterated logarithm The book investigates the limit theory for stationary processes via corresponding results for approximating martingales and the estimation of parameters from stochastic processes The text can be profitably used as a reference for mathematicians advanced students and professors of higher mathematics or Functional Gaussian Approximation for Dependent Structures Florence Merlevède, Magda Peligrad, Sergey Utev, 2019-02-14 Functional Gaussian Approximation for Dependent Structures develops and analyses mathematical models for phenomena that evolve in time and influence each another It provides a better understanding of the structure and asymptotic behaviour of stochastic processes Two approaches are taken Firstly the authors present tools for dealing with the dependent structures used to obtain normal approximations Secondly they apply normal approximations to various examples The main tools consist of inequalities for dependent sequences of random variables leading to limit theorems including the functional central limit theorem and functional moderate deviation principle The results point out large classes of dependent random variables which satisfy invariance principles making possible the statistical study of data coming from stochastic processes both with short and long memory The dependence structures considered throughout the book include the traditional mixing structures martingale like structures and weakly negatively dependent structures which link the notion of mixing to the notions of association and negative dependence Several applications are carefully selected to exhibit the importance of the theoretical results They include random walks in random scenery and determinantal processes In addition due to their importance in analysing new data in economics linear processes with dependent innovations will also be considered and analysed PROBABILITY AND STATISTICS - Volume I Reinhard Viertl, 2009-06-11 Probability and Statistics theme is a component of Encyclopedia of Mathematical Sciences in the global Encyclopedia of Life Support Systems EOLSS which is an integrated compendium of twenty one Encyclopedias The Theme with contributions from distinguished experts in the field discusses Probability and Statistics Probability is a standard mathematical concept to describe stochastic uncertainty Probability and Statistics can be considered as the two sides of a coin They consist of methods for modeling uncertainty and measuring real phenomena Today many important political health and economic decisions are based on statistics This theme is structured in five main topics Probability and Statistics Probability Theory Stochastic Processes and Random Fields Probabilistic Models and Methods Foundations of Statistics which are then expanded into multiple subtopics each as a chapter These three volumes are aimed at the following five major target audiences University and College students Educators Professional practitioners Research personnel and Policy analysts Empirical Process Techniques for Dependent Data Herold Dehling, Thomas managers and decision makers and NGOs Mikosch, Michael Sörensen, 2012-12-06 Empirical process techniques for independent data have been used for many years in statistics and probability theory These techniques have proved very useful for studying asymptotic properties of parametric as well as non parametric statistical procedures Recently the need to model the dependence structure in data sets from many

different subject areas such as finance insurance and telecommunications has led to new developments concerning the empirical distribution function and the empirical process for dependent mostly stationary sequences This work gives an introduction to this new theory of empirical process techniques which has so far been scattered in the statistical and probabilistic literature and surveys the most recent developments in various related fields Key features A thorough and comprehensive introduction to the existing theory of empirical process techniques for dependent data Accessible surveys by leading experts of the most recent developments in various related fields Examines empirical process techniques for dependent data useful for studying parametric and non parametric statistical procedures Comprehensive bibliographies An overview of applications in various fields related to empirical processes e g spectral analysis of time series the bootstrap for stationary sequences extreme value theory and the empirical process for mixing dependent observations including the case of strong dependence To date this book is the only comprehensive treatment of the topic in book literature It is an ideal introductory text that will serve as a reference or resource for classroom use in the areas of statistics time series analysis extreme value theory point process theory and applied probability theory Contributors P Ango Nze M A Arcones I Berkes R Dahlhaus J Dedecker H G Dehling **Almost Sure Invariance Principles for Partial Sums of Weakly Dependent** Random Variables Walter Philipp, William F. Stout, 1975 A strong revival of interest in the law of the iterated logarithm and related asymptotic fluctuation results has occurred in the last decade stimulated by two remarkable papers by Volker Strassen In these papers Strassen introduces a new method for establishing such fluctuation results for sums of independent random variables and for martingales Strassen's almost sure invariance principle for martingales states that each martingale satisfying a certain second moment condition is with probability on close to a Brownian motion In this monograph we investigate the asymptotic fluctuation behavior of sums of weakly dependent random variables such as lacunary trigonometric mixing and Gaussian sequences Weak Dependence: With Examples and Applications Jérôme Dedecker, 2007-07-18 This book develops Doukhan Louhichi s 1999 idea to measure asymptotic independence of a random process The authors who helped develop this theory propose examples of models fitting such conditions stable Markov chains dynamical systems or more complicated models nonlinear non Markovian and heteroskedastic models with infinite memory Applications are still needed to develop a method of analysis for nonlinear times series and this book provides a strong basis for additional studies Stable Convergence and Stable Limit Theorems Erich Häusler, Harald Luschgy, 2015-06-09 The authors present a concise but complete exposition of the mathematical theory of stable convergence and give various applications in different areas of probability theory and mathematical statistics to illustrate the usefulness of this concept Stable convergence holds in many limit theorems of probability theory and statistics such as the classical central limit theorem which are usually formulated in terms of convergence in distribution Originated by Alfred R nyi the notion of stable convergence is stronger than the classical weak convergence of probability measures A variety of methods is described which

can be used to establish this stronger stable convergence in many limit theorems which were originally formulated only in terms of weak convergence Naturally these stronger limit theorems have new and stronger consequences which should not be missed by neglecting the notion of stable convergence. The presentation will be accessible to researchers and advanced students at the master's level with a solid knowledge of measure theoretic probability **High Dimensional Probability** IX Radosław Adamczak, Nathael Gozlan, Karim Lounici, Mokshay Madiman, 2023-06-05 This volume collects selected papers from the Ninth High Dimensional Probability Conference held virtually from June 15 19 2020 These papers cover a wide range of topics and demonstrate how high dimensional probability remains an active area of research with applications across many mathematical disciplines Chapters are organized around four general topics inequalities and convexity limit theorems stochastic processes and high dimensional statistics High Dimensional Probability IX will be a valuable resource for researchers in this area An Author and Permuted Title Index to Selected Statistical Journals Brian L. Joiner, 1970 All articles notes queries corrigenda and obituaries appearing in the following journals during the indicated years are indexed Annals of mathematical statistics 1961 1969 Biometrics 1965 1969 3 Biometrics 1951 1969 Journal of the American Statistical Association 1956 1969 Journal of the Royal Statistical Society Series B 1954 1969 2 South African statistical journal 1967 1969 2 Technometrics 1959 1969 p iv Theory and Applications of Long-Range Dependence Paul Doukhan, George Oppenheim, Murad Taggu, 2002-12-13 The area of data analysis has been greatly affected by our computer age For example the issue of collecting and storing huge data sets has become guite simplified and has greatly affected such areas as finance and telecommunications Even non specialists try to analyze data sets and ask basic questions about their structure One such question is whether one observes some type of invariance with respect to scale a question that is closely related to the existence of long range dependence in the data This important topic of long range dependence is the focus of this unique work written by a number of specialists on the subject The topics selected should give a good overview from the probabilistic and statistical perspective Included will be articles on fractional Brownian motion models inequalities and limit theorems periodic long range dependence parametric semiparametric and non parametric estimation long memory stochastic volatility models robust estimation and prediction for long range dependence sequences For those graduate students and researchers who want to use the methodology and need to know the tricks of the trade there will be a special section called Mathematical Techniques Topics in the first part of the book are covered from probabilistic and statistical perspectives and include fractional Brownian motion models inequalities and limit theorems periodic long range dependence parametric semiparametric and non parametric estimation long memory stochastic volatility models robust estimation prediction for long range dependence sequences. The reader is referred to more detailed proofs if already found in the literature. The last part of the book is devoted to applications in the areas of simulation estimation and wavelet techniques traffic in computer networks econometry and finance multifractal models and hydrology Diagrams and illustrations enhance the presentation Each article

begins with introductory background material and is accessible to mathematicians a variety of practitioners and graduate students. The work serves as a state of the art reference or graduate seminar text. Asymptotic Methods in Probability and Statistics B. Szyszkowicz,1998-10-29. One of the aims of the conference on which this book is based was to provide a platform for the exchange of recent findings and new ideas inspired by the so called Hungarian construction and other approximate methodologies. This volume of 55 papers is dedicated to Mikl's Cs rg a co founder of the Hungarian construction school by the invited speakers and contributors to ICAMPS 97. This excellent treatize reflects the many developments in this field while pointing to new directions to be explored. An unequalled contribution to research in probability and statistics. Liet.

Matem. Rink ,2007. Stochastic Mechanics of Discrete Media. David R. Axelrad,2012-12-06. For the past three decades the mechanics of structured media frequently called micromechanics has been recognized as an important new approach in the analysis of material behaviour. This book discusses the modern use of mathematical analysis to the stochastic mechanics of discrete media. The theoretical study is therefore based on set and measure theory and the application of point processes.

Many Degrees of Freedom in Field Theory L. Streit, 2013-03-09 Volumes 30 and 31 of this series dealing with Many Degrees of Freedom contain the proceedings of the 1976 International Summer Institute of Theoretical Physics held at the university of Bielefeld from August 23 to September 4 1976 This institute was the eighth in a series of summer schools devoted to particle physics and organized by universities and research institutes in the Federal Republic of Germany Many degrees of freedom and collective phenomena play a critical role in the description and understanding of elementary particles The lectures in this volume were intended to display how these structures occur in various recent developments of mathematical physics Lectures ranged from classical nonlinear field theory over classical soliton models constructive quantum field theory with soliton solutions and gauge models to the recent unified description of renormalization group tech niques in probabilistic language and to quantum statisti cal dynamics in terms of derivations The Institute took place at the Center for Inter disciplinary Research of the University of Bielefeld On behalf of all participants it is a pleasure to thank the officials and the administration of the Center for their cooperation and help before and during the Institute Special thanks go to V C Fulland M Kamper and A Kottenkamp for their rapid and competent preparation of the manuscripts **Statistical Inference for Discrete Time Stochastic Processes** M. B. Rajarshi, 2014-07-08 This work is an overview of statistical inference in stationary discrete time stochastic processes Results in the last fifteen years particularly on non Gaussian sequences and semi parametric and non parametric analysis have been reviewed The first chapter gives a background of results on martingales and strong mixing sequences which enable us to generate various classes of CAN estimators in the case of dependent observations Topics discussed include inference in Markov chains and extension of Markov chains such as Raftery's Mixture Transition Density model and Hidden Markov chains and extensions of ARMA models with a Binomial Poisson Geometric Exponential Gamma Weibull Lognormal Inverse Gaussian and Cauchy as stationary distributions It further

discusses applications of semi parametric methods of estimation such as conditional least squares and estimating functions in stochastic models Construction of confidence intervals based on estimating functions is discussed in some detail Kernel based estimation of joint density and conditional expectation are also discussed Bootstrap and other resampling procedures for dependent sequences such as Markov chains Markov sequences linear auto regressive moving average sequences block based bootstrap for stationary sequences and other block based procedures are also discussed in some detail This work can be useful for researchers interested in knowing developments in inference in discrete time stochastic processes It can be used as a material for advanced level research students *Probability* Allan Gut, 2013 Like its predecessor this book starts from the premise that rather than being a purely mathematical discipline probability theory is an intimate companion of statistics. The book starts with the basic tools and goes on to cover a number of subjects in detail including chapters on inequalities characteristic functions and convergence This is followed by a thorough treatment of the three main subjects in probability theory the law of large numbers the central limit theorem and the law of the iterated logarithm After a discussion of generalizations and extensions the book concludes with an extensive chapter on martingales The new edition is comprehensively updated including some new material as well as around a dozen new references NBS Special Publication ,1970

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Table of Contents Limit Theory For Mixing Dependent Random Variables

- 1. Understanding the eBook Limit Theory For Mixing Dependent Random Variables
 - The Rise of Digital Reading Limit Theory For Mixing Dependent Random Variables
 - Advantages of eBooks Over Traditional Books
- 2. Identifying Limit Theory For Mixing Dependent Random Variables
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
- 3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Limit Theory For Mixing Dependent Random Variables
 - User-Friendly Interface
- 4. Exploring eBook Recommendations from Limit Theory For Mixing Dependent Random Variables
 - Personalized Recommendations
 - Limit Theory For Mixing Dependent Random Variables User Reviews and Ratings
 - Limit Theory For Mixing Dependent Random Variables and Bestseller Lists
- 5. Accessing Limit Theory For Mixing Dependent Random Variables Free and Paid eBooks
 - Limit Theory For Mixing Dependent Random Variables Public Domain eBooks
 - Limit Theory For Mixing Dependent Random Variables eBook Subscription Services
 - Limit Theory For Mixing Dependent Random Variables Budget-Friendly Options

- 6. Navigating Limit Theory For Mixing Dependent Random Variables eBook Formats
 - o ePub, PDF, MOBI, and More
 - Limit Theory For Mixing Dependent Random Variables Compatibility with Devices
 - Limit Theory For Mixing Dependent Random Variables Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Limit Theory For Mixing Dependent Random Variables
 - Highlighting and Note-Taking Limit Theory For Mixing Dependent Random Variables
 - Interactive Elements Limit Theory For Mixing Dependent Random Variables
- 8. Staying Engaged with Limit Theory For Mixing Dependent Random Variables
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Limit Theory For Mixing Dependent Random Variables
- 9. Balancing eBooks and Physical Books Limit Theory For Mixing Dependent Random Variables
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Limit Theory For Mixing Dependent Random Variables
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Limit Theory For Mixing Dependent Random Variables
 - Setting Reading Goals Limit Theory For Mixing Dependent Random Variables
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Limit Theory For Mixing Dependent Random Variables
 - Fact-Checking eBook Content of Limit Theory For Mixing Dependent Random Variables
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements

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