

SELF-NORMALIZED LARGE DEVIATIONS

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Let $\{X_i, X_n, n \geq 1\}$ be a sequence of independent and identically distributed random variables. The classical Cramér–Chernoff large deviation states that $\lim_{n \rightarrow \infty} n^{-1} \ln P(\sum_{i=1}^n X_i)/n \geq x) = \ln \rho(x)$ if and only if the moment generating function of X is finite in a right neighborhood of zero. This paper uses $n^{(p-1)/p} V_{n,p} = n^{(p-1)/p} (\sum_{i=1}^n |X_i|^p)^{1/p}$ ($p > 1$) as the normalizing constant to establish a self-normalized large deviation without any moment conditions. A self-normalized moderate deviation, that is, the asymptotic probability of $P(S_n/V_{n,p} \geq x_n)$ for $x_n = o(n^{1/(p-1)/p})$, is also found for any X in the domain of attraction of a normal or stable law. As a consequence, a precise constant in the self-normalized law of the iterated logarithm of Griffin and Kuells is obtained. Applications to the limit distribution of self-normalized sums, the asymptotic probability of the r -statistic as well as to the Erdős–Rényi–Shepp law of large numbers are also discussed.

1. Introduction. Throughout this paper, let (Ω, Σ, P) denote a probability space, and let $\{X_i, X_n, n \geq 1\}$ be a sequence of independent and identically distributed (i.i.d.) nondegenerate real-valued random variables on the probability space. Put

$$S_n = \sum_{i=1}^n X_i, \quad V_n^2 = \sum_{i=1}^n X_i^2, \quad n = 1, 2, \dots$$

The classical Cramér–Chernoff large deviation [Chernoff (1952)] states that if

$$(A) \quad E e^{t_0 X} < \infty \text{ for some } t_0 > 0,$$

then for every $x > EX$,

$$\lim_{n \rightarrow \infty} n^{-1} \ln P\left(\frac{S_n}{n} \geq x\right) = \ln \rho(x),$$

or equivalently,

$$(1.1) \quad \lim_{n \rightarrow \infty} P\left(\frac{S_n}{n} \geq x\right)^{1/n} = \rho(x),$$

where $\rho(x) = \inf_{t \geq 0} e^{-tx} E e^{tX}$.

Roughly speaking, this type of large deviation shows that the convergence rate in the law of large numbers is exponential if the moment generating

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Chapter 3 Self Normalized Large Deviations

Anirban DasGupta



Chapter 3 Self Normalized Large Deviations:

Self-Normalized Processes Victor H. Peña, Tze Leung Lai, Qi-Man Shao, 2008-12-25 Self normalized processes are of common occurrence in probabilistic and statistical studies. A prototypical example is Student's t statistic introduced in 1908 by Gosset whose portrait is on the front cover. Due to the highly non linear nature of these processes the theory experienced a long period of slow development. In recent years there have been a number of important advances in the theory and applications of self normalized processes. Some of these developments are closely linked to the study of central limit theorems which imply that self normalized processes are approximate pivots for statistical inference. The present volume covers recent developments in the area including self normalized large and moderate deviations and laws of the iterated logarithms for self normalized martingales. This is the first book that systematically treats the theory and applications of self normalization.

Asymptotic Theory in Probability and Statistics with Applications T. L. Lai, Lianfen Qian, Qi-Man Shao, 2008 Presents a collection of 18 papers many of which are surveys on asymptotic theory in probability and statistics with applications to a variety of problems. This volume comprises three parts: limit theorems, statistics and applications, and mathematical finance and insurance. It is suitable for graduate students in probability and statistics.

Asymptotic Theory of Statistics and Probability Anirban DasGupta, 2008-02-06 This book developed out of my year long course on asymptotic theory at Purdue University. To some extent the topics coincide with what I cover in that course. There are already a number of well known books on asymptotics. This book is quite different. It covers more topics in one source than are available in any other single book on asymptotic theory. Numerous topics covered in this book are available in the literature in a scattered manner and they are brought together under one umbrella in this book. Asymptotic theory is a central unifying theme in probability and statistics. My main goal in writing this book is to give its readers a feel for the incredible scope and reach of asymptotics. I have tried to write this book in a way that is accessible and to make the reader appreciate the beauty of theory and the insights that only theory can provide. Essentially every theorem in the book comes with at least one reference preceding or following the statement of the theorem. In addition I have provided a separate theorem by theorem reference as an entry on its own in the front of the book to make it extremely convenient for the reader to find a proof that was not provided in the text. Also particularly worth mentioning is a collection of nearly 300 practically useful inequalities that I have collected together from numerous sources. This is appended at the very end of the book.

Empirical Inference Bernhard Schölkopf, Zhiyuan Luo, Vladimir Vovk, 2013-12-11 This book honours the outstanding contributions of Vladimir Vapnik, a rare example of a scientist for whom the following statements hold true simultaneously: his work led to the inception of a new field of research, the theory of statistical learning and empirical inference; he has lived to see the field blossom and he is still as active as ever. He started analyzing learning algorithms in the 1960s and he invented the first version of the generalized portrait algorithm. He later developed one of the most successful methods in machine learning, the support vector

machine SVM more than just an algorithm this was a new approach to learning problems pioneering the use of functional analysis and convex optimization in machine learning Part I of this book contains three chapters describing and witnessing some of Vladimir Vapnik's contributions to science In the first chapter L. Bottou discusses the seminal paper published in 1968 by Vapnik and Chervonenkis that lay the foundations of statistical learning theory and the second chapter is an English language translation of that original paper In the third chapter Alexey Chervonenkis presents a first hand account of the early history of SVMs and valuable insights into the first steps in the development of the SVM in the framework of the generalised portrait method The remaining chapters by leading scientists in domains such as statistics theoretical computer science and mathematics address substantial topics in the theory and practice of statistical learning theory including SVMs and other kernel based methods boosting PAC Bayesian theory online and transductive learning loss functions learnable function classes notions of complexity for function classes multitask learning and hypothesis selection These contributions include historical and context notes short surveys and comments on future research directions This book will be of interest to researchers engineers and graduate students engaged with all aspects of statistical learning

The Annals of Statistics, 2007 **Mathematical Reviews**, 2001 **Journal of the American Statistical Association**, 2002 Probability, Finance and Insurance T. L. Lai, Hailiang Yang, Siu Pang Yung, 2004

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Probability, Finance And Insurance, Proceedings Of A Workshop Siu Pang Yung, Tze Leung Lai, Hailiang Yang, 2004-06-28 This workshop was the first of its kind in bringing together researchers in probability theory stochastic processes insurance and finance from mainland China Taiwan Hong Kong Singapore Australia and the United States In particular as China has joined the WTO there is a growing demand for expertise in actuarial sciences and quantitative finance The strong probability research and graduate education programs in many of China's universities can be enriched by their outreach in fields that are of growing importance to the country's expanding economy and the workshop and its proceedings can be regarded as the first step in this direction This book presents the most recent developments in probability finance and actuarial sciences especially in Chinese probability research It focuses on the integration of probability theory with applications in finance and insurance It also brings together academic researchers and those in industry and government With contributions by leading authorities on probability theory particularly limit theory and large derivations valuation of credit derivatives portfolio selection dynamic protection and ruin theory it is an essential source of ideas and information for graduate students and researchers in probability theory mathematical finance and actuarial sciences and thus every university should acquire a copy The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP CDROM version ISI Proceedings Index to Social Sciences Humanities Proceedings ISSHP ISI Proceedings Index to Social Sciences Humanities Proceedings ISSHP CDROM version ISI Proceedings CC Proceedings Engineering Physical Sciences **Успехи Математических Наук**, 1960 **SeaWiFS Technical Report Series**, 1997 Theory of Probability and Mathematical Statistics, 1996 **The Tapestry of Modern Astrophysics** Steven N. Shore, 2003 Table of contents **Pharmacology and Therapeutics for Dentistry** John A. Yagiela, 2004 Pharmacology and Therapeutics for Dentistry 5th edition emphasizes the clinical application of drugs used in dental treatment This comprehensive text covers the basic principles of drugs and their actions on the body It provides a solid understanding of pharmacology content and helps readers thoroughly evaluate a patient's current medical status and best optimize dental treatment in relation to overall health BOOK JACKET **Technical Basis for the ITER Detailed Design Report, Cost Review and Safety Analysis (DDR)**, 1997 Assessment for Educational Leaders W. James Popham, 2006 Written specifically for school administrators and those preparing to be school administrators this easy to read book contains only what's needed by leaders in today's assessment dominated world of educational accountability The content of the text is unabashedly practical addressed specifically to the assessment related needs of today's school administrators The real world orientation of the book based on the author's extensive and continuing work in the nation's public schools makes the book attractive to those instructors who teach assessment courses taken by prospective school administrators Students and in service school administrators will recognize that this text is not loaded with dry abstruse content about measurement and

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