

SELF-NORMALIZED LARGE DEVIATIONS

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Let $\{X, X_n, n \geq 1\}$ 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 $x_n = o(n^{1/(p-1)})$, 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 Kuelbs is obtained. Applications to the limit distribution of self-normalized sums, the asymptotic probability of the t -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 $\{X, X_n, n \geq 1\}$ 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

Jianjun Gao



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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.

Probability Theory and Mathematical Statistics B. Grigelionis, J. Kubilius, V. Paulauskas, H. Pragarauskas, R. Rudziskis, V. Statulevičius, 2020-05-05. No detailed description available for Probability Theory and Mathematical 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.

The Annals of Statistics, 2007. **Mathematical Reviews**, 2005. **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, and Singapore.

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driver certificate of professional competence dcpc changes - Mar 10 2023

web mar 2 2023 summary proposals for reforms to how drivers renew and evidence their dcpc and how exceptional circumstances could be dealt with this consultation ran from 9 30am on 2 march 2023 to 11 45pm on

driver cpc courses ritchies training - Dec 27 2021

web you must take one of these to your driver certificate of professional competence cpc training course a photocard driving licence lgv c1 c c e or pcv d entitlement a valid passport as photo id a digital tachograph card a driver cpc card passed a module2 4 test only applicable if you passed your car test after the 1st january 1997

driver certificate of professional competence cpc syllabus - Apr 11 2023

web apr 28 2021 driver certificate of professional competence cpc syllabus updated 28 april 2021 1 advanced training in rational driving based on safety regulations all licences 1 1 to know the

what is cpc bus and coach drivers safe driving for life - Jul 02 2022

web all professional bus and coach drivers must complete at least 35 hours of approved periodic cpc training every 5 years periodic training covers various aspects of professional driving and is delivered by independent training bodies what s covered in your training is up to you and your employer but it might include using tachographs

check if you need driver cpc to drive a lorry bus or coach - Sep 04 2022

web may 7 2013 find out if you need the driver certificate of professional competence cpc qualification to drive a lorry bus or coach or if you could be exempt from driver and vehicle standards agency