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 Cramer-Chernoff large deviation states that $\lim_{n\to\infty} n^{-1} \ln P((\sum_{j=1}^n X_j)/n\geq n) = \ln p(x)$ if and only if the moment generating function of X is finite in a right neighborhood of zero. This paper uses $n^{(p-1)/p} Y_{n,p} = n^{(p-1)/p} (\sum_{j=1}^n |X_j|^p)^{1/p} \ (p>1)$ 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 $P(S_n/V_{n,p} \geq s_n)$ for $s_n = o(n^{(p-1)/p})$, 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 Kuelbs is obtained. Applications to the limit distribution of self-normalized sums, the asymptotic probability of the instalistic as well as to the Erdös-Renyi-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

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

The classical Cramer-Chernoff large deviation [Chernoff (1952)] states that if

(A)
$$Ee^{t_0X} < \infty$$
 for some $t_0 > 0$,

then for every x > EX,

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

or equivalently,

(1.1)
$$\lim_{n\to\infty} P\left(\frac{S_n}{n} \ge x\right)^{1/n} = \rho(x).$$

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

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

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