determined by

(i) the k lower extremes,

(ii) $(S_m^{1/(1+a)} + \theta)_{m \leqq k}$ where S_m is the sum of m i.i.d. standard exponential random variables and θ is the location parameter,

(iii) $(S_m^{1/(1+a)} + \theta)_{m=1,2,3,\cdots}$.

The investigations are carried out within the sufficiency and deficiency concept.

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Sums of extreme value processes

Let $X_{1,n} \leqq \cdots \leqq X_{n,n}$ denote the order statistics based on the first n observations of a sequence of independent random variables with common distribution function F assumed to be in the domain of attraction of an extreme value law. Invariance principles, functional laws of the iterated logarithm and Darling–Erdős-type theorems are described for sums of extreme value processes formed by suitably centered and normalized versions of partial sums of the type

$$\sum_{i \leqq tk_n} X_{n+1-i,n}, \qquad 0 \leqq t \leqq 1,$$

where k_n is a sequence of numbers such that

$$0 < k_n \leqq n, \qquad k_n \to \infty, \quad \text{and} \quad k_n/n \to 0 \quad \text{as} \quad n \to \infty.$$

The proofs of these results are based on a representation of these sums as an integral of the quantile or inverse function of F over the uniform empirical distribution.

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On a relationship between record times and record values of an i.i.d. sequence

Let $\{X_n\}$ be an i.i.d. sequence of random variables with a continuous c.d.f. F. Define upper and lower record times by

$$U_0 = 1, \qquad U_{n+1} = \inf\{k; X_k > X_{U_n}\}; \qquad n \geqq 0;$$
$$L_0 = 1, \qquad L_{n+1} = \inf\{k; X_k < X_{L_n}\}; \qquad n \geqq 0.$$

If F is the c.d.f. of an exponential distribution with unit mean, then we have the following result.

Theorem. (a) L_n and $L_n X_{L_n}$ are independent for all $n \geqq 0$.
(b) $L_n X_{L_n}$ is exponentially distributed with unit mean.

This theorem allows the following conclusion.

Corollary. (a) $X_{U_n} - \log U_n$ is asymptotically Λ-distributed for $n \to \infty$ where Λ denotes the c.d.f. of a doubly-exponentially distributed random variable.

(b) $\log U_n = X_{U_n} + O(\log n)$ a.s. $(n \to \infty)$.

Similar results can be derived also for the case of a general c.d.f. F, as well as strong approximations jointly for record times, inter-record times and record values by Poisson and Wiener processes.