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Extremes in systems with linear and nonlinear memory by the return-interval approach[1]

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The occurrence of extreme events above a certain threshold Q in time series can be characterized by their return intervals r_i. Here we review recent work on the distribution $P_Q(r)$ of the return intervals and their correlation properties (i) in systems with linear long-term memory and (ii) in systems with non-linear memory. Examples for (i) are temperature records, examples for (ii) are financial records. The distribution of the return intervals is an important quantity in risk estimation since it enables one to calculate the probability that an extreme event occurs in the next period of time. We discuss the different functional forms of $P_Q(r)$ that range from simple exponential (random systems) to stretched exponentials (systems with long-term memory) and q-exponentials (systems with non-linear memory). We show that both linear and non-linear memory lead to long-term memory in the return intervals, which then results in a clustering of the extreme events. Both the distribution of the return intervals and their correlation properties can be used as a test bed for computer models.

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