

From Bacon and Eggs to Fréchet Shock-Degradation Models

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Some distributions arise naturally to meet practical needs. I'll discuss two interesting examples, Sarmanov multivariate distributions and Fréchet shock-degradation models. One can generate many multivariate distributions having given marginals. The density of the bivariate Sarmanov distributions with beta marginal can be expressed as a linear combination of products of independent beta densities. This pseudo conjugate property greatly reduces the complexity of posterior computations when this bivariate beta distribution is used as a prior (Lee, 1996). An interesting marketing study found that people who purchase bacon will often buy eggs, hence the bivariate beta-binomial distributions applied well in analyzing the data. Recently the method has also been applied in multivariate meta analysis. Many systems experience gradual degradation while simultaneously being exposed to a stream of random shocks that eventually cause failure when the shock exceeds the residual strength of the system. This failure mechanism is found in diverse fields of application. A tractable new family of Fréchet shock-degradation models will be presented. This family has the attractive feature of defining the failure event as a first passage event and the time to failure as a first hitting time (FHT) of a threshold by an underlying stochastic process. The Fréchet shock-degradation family includes a wide class of underlying degradation processes. We derive the survival function for the shock-degradation process as a convolution of the Fréchet shock process and any candidate degradation process that possesses stationary independent increments (Lee, Whitmore 2016). Statistical properties of the survival distribution will be discussed.