Multivariate stochastic mechanisms and information measures in population growth processes

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Abstract: Stochastic differential equations have been intensively used to analyze data from physics, finance, engineering, medicine, biology, and forestry. This study proposes a general multivariate stochastic dynamical model of a population growth development which includes random forces governing the dynamic of multivariate distribution of tree size variables. The dynamic of the multivariate probability density function of individuals size variables in a stand is described by a mixed effect parameters Gompertz-type multivariate stochastic differential equation (SDE). The advantages of multivariate SDE model are that it do not need to choose many different equations to be tried, but it relates the individuals size variables dynamic against the time dimension, and consider the underlying covariance structure driving changes in the size variables. SDE model allows us a better understanding of biological processes driving the dynamic of natural phenomena. The new derived multivariate probability density function and its marginal univariate, bivariate, trivariate, conditional univariate, bivariate, trivariate, and much more distributions can be applied for the modeling of population attributes such as the mean value, quantiles and much more. This study introduces general multivariate mutual information measures based on the differential entropy to capture multivariate interactions between size variables. The purpose of the present study is therefore to experimentally confirm the effectiveness of using multivariate mutual information measures to reconstruct multivariate interactions in size variables.
Keywords: multivariate stochastic differential equation, probability density function, maximum likelihood procedure, information measures

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