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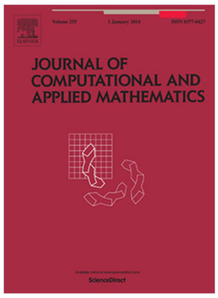

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New classes of power series bivariate copulas

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Abstract

Zhang, Lin and Xu [Insurance: Mathematics and Economics, 2016, 66, 1-10] introduced a copula based on the geometric distribution. Here, we introduce general classes of copulas containing Zhang et al. (2016)'s copula as a particular case. Physical motivations are given for the general classes. One of the general classes is shown to be more flexible by reanalyzing the two real data sets in Zhang et al. (2016).
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1 Introduction

A bivariate copula is a function $C : [0,1]^2 \to [0,1]$ that satisfies $C(u,0) = C(0,v) = 0$, $C(u,1) = u$, $C(1,v) = v$, and

$$\sum_{i_1=1}^{2}\sum_{i_2=1}^{2}(-1)^{i_1+i_2}C\left(u_{1,i_1},u_{2,i_2}\right) \geq 0$$

for $a_i \leq b_i$, $i = 1,2$, where $u_{j,1} = a_j$ and $u_{j,2} = b_j$ for $j = 1,2$.

The concept of copulas was introduced by Sklar (1959). Since then many parametric, non-parametric and semi-parametric models have been proposed for copulas, including methods for constructing models for copulas (Nelsen, 2006). Most of the proposed models have been parametric models. There are fewer non-parametric models and even fewer semi-parametric models. Applications of copulas are too numerous to list, see, for example, Genest and Favre (2007) for an excellent review of applications in hydrology.

The most recent parametric copula was proposed by Zhang et al. (2016). This copula was constructed by taking the componentwise maxima of a sequence of N independent and identical random vectors say $(X_1,Y_1),(X_2,Y_2),\ldots,(X_N,Y_N)$, where N was assumed to be a geometric random variable independent of $(X_1,Y_1),(X_2,Y_2),\ldots,(X_N,Y_N)$ (Marshall and Olkin, 1997). Zhang et al. (2016) gave no physical motivation for their construction. But if N is the number of insurance claims in a year and if (X_i,Y_i) are two variables associated with the ith claim, for example the age of a motor vehicle driver and the amount claimed after accident, then the componentwise maxima, $\big(\max\left(X_1,X_2,\ldots,X_N\right), \max\left(Y_1,Y_2,\ldots,Y_N\right)\big)$, will represent the largest claims made by the oldest drivers. But there is no reason for limiting interest only to this vector. One could also be interested in the: