

In the Name of Allah



Abstracts of
The 7th Seminar on
Copula Theory and its Applications

Department of Statistics
and
Ordered Data, Reliability and Dependency Center of Excellence
Ferdowsi University of Mashhad,
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Disclaimer

This book contains the abstracts booklet of the 7th Seminar on "Copula Theory and its Applications". Authors are responsible for the contents and accuracy. Opinions expressed may not necessarily reflect the position of the scientific and organizing committees.

Preface

The series of biennial workshops on copula theory which took place in Ferdowsi University of Mashhad (2011 and 2013), Shahid Bahonar University of Kerman (2015) and Yazd University (2017) with an emphasis on application in engineering sciences, agricultural sciences, actuarial science, finance, reliability, survival analysis, economics and etc. is the result for the decision of the scientific committee of the Ordered and Spatial Data Center of Excellence (OSDCE) of Ferdowsi University of Mashhad (FUM) to organize workshops and seminars every two years. This seminar is sponsored by the department of statistics, OSDCE of FUM, Islamic world Science Citation database (ISC), Iranian Statistical Society and Actuarial Society of Iran to provide suitable facilities for academics to have efficient research cooperation and will be held at Faculty of Mathematical Sciences of FUM at 8 and 9 Feb. 2023. We hope all of the seminar committees provide a suitable satisfactory atmosphere for the participants. After the first call of the seminar, 30 papers were accepted as oral presentations by the referees and scientific committee. The attendants and participants in the seminar are in summary 40 people which are professors, students and researchers of different institutes around Iran. Finally, we would like to extend our sincere gratitude to the Research Council of FUM, the administration of Faculty of Mathematical Sciences, the OSDCE, the Islamic world Science Citation center, the Iranian Statistical Society, Actuarial Society of Iran, the scientific committee, the organizing committee, the referees, and the students and staff of the department of statistics of FUM for their kind cooperation.

Mohammad Amini (Chair)

Feb. 2023

Topics

The aim of the seminar is to provide a forum for presentation and discussion of scientific works covering theories and methods such as:

- Methods of copula construction
- Copula functions and dependence concepts
- Dependence modelling using copula function
- Inference based on copula
- Application of copula in spatial, survival, reliability, engineering, hydrological, meteorological, agricultural, finance, economic data and etc.

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On the copula-based time between events control chart

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Abstract

Time Between Events (TBE) control charts are developed in this article to monitor processes with multiple dependent production lines. An EWMA-type TBE chart has been proposed for this. The copula approach describes production line dependence, while the homogeneous Poisson process lines defects. The proposed methods are evaluated using an average time-to-signal metric.

Keywords: Time between events, EWMA chart, Average time to signal, Homogeneous poisson process.

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Investigating the effect of dependence of fading coefficients and its modeling with copula theory in non-orthogonal multiple access (NOMA) channels with physical layer security

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Abstract

In wireless communication, in most mathematical modeling, it is assumed that the fading coefficients are independent of each other, if physically, there is a correlation between them. In this paper, the non-orthogonal multiple access (NOMA) Downlink with physical layer security and dependent fading coefficients is investigated. The average secrecy rate (ASR) for the NOMA channel in the presence of an eavesdropper has been investigated by modeling the dependence of extinction coefficients by copula functions. With mathematical calculations and numerical results, we compared the effect of correlation in the studied fading coefficients and independent fading coefficients to find out whether this modeling is useful or harmful.

Keywords: Average secrecy rate, Copula theory, Non-Orthogonal multiple access, Physical layer security.

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Skew-Elliptical distribution of copula related random variables

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Abstract

In this article, we introduce a generalization of the skew distributions when the random variables are associated to a copula. Considering two Gaussian-copula and t-copula, we present a generalisation of skew-normal as well as skew-t distributions. We investigate the performance of our proposed distributions using a simulation study.

Keywords: Skew-normal distribution, Skew-t distribution, Copula function, Gaussian-Copula function, Student's t-copula function.

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Stochastic comparisons of extreme order statistics from the generalized Gompertz distribution

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Abstract

Stochastic comparison on order statistics from heterogeneous-dependent observations has been paid lots of attention recently. This paper devotes to investigating the ordering properties of order statistics from dependent observations. In the presence of the Archimedean copula or survival copula for the random variables of samples having generalized Gompertz distribution, we obtain the usual stochastic order of the sample extremes. In addition, some examples illustrating the main results are presented as well.

Keywords: Generalized Gompertz distribution, Majorization, Usual stochastic order, Extreme order statistics, Archimedean copula.

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Application of D-Vine regression copula in Covid-19 data

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Abstract

The rapid spread of Covid-19 since January 2020 has dramatically affected financial markets and economies all over the world, especially in United States. This paper aims at utilizing the regression model of D-Vine Copula to investigate about the effects of each input variables related to coronavirus news on our three response variables which are three famous indices in U.S. Findings demonstrate that the fitted quantile curves of all input variables suggest that the news variables have the most negative effect on all mentioned indices.

Keywords: Pandemic, Covid-19, Indices, D-Vine copula, Kendalls tau.

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Analysis of spatial survival data using copula functions

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Abstract

Many survival data analyses aim to assess the effect of different risk factors on survival time. When these survival times are correlated, using the copula functions is common to incorporate the data correlations. In some studies, the correlation between survival times is related to their spatial locations. One may use the copula functions to model the spatial dependence of the data. Spatial data are usually positively correlated, and the correlation decreases as the spatial distance between units increases. So, a copula function can be suitable if it covers positive correlations between variables. In addition, the copula results in independence and maximum correlation when the spatial distance between units goes to infinity and zero, respectively. In this talk, we present a useful spatial copula function, which has a proper fit to survival data because of its asymmetric property. Since the copula approach models the marginal density functions and the dependence structure separately, a two-stage method is used to estimate the regression and dependence parameters separately. In a simulation study, we investigate the performance of the proposed model. Next, this model is applied to analyze a real dataset on Acute Myeloid Leukemia. Finally, a brief discussion is presented.

Keywords: Spatial survival data, Spatial copula, Gumbel-Hougaard copula.

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A new family of copulas based on distortion function and its properties

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Abstract

One of the basic methods of constructing the copula function is to use the bivariate survival function. In this article, using the copula function and taking into properties of distortion functions, a family of distribution functions is introduced and its characteristics are investigated. In the following, using the introduced distribution function, a bivariate survival function is presented and based on it, a family of copula functions is introduced.

Keywords: Copula function , Distortion function, Dependence structure, Dependence measures.

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Kolmogorov-Feller weak law of large numbers for FGM random sequences

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Abstract

In this paper we establish convergence rate of the Kolmogorov-Feller weak law of large numbers for maximal weighted sums of FGM random sequences.

Keywords: Copula, FGM random sequences, Kolmogorov-Feller weak law of large numbers, Convergence rate.

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Semiparametric estimation of mutual information for elliptical copulas

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Abstract

Mutual information can be rewritten based on the copula density and considered as a dependency measure. In this paper, a semiparametric estimation of this measure based on the probit transformation method is presented. A simulation study is performed to measure the accuracy of the estimators on elliptical copulas. The simulation results show that the suggested method has better performance than beta kernel and Bernstein methods.

Keywords: Mutual information, Copula density, Probit transformation.

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FGM copula based analysis of wireless communication performances for multi-user channels

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Abstract

The dependence of fading coefficients of wireless communication channels on each other affects communication performances such as Outage probability (OP), coverage region, energy efficiency, and secrecy capacity, possibly being constructive or destructive. In this paper, the outage probability as one of the most important wireless communication performances is investigated by using Copula theory. For this purpose, a wireless three-user multiple access channel (MAC) with Rayleigh fading and independent sources is considered and the outage probability in positive and negative dependence cases is compared. The results show that a negative dependence structure reduces the outage probability (compared to the independent state), but a positive dependence structure increases it.

Keywords: Multiple access channel, Rayleigh fading, Dependence, Copula theory, Outage probability.

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Ordering of conditional asymmetry

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Abstract

The aim of this paper is to study ordering of conditional asymmetry for copulas like those resulting from the concordance ordering for dependence. Several examples are provided to illustrate the result.

Keywords: Bivariate symmetry, Conditional asymmetry, Copula, Ordering.

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Sharpe ratio analysis: a copula approach

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Abstract

Sharpe ratio is a commonly used risk-adjusted measure for evaluating portfolio performance in risk management. Despite of its popularity, whenever the returns are non-normal or dependent, the calculated Sharpe index is either over or underestimated. The aim of this paper is to study the effect of dependence on the Sharpe ratio of a two assets portfolio by using the copula of its returns.

Keywords: Copula, Dependence, Portfolio, Risk-adjusted measure, Sharpe ratio.

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Analysis of diabetes using copula generalized additive regression model

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Abstract

Copulas are important tools to construct multivariate distributions using their marginals. These functions provide a flexible way to measure the strength of dependency structure among variables. In many cases, the parameters of the marginals and copula are a response related to a set of covariates. Considering the covariates affect in the accuracy of copula parameters estimation. Generalized additive model (GAM) is a flexible models which capture a linear and non-linear relationships between response and explanatory variables. In this paper application of GAM model in copula is investigated. Next, using copula GAM the best model is determined for analyzing diabetic patients in Ilam province.

Keywords: Copulas, Copula regression, Generalize additive model, Diabetes.

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Copula-based reliability analysis of a complex system subject to wiener degradation process

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Abstract

The complex systems are of great importance in many real situations. Here, a system consisting n elements each having ℓ dependent components is considered, and the reliability of such system is discussed under degradation performance. It is assumed that the degradation of each component follows a Wiener process and the dependence structure within the components is described by a flexible copula-based multivariate model. Also, it is supposed that system has a k -out-of- n structure, and the components of each elements constitute a series system. A simulation study is provided to illustrate how the dependence of components within each element affects system reliability.

Keywords: Copula function, Complex system, Degradation, Wiener process, System reliability.

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On the use of time-varying vine copulas in multivariate time series analysis

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Abstract

Analyzing and forecasting time-varying multivariate time series is a challenging task because of their long/short-term patterns, and hence, adopting time-varying or dynamic approaches has been proposed in the literature. Many of the traditional methods in the literature assume normality and hence a linear relationship for the data because of its simplicity in calculation and understanding, but despite the popularity, it is well known that this assumption is valid only within the Gaussian framework. In this context, although the classical copula approach has been widely used, it lacks flexibility in modeling complex high-dimensional dependence, especially in multivariate time series analysis. The better performance of vine copula as opposed to the classical copula in modeling the dependence of high-dimensional data has been pointed out by many authors. In this work we apply vine copulas in modelling multivariate time series data. In this regards, we handle time series data, using a change point detection technique. We illustrate our approach using a simulation study as well as a real data set analysis.

Keywords: Vine Copulas, Dynamic copula, Time-varying, Time series.

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