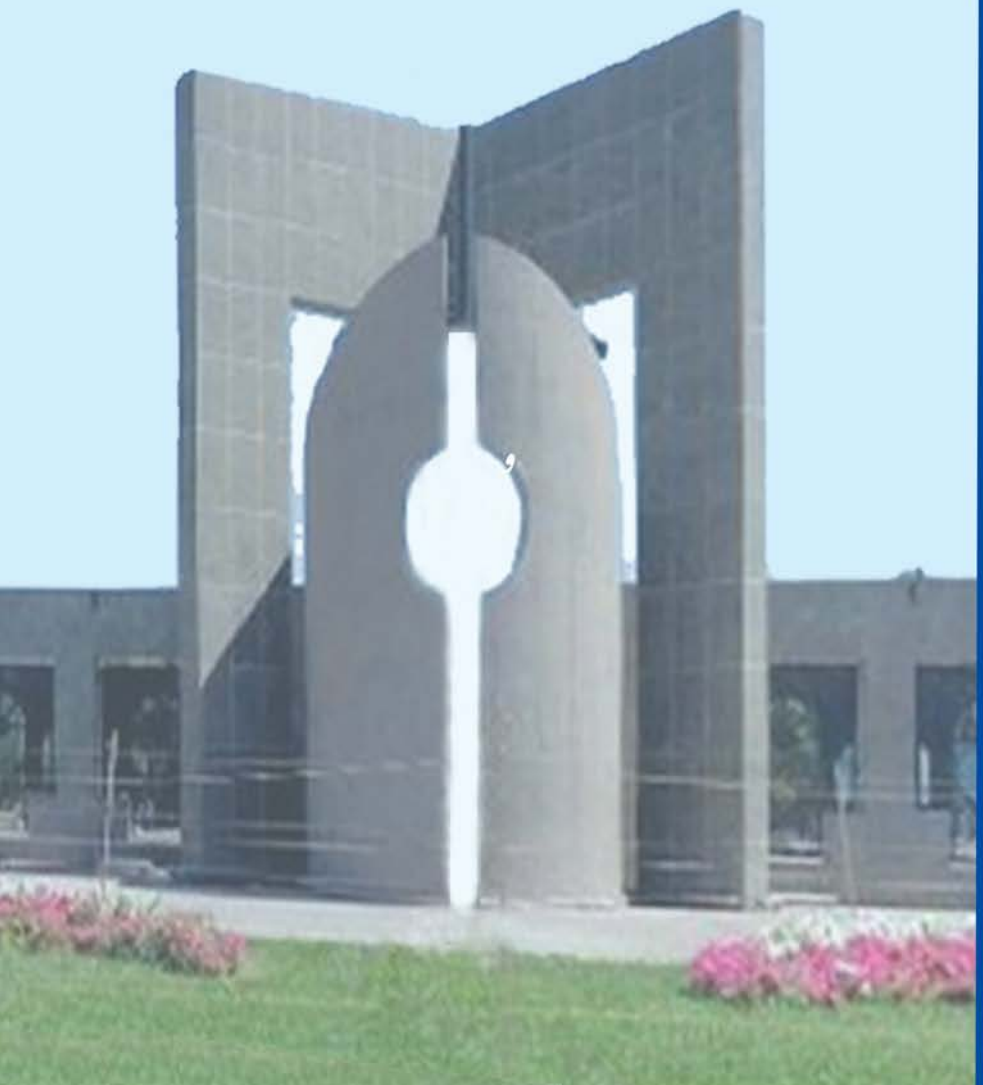
Abstracts Booklet

The 8th Seminar on Reliability Theory and its Applications

Ferdowsi University of Mashhad, Iran



18-19 May 2022

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In the Name of Allah

Abstracts of

The 8th Seminar on

Reliability Theory and its Applications

Department of Statistics

and

Ordered Data, Reliability and Dependency Center of Excellence

Ferdowsi University of Mashhad,

Mashhad, Iran

May 18-19, 2022

Disclaimer

This book contains the abstracts booklet of the 8th Seminar on "Reliability 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.

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Preface

Continuing the series of workshops on "Reliability Theory" in the Ferdowsi University of Mashhad and Seven Seminars at the University of Isfahan (2015), University of Tehran (2016), Ferdowsi University of Mashhad (2017), Shiraz University (2018), Yazd University (2019), University of Mazandaran (2020) and University of Birjand (2021), we are pleased to organize virtually (online) the 8th Seminar on "Reliability Theory and its Applications" during 18-19 May 2022 at the Department of Statistics, Ferdowsi University of Mashhad. On behalf of the organizing and scientific committees, we would like to extend a very warm welcome to all participants in this event. We hope that this seminar provides an environment of useful discussions and will also exchange scientific ideas through opinions. We wish to express our gratitude to the numerous individuals and organizations that have contributed to the success of this seminar, in which around 100 colleagues, researchers, and postgraduate students have participated. Finally, we would like to extend our sincere gratitude to the administration of the Ferdowsi University of Mashhad, the Faculty of Mathematical Sciences, the "Ordered Data, Reliability, and Dependency" Center of Excellence, the Iranian Statistical Society, the Scientific Committee, the Executive Committee, the students of the Department of Statistics at the Ferdowsi University of Mashhad, Islamic World Science Citation Database (ISC), Snowa Tech Company for their kind cooperation.

The Organizing Committee
May, 2022

Topics

The aim of the seminar is to provide a forum for presentation and discussion of scientific works covering theories and methods in the field of reliability theory and its applications in a wide range of areas:

- Lifetime distributions theory
- Accelerated life testing
- Maintenance modeling and analysis
- Reliability of systems
- Stochastic orderings in reliability
- Networks reliability
- Survival analysis
- Bayesian methods in reliability
- Case studies in reliability analysis
- Stress-strength modeling
- Optimization methods in reliability
- Lifetime data analysis
- Stochastic processes in reliability
- Data mining in reliability
- Computational algorithms in reliability
- Stochastic dependency in reliability
- Safety and risk assessment
- Degradation models
- Software reliability
- Stochastic aging

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Contents

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Some Probabilistic Models for Warranty Strategies

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Abstract

A warranty is a formal commitment, for a specified period, by a manufacturer (producer) to provide quality products or services. This commitment provides consumers with some security against the poor quality of the productions. The warranty is also proposed by the manufacturers as a value-added feature to promote a product. In this talk, first, we review some basic types of warranty policies such as 'free replacement policy', 'pro-rata replacement policy' and other related strategies. Then, we discuss a parametric model for the mean-value function to obtain the average number of repairs for a product during its warranty period. This model includes the mean numbers of perfect repairs, minimal repairs and the repairs worse than minimal. We also discuss a cost function to determine the optimum values of the warranty period under the proposed parametric model.

Keywords: Reliability, Warranty, Cost function, Stochastic process.

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Increasing failure rate closure property among discrete $(n-k+1)$-out-of-n systems

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Abstract

It is known that the increasing failure rate property preserves under the formation of $(n-k+1)$-out-of-n systems when the lifetimes are continuously distributed. However, it has not been proved in discrete case so far. We provide it by means of the concept of multiplicative strong unimodality.

Keywords: Order statistics, Logconcavity.

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Goodness-of-fit test for the half-normal distribution

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Abstract

In this paper, a goodness-of-fit test of the half normality based on the common area under the empirical and theoretical distribution curves is proposed. Critical values of the proposed test are obtained via Monte Carlo simulations. Power of the proposed test is studied and compared with the Modified Kolmogorov-Smirnov, Modified U, Cramer-von Mises and the Kuipoer tests. Finally, simulation results are discussed.

Keywords: Empirical cdf, Goodness-of-fit test, Half-normal, Power, Simulation.

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Optimization in a parallel system with random sample size

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Abstract

This paper considers a parallel system with a random number of units according to a power series class of distributions which contains well-known distributions such as modified or truncated Poisson, geometric, and logarithmic distributions. The optimal number of units for this system is derived analytically, and numerically, such that the expected cost is minimized and the reliability of the system is maximized, when the failure times follow a Burr Type XII distribution. Numerical computations are finally given.

Keywords: Parallel system, Optimization, Reliability.

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Reliability modeling of phased mission systems with multi-state components

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Abstract

In this paper, we propose a new model for the reliability assessment of phased mission systems at any time of the mission. The considered system may include different types of multi-state components. For this purpose, a new version of the survival signature is defined which is free of the random failure mechanism of the components. An example is given with fault tree structure to illustrate the new proposed model.

Keywords: Reliability, survival Signature, Phased mission system, Multi-state component.

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Optimization of condition-based maintenance with batch reinforcement learning for a parallel system with individually repairable components

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Abstract

In this study, we aim to develop a new maintenance policy for multi-component parallel systems with individually repairable components by using a batch reinforcement learning approach. First, component degradation is used to define the system states. Then, the optimal maintenance action for each component at each specific state is found by modelling the problem as a Markov decision process and solving it by using a batch reinforcement algorithm. Finally, a numerical example is given to show how batch reinforcement learning can be used to find the optimal maintenance policy for parallel systems.

Keywords: Batch reinforcement learning, Condition-based maintenance, Markov decision process, Q-learning.

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Bivariate total time on test transform, properties and applications

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Abstract

The total time on test (TTT) transform is a useful concept in various fields. This paper presents bivariate TTT transform. In addition the conditions for establishing TTT transform ordering in bivariate mode and its relationship with some stochastic orders, and establishing the bivariate TTT transform order as well as the presentation of the new better than used in bivariate total time on test transform ($NBUT$) class. Finally, describing the relationship between TTT transform and aging classes in bivariate mode.

Keywords: Total Time on Test Transform , Copula, Bivariate Aging Classes, NBUT.

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Comparing of sequential $(n-k+1)$-out-of-n systems with different structures

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Abstract

Sequential order statistics have been introduced to model sequential $(n-k+1)$-out-of-n systems which, as an extension of $(n-k+1)$-out-of-n systems, allow the failure of some components of the system to influence the remaining ones. Based on an a specific proportional failure rates model, we provide a general method for comparing of two sequential $(n-k+1)$-out-of-n systems with different structures when the initial components have the same or two different lifetime distributions. Finally, an illustrative example is also given.

Keywords: Sequential order statistics, Failure rate.

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Reliability evaluating for multi-state weighted systems

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Abstract

In the present paper, a multi-state weighted system (MSWS) containing of n components is considered. It is assumed that the system has a number of states ranges from perfect working to completely failure according to the weights of the functioning components. We study the reliability function and other reliability indices of such systems based on the concept of survival signature.

Keywords: Weighted systems , Multi-state systems, Survival signature.

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On the moment estimation of an inverse Gaussian deteriorating system subject to an imperfect maintenance

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Abstract

This paper studies a degrading system that its deterioration level is modeled by an inverse Gaussian process. The system undergoes preventive imperfect maintenance actions in each period of time T. The maintenance action removes $\rho\%$ of the degradation accumulated from the last maintenance action. We develop the moment estimation method in the framework of the proposed imperfect repair model, in order to estimate the model parameters.

Keywords: Imperfect repair, Inverse Gaussian process, Moment estimation.

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Signature-based reliability and maintenance modeling for a coherent system with failure interaction

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Abstract

In the present paper, Using the signature technique we present a reliability model for a coherent system with an absolutely continuous exchangeable distribution in which the dependence structure is modelled by the FGM copula function. The model is developed by considering an age-based preventive replacement policy. The model is examined by providing a numerical example.

Keywords: Maintenance, Average cost rate, Coherent system, Generic FGM Copula model, signature vector.

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Some goodness-of-fit tests based on Cox's empirical estimator under length-biased sampling

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Abstract

For studies in reliability, biometry and survival analysis, the length-biased distribution is frequently appropriate for certain natural sampling plans. In this paper, several new goodness-of-fit tests in the presence of length-biased sampling are considered. Indeed, the new tests are made based on using the Cox's empirical estimator of distribution function in the classic goodness-of-fit tests. Also, the Monte Carlo simulation is conducted to evaluate the performance of the proposed tests and compare them in terms of power to select the most powerful ones.

Keywords: Cox's estimator, Goodness-of-fit test, Length-biased data, Monte Carlo, Power study.

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A note on the stress-strength reliability of a coherent system based on signature

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Abstract

This article considers the stress-strength reliability of a coherent system and discusses its computation based on the concept of system signature. The system components may experience the same or different stress levels. We have found some mistake results given by Eryilmaz (2008). Some other mistake results of Bhattacharya and Roychowdhury (2013) was pointed out by Sadegh (2021). All these mistake results are due to misapplication of the system reliability in case of the system components are subjected to a common stress level. It is shown that the system signature can be used for calculating of the stress-strength reliability of a coherent system with different stress levels whereas when the system components are subjected to a common stress level, the use of system signature may leads to a mistake result. Regarding this, some mistake results given in Eryilmaz (2008) are pointed out.

Keywords: Coherent systems, Stress-strength reliability, System signature.

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Inference for shanker distribution based on type-II progressive censoring samples

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Abstract

In this paper, the estimation of parameter of the Shanker distribution based on progressively type-II right censored sample is studied. The maximum likelihood, Bayes, and parametric bootstrap methods are used for estimating the unknown parameter. Approximate confidence interval for the unknown parameter is constructed based on the s-normal approximation to the asymptotic distribution of maximum likelihood estimators. In addition, two bootstrap confidence intervals are also proposed. Bayes estimate of the unknown parameter is obtained by using the Gibbs within Metropolis-Hasting samplers procedure. Finally, a Monte-Carlo simulation study is carried out to investigate the precision of the Bayes estimate with maximum likelihood estimator and two bootstrap estimates, also to compare the performance of different corresponding confidence intervals considered.

Keywords: Maximum likelihood estimation, Asymptotic confidence interval, Bayes estimation, Type-II progressive censoring.

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Stochastic comparison of system lifetimes subject to random shocks

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Abstract

In this paper, we obtain the distribution and density functions of the lifetime of the system when the system is subject to random shocks. Under the extreme shock model, the lifetime of two systems with different critical values are then stochastically compared.

Keywords: Extreme Shock Model, Usual Stochastic Ordering, Hazard Rate Ordering, Likelihood Ratio Ordering, Dispersive Ordering.

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Time dependent perfect corrective maintenance policy

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Abstract

The same maintenance actions could induce different costs during time. In this paper, a single-unit system is considered under the lifetime test. The system is inspected periodically, and the inspection interval is considered as a decision parameter which should be optimized. A maintenance policy is proposed such that a set of corrective maintenance actions with different costs is considered and in the case of failure detection at inspection times the system is replaced by a new one. In this setup, it makes sense that choose of maintenance action depends on time or other covariates, through a statistical model. Eventually, the proposed maintenance policy is applied by a numerical simulation.

Keywords: Corrective Maintenance, Statistical Model, Time-dependent Maintenance Policy.

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Comparison of shared parameter model and latent class model for joint modeling of longitudinal and time-to-event data

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Abstract

There is a growing interest in using joint models to explore the relationship between longitudinal measurements and survival time data in follow-up studies. The shared parameter model is the most popular method for joint modeling in which features of the longitudinal model are present in the survival model explanatory variables. Also, a newer method is the joint latent class model in which a latent class structure is considered to fully achieve the relationship between longitudinal measurements and event outcome. The aim of this paper is to present a comparison of the shared parameter joint model and the joint latent class model. Thus, we first discuss about these models separately and then provide a real data set analysis as an application to see the performance of these two models.

Keywords: Joint model, Latent class model, Longitudinal measurements, Shared random effects model, Time to event outcome.

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A flexible mean past life regression model

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Abstract

The mean past lifetime measures the expected time elapsed since the failure of a subject till the time of observation. In this paper, we propose a flexible mean past life model to assess the effects of potential covariates on the mean past life function in the presence of left censoring. This model evaluates both multiplicative and additive effects of covariates on the mean past life function. We develop an estimation procedure to estimate the model parameters using martingale estimating equations. We also establish the asymptotic properties of the resulting estimators.

Keywords: Additive model, Counting process, Left censoring, Martingale estimating equation, Mean past lifetime, Proportional model.

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The impact of webinar advertising on the loyalty of the participants

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Abstract

A proper understanding and analysis of the processes involved in scientific event organising is essential to provide reliable information about the effect of event and how advertisement can affect matters of critical importance such as the number of participants and their contributions. This paper deals with the methodology of capturing the impact of the advertisement on the loyalty of the participants of the webinars. The idea uses Bayes theory and demonstrate the usefulness of the proposal in a real data set.

Keywords: Advertisement, Bayes, Negative Binomial.

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Comparing two bayesian tests for the lifetime performance index of products under progressively type-II censored Pareto data

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Abstract

In manufacturing industries, the lifetime of a product is usually characterized by a random variable, say X, and the product is considered to be satisfactory if X is larger than a given lower lifetime limit (L). The probability of a product being satisfactory is called the conforming rate. In practice, instead of using the conforming rate of products, indices such as the lifetime performance index (C_L) are utilized to assess whether products' quality meets the required level. Under a parametric model for lifetimes of products, it is observed that there is a strictly increasing relationship between the conforming rate and the lifetime performance index of products. Hence, the statistical inferences about the conforming rate and C_L are equivalent. This paper confines itself to the the Bayesian statistical inferences about C_L under progressively Type-II censored samples coming from the Pareto distribution with known shape parameter. Finally, the proposed Bayesian test via a simulation study is compared to the Bayesian test which is constructed similar to the work of Lee *et al.*

Keywords: Bayesian test, Lifetime performance index, Pareto distribution, Progressive Type-II censoring.

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Designing control charts for monitoring Weibull distribution under type-II right censoring

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Abstract

Lifetime data has some distinguishing features which make the development of control charts for lifetime monitoring more demanding, i.e., the data is usually censored, and has non-normal-skewed distributions. To deal with censored data, different schemes are proposed, right censoring, left censoring and interval censoring are among others. In this paper, to monitor the lifetime data of Weibull distribution, a variable control chart is developed. The data is obtained according to a type II right censoring which is also known as failure censoring. The performance of the proposed control chart is compared with another control chart presented in the literature. In designing the control charts, a new parameter is introduced which arbitrarily distributes type I error between the upper control limit and lower control limit of the control charts. By changing this parameter, the one-sided and two-sided control charts can be easily provided. Using simulation studies, applications of the control charts are illustrated. Also, a discussion regarding the applications in real data is provided.

Keywords: Lifetime, Control chart, Censored data, Life testing, Reliability.

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Some applications of the SSMESN family of matrix variate distributions

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Abstract

In this paper, the problem of finding a Bayes estimation for the mean matrix of the scale and shape mixtures of matrix variate extended skew normal distributions is considered, and an application in stress-strength models is described for the result.

Keywords: Bayes estimation, Random matrix, Stress-strength model.

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A series-parallel stress-strength reliability estimation based on Exponential distribution

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Abstract

In this paper we consider the estimation of reliability in a series-parallel stress-strength model when the stress and strength variables have Exponential distributions. The maximum likelihood estimation (MLE), asymptotic confidence interval (ACI) and uniformly minimum variance unbiased estimation (UMVUE) are obtained. Bayes estimation and Lindley approximation for bayes estimation of reliability under the squared error loss function are derived. Also a simulation study is performed and two real data are analyzed.

Keywords: Coherent System, Stress-Strength Reliability, Maximum Likelihood Estimation, Asymptotic Confidence Interval.

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Discussion on the conditional residual lifetime and inactivity time in coherent systems

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Abstract

In this article, we study the types of conditional residual lifetime and inactivity time in different scenarios for coherent systems. We also consider unordered observations in a random sample given an order statistic of the same sample. Some stochastic properties of these conditional random variables is provided. Real examples to show the application of results in practical are presented.

Keywords: Copula, Dependence, Coherent system, Order statistics, Reliability.

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Inferance in the statistical distributions based on progressively type-II censored data with dependent and independent random removal

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Abstract

An important challenge in using progressive Type-II right censoring is to determine a removal scheme. It can be fixed in advance or randomly chosen according to some discrete probability distributions. This paper considers the random removal problem in two cases. In the first case, the number of units removed at each failure time is independent of the lifetime distribution and follows the binomial or the discrete uniform distribution. The second one refers to the distribution of removed units is dependent on the lifetimes. In this case, some approaches are proposed for determining the progressive censoring scheme based on the time distance between consecutive failure times (spacing) with random and fixed coefficients from the Exponential distribution. Then, the performance of different removal distributions are compared with each other in terms of the expected duration of an experiment and point estimations of model parameters by Monte Carlo simulations and real data sets.

Keywords: Expected Test Time, Maximum Likelihood Estimator, Progressive censoring, Random removals, lifetime data.

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Asymptotic behavior of the α-mixture hazard rate

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Abstract

The α-mixture model is a new flexible family of distributions, that includes many existing mixture models as special cases. This paper discusses the asymptotic behavior of α-mixture hazard rate. The cumulative hazard rate considered in the paper includes many specific models such as the multiplicative hazards model, additive hazards model and accelerated life (scale) models. Under some assumptions, we show that the behavior of the mixing distribution plays a crucial role on asymptotic behavior of the α-mixture hazard rate.

Keywords: Mixture models, Limiting behavior, Hazard rate.

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Estimation of increasing hazard function in random left truncation model

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Abstract

There exist many investigations on curve estimation in right-censored and complete data under shape constraints. In contrast, researchers rarely have paid attention to such estimations under the random left truncation model. To the best of our knowledge, the previous researches contain no result on the non-parametric estimation of a hazard function from this model under monotone constraint using unconditional likelihood. Here, we derive an estimator that maximizes the likelihood function over the set of all non-increasing right-continuous step-wise hazard functions for estimating increasing hazard function. Additionally, we studied large sample properties of our proposed estimator and the small sample behavior of it using simulated data.

Keywords: Lynden-Bell estimator, Greatest convex minorant, Random left truncation model, Right continuous slope, Uniform weak consistency.

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Reliability bounds for a complex system with positively associated components

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Abstract

A complex k-out-of-n system consisting n elements each having some dependent components is considered. It is assumed that the degradation of each component follows a gamma process, and the reliability bounds are obtained by assuming that the components are positively associated. In this case, the performance of bounds is investigated by considering Frank copula as the exact dependence structure of components. Some numerical results are presented to discuss how the model parameters influence the system reliability.

Keywords: Coherent system, Complex system, Degradation, Gamma process, System reliability.

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Preventive maintenance of systems with multi-state components

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Abstract

In this paper, we give a preventive maintenance model for the systems with multi-state and non-identical components. It is assumed that all components are held in the state up using minimal repairs until a specific time at the initial time of working the system. After that time, a policy of preventive maintenance is applied to the system. To find the optimal time of maintenance we minimize the cost function written based on the concept of survival signature. The results are illustrated using an example.

Keywords: Reliability, Survival signature, Preventive maintenance, Fault tree model.

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Some properties of quantile past lifetime extropy

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Abstract

Extropy is a dual complement to entropy that has been the focus of information theory research. In this paper, we obtained various characterizations based on the lifetime distributions and quantile-based reliability measures functions for the past extropy and its properties based on quantile function. We introduce a new stochastic order based on the quantiles that is built on this measure.

Keywords: Characterization, Past Extropy, Quantile Function, Stochastic Orders.

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Stress strength estimation for a new modified Weibull distribution and its applications

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Abstract

The paper investigates the estimation and monitoring process of stress strength parameters for a new modified Weibull distribution. The mentioned density was provided in mathematical form and relating figures for its main characteristics including probability density function and cumulative distribution function. Thereafter, the parameter is calculated. The likelihood function is maximized and accordingly, not only maximum likelihood estimations but the corresponding Fisher information matrix are also provided in detail. The monitoring process is described and hereafter, based on some numerical results, the performances of presented concepts are also examined. The conclusion of the study will given in the last part of the present paper.

Keywords: Control chart, Maximum likelihood Estimation, Modified Weibull Distribution, Monitoring, Stress Strength.

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Redundancy allocation to weighted k-out-of-n systems with dependent components

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Abstract

In this paper, we examine the problem of redundancy allocation for a weighted k-out-of-n system when component lifetimes are dependent and heterogeneous. First, this problem is investigated with one redundant component and then it is generalized to two redundant components. The optimal allocation is determined based on the concept of usual stochastic order and the mean of the system. Some examples are provided to illustrate the results.

Keywords: Reliability, Stochastic ordering, Copula function, Redundant component.

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