In the Name of God

Abstracts of

the 4th Seminar on

Reliability Theory and its Applications

Department of Statistics

Shiraz University,
Shiraz, Iran

25-26 April, 2018

Preface

Following the series of workshops on "Reliability Theory and its Applications" in Ferdowsi University of Mashhad and three seminars in University of Isfahan (2015), University of Tehran (2016) and Ferdowsi University of Mashhad (2017) we are pleased to organize the 4th Seminar on "**Reliability Theory and its Applications**" during 25-26 April, 2018 at the Department of Statistics, Shiraz University. On behalf of the organizing and scientific committees, we would like to extend a very warm welcome to all participants, hoping that their stay in Shiraz will be happy and fruitful. Hope that this seminar provides an environment of useful discussions and would also exchange scientific ideas through opinions. We wish to express our gratitude to the numerous individuals that have contributed to the success of this seminar, in which around 90 colleagues, researchers, and postgraduate students from universities and organizations have participated.

Finally, we would like to extend our sincere gratitude to the Research Council of Shiraz University, the administration of College of Sciences, the Ordered and Spatial Data Center of Excellence, the Islamic World Science Citation Center, the Fars Science and Technology Park, the Iranian Statistical Society, the Scientific Committee, the Organizing Committee, the referees, and the students and staff of the Department of Statistics at Shiraz University for their kind cooperation.

Somayeh Zarezadeh (Chair)
April, 2018

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 and its application in a wide range of areas:

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

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Contents

Properties of the components of a system given the ith failure
Ahmadi, J. 9

A test for exponentiality based on gamma-divergence
Ahrari, V., Habibirad, A., Baratpour, S. 10

Stochastic comparisons of mixture of coherent systems with Dependent component lifetimes
Amini-Seresht, E. 11

Regression analysis of clustered interval-censored failure time data with the proportional hazards model
Amoorahimi, E., Kelkinnama, M. 12

On the reliability and failure rate properties of mixed populations
Asadi, M. 13

A note on the comparisons between largest order statistics from multiple-outlier models with dependence
Asgari, T., Kelkinnama, M. 14

Three-state systems with different types of components
Ashrafi, S. 15

Planning of step-stress accelerated degradation test with tampered failure rate model under an inverse Gaussian process
Azizi, F., Mosayebi Omshi, E., Haghighi, F., Shemehsavar, S. 16

Stop loss order and version of risk measures in connection with inequality criteria
Behdani, Z., Mohtashami Borzadaran, V., Mohtashami Borzadaran, G.R. . . . 17

Cumulative residual inaccuracy for minimum and maximum of order statistics
Daneshi, S., Nezakati, A., Tahmasebi, S. 18

$P\{\mathbf{Y} < \mathbf{X}\}$ using generalized order statistics and concomitant
Domma, F., Eftekharian, A., Razmkhah, M. 19

An imputation approach to Cox proportional hazards model in the presence of interval-censored Data
Fani, S. 20

Statistical inferences for stress-strength in the Marshal-Olkin models based on progressively type-II censored samples
Ghanbari, S., Rezaei, A., Salehi, M. 21

Reliability estimation under degradation-shock model
Haghighi, F. 22

Comparison of equivalency and optimality between constant-stress and step-stress tests under type-I censoring for rayleigh distribution
Hakamipour, N. 24

Cumulative residual entropy in sequential order statistics and some characterizations
Hashempour, M., Doostparast, M. 25

Some results on proportional mean past lifetime frailty model
Hooti, F., Ahmadi, J. 26

On mean time to failure in age replacement
Izadi, M., Khaledi, B. 27

Reliability estimation for the two-parameter exponential distribution based on records
Jafari, A. A., Bafekri Fadafen, S. 28

Multi-objective redundancy allocation problem with entropy constraint using two approaches
Kamandi, R., Zarezadeh, S., Mirdehghan, M. 29

Statistical inference for a repairable system with weibull distribution subject to shocks
Kamranfar, H., Etminan, J., Chahkandi, M. 30

On the coherent systems with two different types of dependent components
Kelkinnama, M. 31

Testing exponentiality based on the residual Lin-Wong divergence
Khalili, M., Habibirad, A., Yousefzadeh, F. 32

Some results on comparison among coherent systems
Khanjari Sadegh, M., Mirjalili, A. 33

On the point reconstruction of order statistics from Geometric distribution
Khatib Astaneh, B. 34

Bayesian inference for $R = P(X < Y)$ under adaptive type-II hybrid progressive censored samples in generalized inverted exponential distribution
Kohansal, A. 35

Generalized δ-shock model for the multi-state system
Lorvand, H., Poursaeed, M. H., Nematollahi, A.R. 36

An additive-multiplicative mean past life regression model
Mansourvar, Z. 37

Parametric inference from system lifetime data under a proportional hazard rate model based on the minimum Jensen-Gini estimator
Mehrali, Y. 38

Survival analysis of dependent competing risks with masked failure causes
Mireh, S., Khodadadi, A., Haghighi, F. 39

Bi-objective reliability-redundancy allocation problem with cold standby strategy
Mohammadi, Z., Zarezadeh, S., Dehbozorgi, M. 40

Bayesian designing of step-stress accelerated degradation test under an inverse Gaussian process with tampered failure rate model
Mosayebi E., Azizi F., Shemehsavar S., Haghighi F. 41

Connections between diversion concepts and reliability measures
Nasr Esfahani, S., Asadi, M. 42

Reliability analysis of k-out-of-n:F system with soft and hard failures
Nezakati, E., Razmkhah, M. 43

On a goodness of fit test for normality based on Lin-Wong divergence with type-I censored data
Pakgohar, A., Habibirad, A., Yousefzadeh, F. 44

Bayes estimation of mean lifetime in a proportional hazard rate model under progressive censoring
Razmkhah, M., Khatib, B. 45

Application of skip-free markov chains for degradation
Sajadi, F.A. 46

On the reliability modeling of weighted k-out-of-n systems with randomly chosen components
Salehi, M., Shishebor, Z., Asadi, M. 47

Bayesian and non-bayesian reliability analysis of the exponential family based on dual generalized order statistics
Salim, N., Dordizadeh, H. 48

Optimal step stress test plan based on bivariate gamma degradation model
Shemehsavar , S., Mosaebi Omshi , E. 49

A new class of bivariate failure time distributions in shock and competing risk models
Shoaee, Sh. 50

Reliability and time series
Soltani, A. R. 51

On the behavior of the system failure rate
Tavangar, M. 52

On the estimation of stress strength reliability parameter of new burr distribution
Yari, G. H., Tondpour, Z. 53

An RSS-based estimator of mean residual life
Zamanzade, E., Parvardeh, A., Asadi, M. 54

On the reliability of networks with multiple types of ternary components
Zarezadeh, S. 55

Properties of the components of a system given the ith failure

Ahmadi, J. [1]

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Abstract

Suppose there is a system with n components that the ith component has failed at the time t. In this talk, we are interested in studying the properties of the components lifetimes when system fails. Some distributional results are obtained which can be used in inspection problem for components with a stochastic life time. The monotonicity properties of the expected life length of a specific component with respect to n, i and t are studied. It is shown that some stochastic ordering are preserved.

Keywords: k-out-of-n system, Cost of replacement, Stochastic orders.

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A test for exponentiality based on gamma-divergence

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Abstract

In this paper, first we use the already defined gamma-divergence and then introduce a goodness of fit test for exponentiality. This divergence measure is very robust with respect to outliers. In order to construct test statistics, two estimators are used as estimators of gamma-divergence. In the first one we consider the gamma-divergence of the equilibrium distribution function, which is well defined on the empirical distribution function (EDF) and is proposed as an EDF-based goodness of fit test statistic. The second one is an estimator in manner of Vasicek entropy estimator. Critical values of test statistics are computed by Monte Carlo simulations. Then, the power values of the proposed tests are compared with some known competing tests under various alternatives. Simulation results indicate that in comparision with the other tests statistics, our mentioned test statistics almost in most of the cases have higher power. Finally, an example containing outliers illustrate the importance and use of the proposed tests.

Keywords: Entropy estimator, Equilibrium distribution, Ggamma-divergence, Goodness of fit test, Outliers, Testing exponentiality.

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Stochastic comparisons of mixture of coherent systems with Dependent component lifetimes

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Abstract

In this paper, we are investigated that various stochastic orders between the random environments can be translated into stochastic orders between the lifetime of the systems with dependent component lifetimes sharing the different random environment variables.

Keywords: Stochastic orders, Coherent system, Random environment, Distorted function, Copula function.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Regression analysis of clustered interval-censored failure time data with the proportional hazards model

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Abstract

The Cox proportional hazard (PH) model is the most popular regression model for analyzing the survival data. In this paper, we consider the clustered interval-censored failure time data and discuss the regression analysis under the PH model. This type of data set can occur when the desired failure times are gathered from several clusters and known only to lie in certain intervals. We propose the use of expectation-maximization (EM) algorithm for obtaining the maximum likelihood estimates of model parameters. The developed EM algorithm consists of two-stage data augmentation involving latent Poisson random variables. The performance of the proposed method is evaluated through a simulation study.

Keywords: Cluster interval-censored data, Within-cluster resampling, EM algorithm, Monotone splines, Proportional hazard model.

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On the reliability and failure rate properties of mixed populations

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Abstract

The arithmetic mixture models and mixture hazards models are widely used in various applications in reliability and survival analysis. In this talk we address the reliability and failure rate properties of a parametric class of mixed populations called α-mixture distribution, where $\alpha \in (-\infty, \infty)$ is a parameter. The α-mixture subsumes the arithmetic mixture models, mixture hazards models and harmonic mixture models, as special cases, in both finite and infinite settings. We show that the class of α-mixture is closed under *increasing failure rate* property for $\alpha < 0$, it is closed under *decreasing failure rate* property for $\alpha > 0$, while the limiting case $\alpha \to 0$ (mixture hazard models) is closed under both properties. The failure rate property of the α-mixture family is also investigated in two important special cases where the baseline failure rate follows an additive failure model or it follows a multiplicative failure model.

Keywords: Reliability, closure property, mixture models, mixture hazards model, IFR (DFR).

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

A note on the comparisons between largest order statistics from multiple-outlier models with dependence

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Abstract

We study stochastic comparisons between the largest order statistics from samples which may contain outliers. We assume that the random variables come from two different distributions which may be from proportional reversed hazard rates or proportional hazrad rate models. In this paper, for model the dependece structure between random variables the Archemedean copula, specifically Clayton copula is used.

Keywords: Multiple outlier, Order Statistics, Copula, Proportional reversed hazard rate model, Proportional hazard rate model.

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Three-state systems with different types of components

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Abstract

In this paper, we consider a three-state system consisting of n binary components of two different types. We assume that component lifetimes of the same type are exchangeable and component lifetimes of two different types are independent. A mixture representation is obtained for the joint reliability function of the state lifetimes of the system. For this purpose, we generalize the concept of survival signature to the three-state systems and call it bivariate survival signature. The bivariate survival signature is computed for several systems composed of two different types of independent modules.

Keywords: Survival signature, Redundancy system, Reliability.

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Planning of step-stress accelerated degradation test with tampered failure rate model under an inverse Gaussian process

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Abstract

In this article, we consider the planning of simple step-stress accelerated degradation test (SSADT) when the degradation follows an inverse Gaussian (IG) process. We apply the idea of the TFR model to describe the effect of the changing stress on the degradation and obtain maximum likelihood estimates (MLEs) of the model parameters. Under the constraint that the total experimental cost does not exceed a pre-specified budget, the optimal settings such as sample size, measurement frequency, and number of measurements at each stress level are obtained using variance optimality. Finally, a real-world example is analyzed to illustrate the application of the proposed methods.

Keywords: Step-Stress Accelerated Degradation Test, Tampered Failure Rate Model, Inverse Gaussian Process, Optimal Test Plan.

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Stop loss order and version of risk measures in connection with inequality criteria

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Abstract

Stochastic orders have shown to be useful notions in several areas of economics, the inequality analysis, risk analysis, reliability or portfolio insurance. Since the 1970, stochastic dominance rules have been used in comparison and analysis of poverty and income inequality. Recently stochastic orders have also played important role in the interpretation of decision under risk and actuarial suer us with comparing and measuring different risks.
Given a random variable $(X-t)_+$ where $(x)_+ = \max\{x, 0\}$ represent the amount by which X exceeds the t.
The function $\Pi_X(t) = E((X-t)_+) = \int_t^\infty \overline{F}(x)dx$ is called stop loss transform.
We will focus on stochastic dominance order, stop loss order and convex order and their links. The convex order is not location free. This means that only random variables having the same mean are comparable in convex order and dilation order, with Lorenz order, Total value of risk, conditional expectation, conditional value at risk, expected shortfall and expected proper formed shortfall have concepts related to Lorenz curve criteria.
Some theoretical and characterization results linking with the various ordering especially concentration on inequality measure, insurance criteria, step loss order and expected proportions shortfall is another direction of this paper. Also, a view based on distortion is the last part of this note.

Keywords: Risk measure, Order statistics, Lorenz order, Distortion function, Expected shortfall.

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Cumulative residual inaccuracy for minimum and maximum of order statistics

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Abstract

In this paper, we propose a measure of cumulative residual inaccuracy between survival function of the first-order statistic and parent survival function $\bar{F}$. We also consider cumulative inaccuracy measure between distribution of the last- order statistic and parent distribution F. We discuss some reliability properties of the proposed measures.

Keywords: Cumulative inaccuracy, Order statistics, Empirical approach.

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$P\{\mathbf{Y} < \mathbf{X}\}$ using generalized order statistics and concomitant

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Abstract

The stress-strength model is proposed based on the m-generalized order statistics and corresponding concomitant. For dependency between m-generalized order statistics and its concomitant, a bivariate copula expansion is considered and the stress-strength model is obtained for two special cases of order statistics and upper record values. Basis on the order statistics and record values, two estimators of stress-strength are presented using a similar procedure to the inference functions for margins.

Keywords: Copula function, Order statistics,stress-strength.

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An imputation approach to Cox proportional hazards model in the presence of interval-censored Data

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Abstract

Due to the complexity of analyzing interval-censored data, the imputation approaches can be employed in order to reduce this problem to that of analyzing right-censored data. Then, classical nonparametric methods in the case of right-censored data can be used for imputed interval-censored observations. Four different imputation approaches are studied in this paper for computing the regression coefficients within the Cox proportional hazards model as one of the most popular methods of reliability analysis in the presence of covariates. Based on the proposed approach, the regression coefficients in the Cox model can be estimated by the traditional partial likelihood method. A numerical study is conducted to perform the proposed methods using a real data set.

Keywords: Cox Proportional Hazards Model, Interval-censored Data, Imputation.

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Statistical inferences for stress-strength in the Marshal-Olkin models based on progressively type-II censored samples

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Abstract

In this article, we are mainly interested in estimating the parameter $\mathcal{R} = P(X > Y)$ when the parent distribution follows the well-known Marshall-Olkin model and the accessible data have the form of the progressively Type-II censored sample. In this case, the parameter $\mathcal{R}$ is free of base distribution. So, we use exponential distribution for simplicity. Also, The model is evaluated as a proportional odds. Maximum likelihood estimator, asymptotic confidence interval and bootstrap confidence interval for $\mathcal{R}$ are derived.

Keywords: Stress-Strength, Marshall-Olkin distribution, Maximum likelihood estimator, Bootstrap confidence interval, Proportional odds.

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Reliability estimation under degradation-shock model

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Abstract

In practice, a system is generally subject to several shocks. Based on the type of shocks, two shock models have been considered in the literature: extreme shock model and cumulative shock model. In extreme shock models, the impact of current shock is considered while in cumulative shock models the impact of the successive shocks is accumulated and is taken into account. It is clear that the number of shocks occurred up to a specific time t, is involved to reliability estimation. In this work, we combine an extreme shock model with a cumulative shock model and the degradation of system is modeled by general degradation path model proposed by Meeker and Escobar (1985). It is denoted by $Z(t)$, at time t, and given by $Z(t) = g(t, A)$, where g, is a non-decreasing invertible function and A, is a random vector related to random properties of each unit. Let $h(Z; A)$ and $G(a)$ be the inverse function of g, and the distribution function of A. The random shocks arrive according to counting process. Consider $N(t)$ as the stochastic process that counts the total number of shocks occurred in time t. Each shock increases the age of a system by random increment $W_i \geq 0$, with distribution function F. Soft failure occurs where $g(t+\sum_{i=0}^{N_2(t)} W_i)$, reaches to a critical level z_0. The reliability function is given as

$$P(T > t) = \left\{ \int_{h(z_0;a)\geq t} dG(a) \right\} P(N(t) = 0) + \sum_{n=1}^{\infty} \left\{ \int F^{n*}(h(z_0; a) - t) dG(a) \right\} P(N(t) = n).$$

where F^{n*} is $n-$fold convolution. This model is generalization of cumulative damaged model proposed by Ebrahimi (1999).

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Keywords: Counting process, Degradation-shock model, General degradation model, $k-$fold convolution , Reliability Estimation.

Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Comparison of equivalency and optimality between constant-stress and step-stress tests under type-I censoring for rayleigh distribution

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Abstract

By running life tests at higher stress levels than normal operating conditions, accelerated life testing quickly yields information on the lifetime distribution of a test unit. The lifetime at the design stress is then estimated through extrapolation using a regression model. In constant-stress testing, a unit is tested at a fixed stress level until failure or the termination time point of test, whereas step-stress testing allows the experimenter to gradually increase the stress levels at some pre-fixed time points during the test. In this work, the optimal k-level constant-stress and step-stress ALTs are compared for the Rayleigh failure data under complete sampling and Type-I censoring. The objective is to quantify the advantage of using the step-stress testing relative to the constant-stress one. A log-linear relationship between the scale parameter and stress level is assumed and the Khamis-Higgins model holds for the effect of changing stress in step-stress testing. The optimal design point is then determined under C/D/A-optimality criteria. The efficiency of step-stress testing to constant-stress one is then discussed in terms of the ratio of optimal objective functions based on the information matrix.

Keywords: Accelerated Life Testing, Constant-Stress Testing, Optimal Regression Design, Step-Stress Testing, Type-I Censoring.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Cumulative residual entropy in sequential order statistics and some characterizations

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Abstract

This article considers the problem of characterizing the parent distributions based on the cumulative residual entropy of sequential order statistics under a conditional proportional hazard rates model. It is shown that the equality of the cumulative residual entropy in first sequential order statistics determine uniquely the parent distribution. Subsequently, we characterized the Weibull distribution based on the ratio of the cumulative residual entropy of first sequential order statistics to the mean of the first sequential order statistics. Also, we considered characterizations based on the dynamic cumulative residual entropy and derived some bound for the cumulative residual entropy of residual lifetime of the first sequential order statistics.

Keywords: Cumulative residual entropy, Sequential order statistics, Residual lifetime.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Some results on proportional mean past lifetime frailty model

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Abstract

The general proportional mean past lifetime frailty model is introduced and some of its properties are studied. The unconditional cumulative distribution and density functions of the lifetime variable are derived. Also, some dependency concepts between the two variables are investigated.

Keywords: Frailty model, PMPL model, Stochastically increasing (decreasing), Totally positive of order 2, Reverse regular of order 2.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

On mean time to failure in age replacement

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Abstract

In-service, failure of a unit can sometimes lead to costly or hazardous consequences. Age replacement policy is the most common maintenance policy to prevent a unit from the failure during operation. In age replacement policy, we replace the item either at failure time or at the pre-specified time t if it is active at time t. The mean of the first in-service failure time of an item under the age replacement policy, known as mean time to failure (MTTF) in age replacement, is used to evaluate the performance and effectiveness of the age replacement policy. Based on the MTTF function, we introduce two new non-parametric classes of lifetime distributions with non-monotonic mean time to failure in age replacement; increasing then decreasing MTTF (IDMTTF) and decreasing then increasing MTTF (DIMTTF). We characterize the IDMTTF and DIMTTF classes of distributions in terms of the scaled TTT-transform function. The implications between these classes of distributions and some existing classes of non-monotonic aging classes are studied.

Keywords: Age replacement, bathtub failure rate, non-monotonic aging class, total time on test transform.

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Reliability estimation for the two-parameter exponential distribution based on records

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Abstract

In this paper, we estimate the reliability function of two-parameter exponential distribution based on record data. For this purpose, we consider different estimators including the maximum likelihood estimator, a bootstrap estimator, a Bayesian estimator and an estimation based on the generalized pivot approach.These estimators are compared by simulation studies, and finally, they are illustrated by using a real data set.

Keywords: Maximum liklihood estimate, Bootstrap estimate, Bayesian estimate, generalized pivot variables, record data.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Multi-objective redundancy allocation problem with entropy constraint using two approaches

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Abstract

A redundancy allocation problem consists of the selection of a number of redundancies to be allocated in each subsystem of a series-parallel configuration to maximize and minimizing reliability and overall system cost, respectively. In this study, two methods based on weighted sum and goal programming approaches are proposed to solve the multi-objective redundancy allocation problem with the entropy constraint. A standard example is presented to show the effectiveness and advantages of the two proposed methods comparing to the existing approaches.

Keywords: Reliability, series-parallel system, optimization, goal programming method, weighted-sum method.

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Statistical inference for a repairable system with weibull distribution subject to shocks

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Abstract

Consider a repairable system that is replaced at the nth type I failure, or at the first type II failure whichever comes first. Type I failure occurs with probability p and is removed by minimal repair, whereas type II failure occurs with probability $1-p$ and is removed by replacement. Theoretical results usually consider an interarrival-time distribution F with known parameters, and obtain an optimal policy in selecting n to minimize the expected cost. However, this is not generally the case in practice, and the parameters are usually unknown . In this paper, we assume that F is a Weibull distribution, and then study the problem of estimating the parameters of F and the repair efficiency parameter p. The likelihood-ratio test statistic is also obtained for testing the parameters. Finally, a Monte Carlo simulation study is conducted to compute the critical values and power estimates of the proposed test.

Keywords: Reliability and Maintainability, Imperfect repair,Weibull Distribution, Maximum likelihood estimation, Hypothesis test.

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On the coherent systems with two different types of dependent components

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Abstract

Stochastic comparisons on coherent systems composed of heterogeneous and dependent variables are invstigatd. For model the depnedence structure among components lifetime we employ Archimedean copula. Also, we suppose that the component distributions follow the proportional hazard rate model. Specifically we consider the 3-components coherent systems and based on some majorization orders between proportionality coefficients and by some assumptions on generator function of copula, stochastically compare the coherent systems.

Keywords: Archimedean copula, majorization, stochastic order, proportional hazard rates.

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Testing exponentiality based on the residual Lin-Wong divergence

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Abstract

Testing exponentiality has long been an interesting issue in statistical inferences. This article is based on a modified measure of distance between two distributions. New measure is similar Kullback Leibler divergence and it is related to the Lin Wong divergence applied on the residual lifetime data. Modified measure, a consistent test statistic for testing the hypothesis of exponentiality against some alternatives is developed. In order to estimate the divergence, we first consider a method similar to Vasicek's method for estimating the Shannon entropy. Then, critical values of the test are computed by Monte Carlo simulation. Finally, we found that the powers differences between the proposed test and other tests. It is shown that the proposed test is better than other tests of exponentiality, when hazard rate function is increasing. Finally, the use of the proposed test is shown in two illustrative examples.

Keywords: Exponentiality test, Goodness of fit testing, Kullback Leibler divergence, Lin Wong divergence, Residual lifetime data.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Some results on comparison among coherent systems

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Abstract

In this paper we first do an extensive review the literatures on the subject of comparison among systems and then extend some of them. Particularly we obtain some ordering results for comparing of coherent used systems with exchangeable components in terms of the hazard rate and likelihood ratio orders. Also we suggest a simple modified dynamic signature that can be used for ordering coherent used systems sometimes they can not be ordered by using of their usual dynamic signatures. It also makes some more weak conditions for ordering of used systems.

Keywords: Coherent systems, stochastic ordering, signature, dynamic signature, used systems.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

On the point reconstruction of order statistics from Geometric distribution

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Abstract

Sometimes the life testing experiment may be studied in a discrete set up. Here, the problem of reconstructing missing order statistics from Geometric distribution is investigated; some classic and Bayes reconstructors are presented.

Keywords: Order statistics, Missing order statistics, Conditional distribution, Geometric distribution.

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Bayesian inference for $R = P(X < Y)$ under adaptive type-II hybrid progressive censored samples in generalized inverted exponential distribution

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Abstract

In this paper, the Bayesian inference of $R = P(X < Y)$ for generalized inverted exponential distribution under the adaptive Type-II hybrid progressive censored samples is considered. We solve the problem in three cases. In first case, assuming that X and Y have the unknown common scale parameter and different shape parameters, the Bayes estimate of R is derived by two approximation method: Lindley's approximation and MCMC method. In second case, assuming that X and Y have the known common scale parameter and unknown different shape parameters, the exact Bayes estimate of R is derived. In third case, assuming that all parameters are different and unknown, the Bayesian inference of R is derived by MCMC method. We use one Monte Carlo simulation study to compare the performance of different methods.

Keywords: Adaptive Type-II hybrid progressive censored sample , Stress-strength model, Generalized inverted exponential distribution, Bayesian inference.

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Generalized δ-shock model for the multi-state system

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Abstract

The shock models are applied to study the lifetimes of the systems in the presence of a random instability environment. The δ-shock model is one of these kind of shock models. In this model, the system fails when the time interarrival between two successive shocks is less than a predetermined value, say δ. In this paper, we propose a generalized δ-shock model. Indeed, we assume the system transits into a lower partially working state upon the occurrence of each time interarrival between two successive shocks less than δ. The k out of time interarrival between two successive shocks with a magnitude less than δ has a catastrophic effect on the system and it causes a complete failure. Such model creates a multi-state system having number of different states. The lifetime, the time spent by the system in a perfect functioning state, and the total time spent by the system in partially working states are defined for the proposed model and their survival functions are derived.

Keywords: δ-shock model, Multi-state system, Survival function.

An additive-multiplicative 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 an additive-multiplicative mean past life model to study the association between the mean past life function and potential regression covariates in the presence of left censoring. This model extends the proportional mean past life model using an additive model as its covariate dependent baseline. For the suggested model, some covariate effects are allowed to be time-varying. To estimate the model parameters, martingale estimating equations are developed, and the asymptotic properties of the resulting estimators are established.

Keywords: additive model, counting process, left censoring, martingale estimating equation, mean past lifetime, proportional model, reversed hazard rate, time-varying effect.

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Parametric inference from system lifetime data under a proportional hazard rate model based on the minimum Jensen-Gini estimator

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Abstract

In this paper, we discuss the statistical inference of the lifetime distribution of components based on observing the system lifetimes when the system structure is known. A general proportional hazard rate model for the lifetime of the components is considered, which includes some commonly used lifetime distributions. the minimum Jensen-Gini estimator, that recently presented by [7], for the proportionality parameter is discussed. We focus on a special case when the lifetime distributions of the components are exponential. Computational formulas for point and interval estimations of the unknown mean lifetime of the components are provided. A Monte Carlo simulation study is used to compare the performance of our method with some other estimation methods that recently considered by [8].

Keywords: Coherent systems, Exponential distribution, Order statistics.

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Survival analysis of dependent competing risks with masked failure causes

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Abstract

The competing risks model is useful in settings in which units may fail for different reasons. Traditionally, statistical inference is performed under the assumption that the failure causes act independently on each item. In this paper we propose a copula-based approach which allows for dependent competing risks. In addition to failure time data, we also use degradation data that has not been investigated in previous studies. A complication arises when some of the failures are masked within a group of possible causes. Following a failure, immediate procedures are used in an attempt to reach a definitive diagnosis (stage-1). The cause of failure may not have been identified but has only been narrowed down to a subset of all potential risks. Stage-2 procedures, such as failure analysis, provide definitive diagnosis for a sample of the masked cases. We show how stage-1 and stage-2 information can be combined to provide statistical inference about three things: survival functions, the proportions of failures associated with individual risks and probability that each of the masked competing risks is responsible for the failure. We suppose that the intensity function corresponding to each cause of failure be a khown function.

Keywords: Dependent competing risks, Masked cause, Copula function.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Bi-objective reliability-redundancy allocation problem with cold standby strategy

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Abstract

This paper is concerned with the problem of optimization of reliability redundancy allocation with cold standby strategy in series-parallel systems. Most of the existing approaches in the reliability-redundancy allocation problems (RRAPs) literature concentrate only on maximizing the reliability function. Since there is an uncertainty in the estimates of components reliability, we does not only optimize the system reliability and also consider the associated variance structure to reduce the variability in system reliability.

Keywords: Reliability-redundancy allocation, Cold-standby strategy, Genetic algorithm.

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Bayesian designing of step-stress accelerated degradation test under an inverse Gaussian process with tampered failure rate model

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Abstract

In this paper, we consider a step-stress accelerated degradation test (SSADT) when the degradation follows an inverse Gaussian (IG) process. It is assumed that change of stress from a level to another has a multiplicative effect on the degradation path and a tampered failure rate (TFR) model type is used. This study proposes a Bayesian method to obtain parameter estimates and optimal design for simple step-stress accelerated life tests by minimizing the expected pre-posterior variance of the p-quantile of the products lifetime distribution. Finally, a real-world example is analyzed to illustrate the application of the proposed methods.

Keywords: Step-Stress Accelerated Degradation Test, Tampered Failure Rate Model, Inverse Gaussian Process, Bayesian Optimal Test Plan.

Connections between diversion concepts and reliability measures

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Abstract

The aim of this paper is to investigate the connection between the Gini coefficient and some important reliability measures. After reviewing the recent results in connections between the reliability measures and well known measures of disparity, such as cumulative residual entropy and Gini coefficient, we show that the Gini coefficient can be represented as the sum of expectation of the mean residual life (MRL) of a series system and the mean inactivity time (MIT) of a parallel system lifetime with three components. We also show that the expectation of the MRL (MIT) of a stand by system consisting of n components can be decomposed in terms of the the expectation of MRLs (MITs) of its components. This leads to an upper bound for the cumulative residual (past) entropy of such system in terms of cumulative residual (past) entropies of the system components.

Keywords: Gini mean difference, mean residual life, cumulative residual entropy, mean inactivity time.

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Reliability analysis of k-out-of-n:F system with soft and hard failures

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Abstract

In this paper, degradation performance of a k-out-of-n:F system with soft and hard failures is considered. Four different cases are introduced for intensity function of hard failures. The expected number of soft and hard failures and the reliability function are derived in these cases. Also, a comparison study is done for a 2-out-of-4:F system to compare reliability and expected number of hard failures for different cases of intensity function.

Keywords: Degradation, Soft failure, Hard failure, Intensity function, Reliability, Expected number of failures.

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On a goodness of fit test for normality based on Lin-Wong divergence with type-I censored data

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Abstract

Normality testing in goodness of fit test field has long been an interesting issue in statistical inferences. In this paper, we use the Lin-Wong divergence as our proposed measure of distance between distributions and compare its performance with that of other well known distance measures using the empirical distribution function and Shannon entropy concept such as Kullback-Leibler, Cramer von Misses, Anderson-Darling and Kolmogorov-Smirnov. Finally, the use of the proposed test is shown in a illustrative example.

Keywords: Anderson-Darling, Goodness of fit test, Lin Wong divergence, Normal distribution, Type I censored scheme.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Bayes estimation of mean lifetime in a proportional hazard rate model under progressive censoring

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Abstract

Suppose that the lifetimes of some units are independent but not identically distributed random variables, such that they come from a proportional hazard rate model; moreover, suppose that units are placed under progressively Type-II censoring scheme. In this paper, one-parameter exponential distribution is considered as the baseline distribution; the Bayes estimation of the mean time to failure for the baseline distribution is derived under a Balanced loss function. Toward this end, a conjugate prior is considered and the corresponding posterior distribution is determined. The performance of the proposed procedure is investigated via a real data set.

Keywords: Balanced loss function, Conjugate prior, Maximum likelihood estimation, Progressive censoring scheme.

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Application of skip-free markov chains for degradation

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Abstract

In this paper we review some applications of stochastic processes in reliability theory. In particular, we focus attention on the so called skip-free Markov chains on $\mathbb{N}$ for which upward jumps may be only of unit size, and there is no restriction on downward jumps. These processes can be used as models for the time-evolution of degradation. Under some sufficient conditions, there exists the usual stochastic ordering between hitting times of two skip-free Markov chains with the same state-space. This ordering leads to an application in the frame of degradation models.

Keywords: Skip-free Markov chains , degradation, stochastic ordering.

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On the reliability modeling of weighted k-out-of-n systems with randomly chosen components

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Abstract

The weighted k-out-of-n (in briefly k/n) systems are among the most important kind of redundancy structures. We consider a weighted k/n system with dependent components where the system is built from two classes $\mathfrak{C}_X$ and $\mathfrak{C}_Y$ of components that are categorized according to their weights and reliabilities. It is assumed that a random number M of the components are chosen from $\mathfrak{C}_X$ with distribution F_X and $n-M$ components are from the set $\mathfrak{C}_Y$ with distribution function F_Y. We further assume that the structure of dependency of the components can be modeled by a copula function. The reliability of the system, at any time t, is expressed as a mixture of reliability of weighted k/n systems with fixed number of the components of types $\mathfrak{C}_X$ and $\mathfrak{C}_Y$ in terms of the probability mass function M. Some stochastic orderings are made between two different weighted k/n systems. It is shown that when the random mechanism of the chosen components for two systems are ordered in usual stochastic (st) order then, under some conditions, the lifetimes of the two systems are also ordered in st order. We also compare the lifetimes of two different systems in the sense of stochastic precedence concept. The results are examined by several illustrative examples under different conditions.

Keywords: Reliability, Weighted k-out-of-n system, Copulas, Stochastic order, Stochastic precedence.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Bayesian and non-bayesian reliability analysis of the exponential family based on dual generalized order statistics

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Abstract

In this paper, the Bayesian and the non-bayesian estimators for the parameters, the reliability and the hazard functions of the class of an exponential family are obtained based on dual generalized order statistics ($DGOS$). The Bayesian estimators are acquired under the symmetric (squared error loss) and the asymmetric (linex) loss functions. Finally,a simulation study is performed to compare different Bayesian estimators based on different loss functions with the classical estimators.

Keywords: Bayes analysis, DGOS, Exponential family, Loss function, MLE.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

Optimal step stress test plan based on bivariate gamma degradation model

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Abstract

Modern products usually have complex structure, situation where the failure of the test unit is not related deterministically to an observable degradation process. Step Stress Accelerated Degradation Test(SSADT) is applicable for assessing the lifetime distribution of high reliable products when the number of test units is relatively few. In this paper, we introduce SSADT model when the degradation path is latent and follow a Gamma process, so a bivariate Gamma process is considered in which the first component to be latent degradation process and the second component represent a marker process. For such a pattern, the optimal hold time is obtained at which the stress level is changed . The optimization criterion is to minimize the approximate variance of the estimated MTTF of the lifetime distribution of the products at the stress changing time.

Keywords: bivariate Gamma process, Step Stress Accelerated Degradation Test, Fisher information matrix, Optimal design, Marker process.

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A new class of bivariate failure time distributions in shock and competing risk models

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Abstract

In this paper, we introduce a new class of bivariate distributions. This new class of bivariate distributions contains several bivariate lifetime models and is more flexible. We call this new class of distributions as the bivariate proportional hazard rate-geometric (BPHRG) models. We investigate various properties of the new class of distributions. We propose to use the EM algorithm to compute the maximum likelihood estimators of the unknown parameters, and it is computationally quite tractable. We also evaluate the performance of the EM algorithm on a real data set. Finally, we compare BPHRG models to BPHR models.

Keywords: Bivariate model, EM algorithm, Proportional hazard rate model, Pseudo likelihood function, Monte Carlo simulation.

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Reliability and time series

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Abstract

In this talk, certain time series models that are applied in the theory of reliability for modelling certain phenomena will be presented and discussed.

Keywords: Reliability, time series.

On the behavior of the system failure rate

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Abstract

In this talk, we consider a coherent (or mixed) system with identical components where it is assumed that the lifetimes of the components are independent and have a common distribution function F. We are interested in the study of the behavior of the failure rate and reversed failure rate of the system or its component. Sufficient conditions are provided under which the system failure rate is increasing and the system reversed failure is decreasing. Some characterization results based on the generalized reversed failure rate function are also obtained.

Keywords: reliability, aging concepts, failure rate, reversed failure rate, order statistics.

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On the estimation of stress strength reliability parameter of new burr distribution

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Abstract

In this article, the estimation of the stress-strength reliability parameter $R = P(X > Y)$, where X and Y are independent random variables with New Burr distribution, has been considered. The maximum likelihood and bayes estimators of R are obtained. The bayes estimation of reliability parameter has been discussed under the assumption of exponential prior and under two different loss functions (entropy and linex loss functions).

Keywords: Bayes estimator, Maximum Likelihood estimator, New Burr distribution, Stress-Strength reliability parameter.

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An RSS-based estimator of mean residual life

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Abstract

Mean residual life (MRL) is one of the most applicable measures in survival analysis and reliability theory. In this article, an empirical MRL based on a ranked set sampling (RSS) is described and some of its theoretical properties are explored. Our simulation and numerical results show that the RSS-based estimator of MRL beats its counterpart in simple random sampling (SRS).

Keywords: Estimation, Ranked set sample, Mean residual life.

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Forth Seminar on
Reliability Theory and its Applications
April 25-26, 2018

On the reliability of networks with multiple types of ternary components

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Abstract

The concept of survival signature is an important tool to get the reliability of networks with multiple types of components. An arguable assumption in definition of this concept is the binary state of components. In this paper, we give a model to get the reliability of two-state networks with multiple types of three-state components. To this, a generalized concept of survival signature is introduced which does not depend on the lifetimes of components.

Keywords: Reliability, structure function, survival signature, coherent system.

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