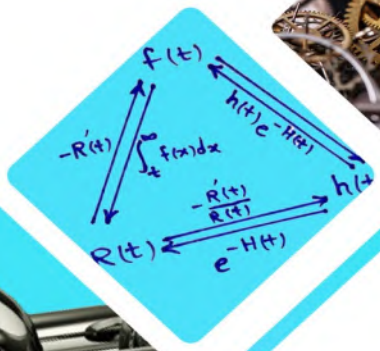
Seminar Schedule and Abstracts Book

9th Seminar on Reliablity Theory and its applications



Isfahan University of Technology
May 24-25
2023

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In the Name of Allah

Abstracts of

The 9th Seminar on

Reliability Theory and its Applications

Department of Mathematical Sciences, Isfahan University of Technologgy,
Isfahan, Iran

and

Ordered Data, Reliability and Dependency Center of Excellence

Ferdowsi University of Mashhad,

Mashhad, Iran

May 24-25, 2023

Disclaimer

This book contains the abstracts booklet of the 9th 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.

Preface

Continuing the series of workshops on "Reliability Theory" in the Ferdowsi University of Mashhad and Eight 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), University of Birjand (2021), and Ferdowsi University of Mashhad (2022) we are pleased to organize virtually (online) the 9th Seminar on Reliability Theory and its Applications" during 24-25 May 2023 at the Department of Mathematical Sciences, Isfahan University of Technology. 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 Isfahan University of Technology, the Department of Mathematical Sciences, Ferdowsi University of Mashhad, the "Ordered Data, Reliability, and Dependency" Center of Excellence, the Iranian Statistical Society, the Mathematic House, Islamic World Science Citation Database (ISC), Snowa Tech Company, the Scientific Committee, the Executive Committee, and the students of the Department of Statistics at the Isfahan University of Technology, for their kind cooperation.

The Organizing Committee
May, 2023

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
- Shock models in reliability
- 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
- Warranty models

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Contents

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Reliability Theory and its Applications
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Estimation of parameters of Kumaraswamy distribution from progressively Type-I interval censored data using EM algorithm

Ahmadi, M. V. [1]

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Abstract

EM algorithm is used to derive the maximum likelihood estimates of unknown parameters when the gathered data are progressively Type-I interval censored. It is assumed that the lifetimes follow a Kumaraswamy distribution. Finally, a simulated data set is analyzed for demonstrative purposes.

Keywords: EM algorithm, Kumaraswamy distribution, Maximum likelihood estimate, Progressive Type-I interval censoring scheme.

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Testing stochastically increasing by non-parametric kernel method

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Abstract

This paper, investigates the problem of testing that non-negative random variables X and Y are independent against the alternative that Y stochastically increasing (SI) in X. Two new statistical tests, based on the kernel density estimator, are proposed. Their limiting distributions are derived. The finite-sample performance of the proposed tests in comparison with various alternative tests, is studied.

Keywords: Stochastically increasing, Kernel estimation, Empirical processes, Wiener process, Brownian bridge process, Copula function.

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Machine learning methods to predict the deaths of people experiencing shocks

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Abstract

One of the factors that is influential in mortality rates and can change this rate, is shock which people can experience in their lives. With consideration of a stochastic process, non-homogeneous poisson process, some of these mortality rates with shocks have defined and we aim to use these processes and their information and reliability to predict the number of people who are influenced by this process with a specific rate, at a special age; So we use some of machine learning methods for our purpose and find the best one of them.

Keywords: Mortality rate, Shock, Stochastic process, Reliability, Machine learning.

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Some developments on the reliability of systems under Marshall-Olkin shocks

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Abstract

In real world, the systems may operate in environments that may be exposed to shocks. The shocks may affect on the performance of the system and cause the failure of system. For example, voltage changes, or environmental temperature changes are among the shocks that may affect electrical systems. In recent years, many developments have been made in the approach of shock models and systems exposed to shocks. One of most important type of the shocks is the Marshall-Olkin (MO) type of shocks. In MO shock model, an n-component system is exposed to shocks that come from different sources and affect on the components of the system. The shock that arrives from ith source affects on the ith component and destroys it and one shock affects on all components of the system and puts them down. In this talk, first, we review some of the existing results about the systems that are subject to MO type of shocks and its extensions. Then, we explore the reliability of the systems whose performances is made up of three states and their components are subject to MO type of shocks. For such systems, some aging and stochastic properties are aslo studied. Some illustrative examples are proposed to give the applications of the theoretical results.

Keywords: Extended Marshall-Olkin, Three-state systems, Order Statistics.

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Factors affecting the growth disorder of children under two years of age using multilevel models

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Abstract

Delay or stop in children's growth is referred to as failure to thrive (abbreviated as FTT) which leads to adverse effects such as increased mortality, reduced learning, cognitive, physical, and emotional disability, and other related illnesses. To date, different studies have been carried out in this field and factors affecting growth failure have been identified. Stopping breast feeding, teething, urinary and respiratory tract infection, fever, diarrhea, and malnutrition are identified as the most important factors affecting failure to thrive. Most of these studies apply common regression models; however, multilevel regression models involve the random effects model which allows taking genetic and individual factors into account. In the present study, given that the data were longitudinal and multilevel regression models were used for data analysis, the individual characteristics of children were identified as being among the factors affecting failure to thrive. Accordingly, it can be argued that, in identical conditions, children develop different levels of growth disorder.

Keywords: Multilevel Model, Regression Model, Longitudinal Data, Growth Disorder.

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Maintenance planning for a continuous monitoring system using deep reinforcement learning

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Abstract

This paper proposes a maintenance decision-making framework for multi-unit systems using Machine Learning (ML). Specifically, we propose to use Deep Reinforcement Learning (RL) for a dynamic maintenance model of a multi-unit parallel system that is subject to stochastic degradation and random failures. As each unit deteriorates independently in a three-state homogeneous Markov process, we consider each unit to be in one of three states: healthy, unhealthy, or a failed state. We model the interaction among system states based on the Birth/Birth-Death process. By combining individual component states, we define the overall system state. To minimize costs, we use the Markov Decision Process (MDP) framework to solve the optimal maintenance policy. We apply the Double Deep Q Networks (DDQN) algorithm to solve the problem, making the proposed RL solution more practical and effective in terms of time and cost savings than traditional MDP approaches. A numerical example is provided which demonstrates how the RL can be used to find the optimal maintenance policy for the system under study.

Keywords: Dynamic Maintenance, Manufacturing Systems, Deep Reinforcement Learning

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Confidence regions for the parameters of an inverted exponentiated Pareto distribution based on progressively Type-II censored samples

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Abstract

In this article, based on progressively type-II censored order statistics, we create balanced confidence regions (BCR) and optimal confidence regions (OCR) for the parameters of an inverted exponentiated Pareto (IEP) distribution. Constraint optimization problem and nonlinear programmings methods are used in order to construct OCRs. Monte Carlo simulation studies are used to evaluate the performance of the methods proposed in this paper. Finally, a numerical example is presented to illustrate the proposed regions.

Keywords: Confidence region, Inverted exponentiated Pareto distribution, Progressively Type-II censored, Optimization, Monte Carlo.

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On the reliability of phased mission systems with non-identical components subject to external shocks

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Abstract

A phased mission system (PMS) accomplishes its mission if it completes different tasks successively. In fact, the PMS includes multiple consecutive, non-overlapping phases. In this paper, some representations based on the concept of survival signature are given for the reliability function of a PMS with non-identical components in three scenarios: (a) the component failures occur only based on their aging, (b) the component failures are only subject to external shocks and (c) the components failures are subject to both of aging, and external shocks. Finally, a numerical example is presented to explain the theoretical results.

Keywords: External shock, Phased mission system, Reliability, Survival signature.

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A new discrete-time mixed δ-shock model

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Abstract

In this paper, a mixed δ-shock model with discrete-time is studied by combining δ-shock and extreme shock models. In this model, a system fails in two ways: first, when k interarrival times between two consecutive shocks with magnitude larger than the critical threshold γ are in $[\delta_1, \delta_2], \delta_1 < \delta_2$; and second, when the interarrival time between two consecutive shocks is less than δ_1. The lifetime of the system under the proposed mixed δ-shock model is investigated. Finaly, a numerical example is presented.

Keywords: Discrete time, Interarrival times, Lifetime, Mixed δ-shock model

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Stochastic comparisons of series and parallel systems with heterogeneous components

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Abstract

In this paper, we explore stochastic comparisons of order statistics arising from a multi parameter distribution with bathtub shaped failure rate. Under the independency assumption for random lifetimes, the usual stochastic order and the reversed hazard rate order between the minimums and also the maximums order statistics are obtained by using the concept of vector majorization and related orders.

Keywords: Stochastic comparisons, Order statsitics, Majorization, Heterogeneous components

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System survival probability based on mission abort policy

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Abstract

In this talk, we focus on the importance of system survivability in critical systems, such as satellites and aircraft, where failure can result in significant economic loss and human damage. We propose a mission abort policy as an effective means to enhance system survivability and reduce the risk of system failure. Specifically, we consider a coherent system with n components and abort the system mission if L components fail. Our approach provides insights into the design of mission abort policies that can improve system survivability and reduce economic losses.

Keywords: Mission abort policy, Signature vector, Mission success probability, System survival probability

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Emprical estimators for multi-component conditional stress-strength parameter

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Abstract

In many of reliability models, there exist certain information about the strength and stresses that experienced by the system. We are interested in how the model functions via these extra information or whether employing them does improve the performance of the system. In the present study the conditional stress-strength parameter have been investigated for s of k systems and the multi-component conditional stress-strength parameter (MCCSSP) has been estimated by using the Bayesian and non-parametric methods. In the case of having extra information about the parameters of the system, a closed form has been derived for the Bayes estimator of MCCSSP and has been calculated by using an algorithm together with Monte Carlo method. For simplicity, it has been done under the assumption of exponential distributions for the strength and stress random variables and gamma conjugates. For the case of non-exponential or general stress or strengths, the nonparametric estimator of the considered parameter has been derived. Finally to verify the analytic results, some simulation study for the Bayes estimator as well as nonparametric estimation of a real data set and some comparisons have been done.

Keywords: Conditional Reliability, Multi-Component Systems, Stress-Strength Parameter, Nonparametric Estimator, Bayes Estimator.

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A generalized of mixed shock model

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Abstract

In this paper, a mixed shock model is studied and generalized this model. In proposed model, the system fails, if k interarrival times between two successive shocks are less than δ, or l shock with magnitude bigger than γ entered the system. By these assumptions, the survival functions of the systems lifetime, the time used by the system in a perfectly functioning state, and the total time used by the system in partially working states are derived under the proposed model.

Keywords: δ-shock model, Extreme shock model, Mixed shock model, Lifetime, Survival function.

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Survival analysis in the presence of competing risks: a Lunn–McNeil approach

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Abstract

This study considers survival data in which each subject can experience only one of several different types of events over follow-up. When only one of several different types of events can occur, we refer to the probabilities of these events as competing risks. This study aimed to model the survival of patients with Brain stroke in the presence of competing risks.

Keywords: Brain Stroke, Survival, competing risks, Lunn-McNeil model.

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A brief study on series systems consisting of used components based on copulas

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Abstract

In this note, we consider series systems consisting of arbitrarily dependent used components. We study the lifetime of such systems using copulas family and obtain a formula for its survival function. In following, we provide stochastic ordering properties for the lifetimes of the series systems based on the mean function. Finally, to show the results we give a numerical example.

Keywords: Copula, Mean function, Stochastic order, Reliability.

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Usual stochastic order of α-mixtures with proportional odds model as a baseline

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Abstract

As a new flexible family of distributions, the α-mixture model includes many existing mixture models as special cases. This paper is an attempt to the usual stochastic order of this family when the underlying distribution follows from the proportional odds model. Sufficient conditions are provided for comparing two finite α-mixtures of survival functions with the baseline survival functions following the PO model in the sense of usual stochastic order when both the mixing proportions and the PO parameters of the first α-mixture majorize the mixing proportions and the PO parameters of the second one. Also, an upper bound for the reliability function of the α-mixture of survival function. Moreover, similar results are obtained for the α-mixture of cumulative distribution function. Finally, our theoretical findings are evaluated by some numerical examples.

Keywords: Mixture models, Usual stochastic order, Proportional odds model.

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The optimal age replacement strategy under epistemic uncertainty

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Abstract

Applying the theory of uncertainty is a good approach to study the reliability of a system when there is a little frequency of suitable data. Based on this theory, the policy of age replacement is considered assuming the system lifetime follows Weibull distribution. The unknown parameters are estimated according to evidence theory that affects the epistemic uncertainty. The Dempster-Shafer as well as Yager rules are applied to aggregate the judgements and mental estimates of two or more experts. After determining the unknown parameters, the optimal replacement time is derived using the long-run cost criterion. The results show that the Dempster-Shafer rule is more accurate than yager rule, but Yager's rule is more conservative than Dempster-Shafer's rule.

Keywords: Dempster-shafer theory; Maintenance policy; Uncertainty theory; Yager rule.

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An upper bound for the reliability of engineering systems

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Abstract

Since the exact reliability of coherent systems is notoriously difficult to calculate, so bounds can be useful in such situations. In this note, we establish an upper bound for the reliability of coherent systems lifetime by using the system signature. An advantage of the new bound is that it is easy to compute.

Keywords: Coherent system, System signature, Variance.

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Quantile based dynamic cumulative extropy

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Abstract

In this paper, we propose the quantile based dynamic cumulative extropy in residual lifetime. Various characterizations are obtained based on the lifetime distributions and quantile-based reliability measures function. We introduce a new stochastic order based on the quantiles that is built on this measure. Also, some properties of the quantile based dynamic cumulative extropy is studied.

Keywords: Characterization, Quantile Function, Residual Extropy, Stochastic Orders, Survival Extropy.

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An optimal selection problem in a k-out-of-n system with dependent components

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Abstract

One of the methods to improve the reliability of a system is redundancy allocation. In this paper, we aim to examine the redundancy allocation in a k-out-of-n system with dependent and heterogeneous components. Some examples are provided to illustrate the optimal allocation based on criteria of the usual stochastic order and the mean residual lifetime of the system.

Keywords: Reliability, Active redundancy, Copula function.

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