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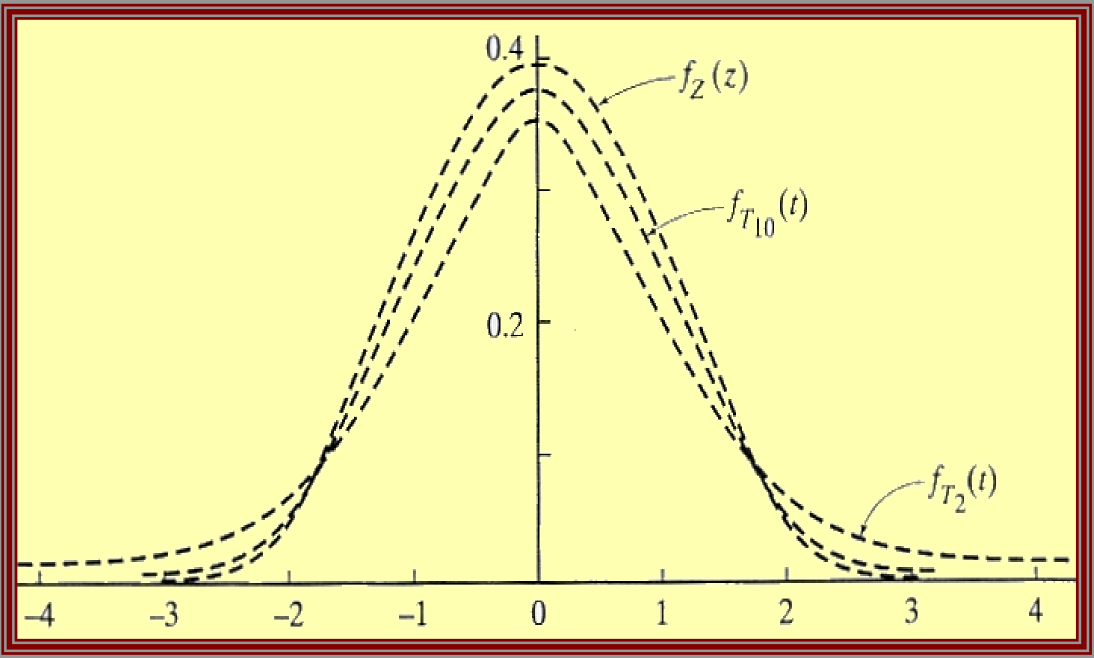
JPSS

A comprehensive journal of probability and statistics
for theorists, methodologists, practitioners, teachers, and others



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Aims and Scope The ***Journal of Probability and Statistical Science*** (***JPSS***, ISSN 1726-3328) is a modified version of the ***Journal of Propagations in Probability and Statistics*** (***JPPS***, ISSN 1607-7083). ***JPSS***, like its predecessor ***JPPS***, is a multipurpose and comprehensive journal of probability and statistics that publishes papers of interest to a broad audience of theorists, methodologists, practitioners, teachers, and any other users of probability and/or statistics. The scope of ***JPSS*** is intended to be quite broad, including all the major areas of probability and statistics. Research papers involving probability and/or statistics, either theoretical or applied in nature, will be seriously considered for publication. Additionally, papers involving innovative techniques or methods in teaching probability and/or statistics will also be considered. Papers submitted for publication consideration will be peer reviewed. Initially, we will publish semiannually, one issue each in February and August. Hopefully, as time accrues, we will be able to publish quarterly. It is the goal of ***JPSS*** to publish a wide range of works involving probability and/or statistics (theoretical and/or applied in nature) and provide widespread availability of such to a broad audience of people interested in probability and/or statistics.

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Volume 11 Number 2 August 2013

Table of Contents

Appendix

Journal of Probability and Statistical Science
11(2), 111-127, Aug. 2013

Functional Central Limit Theorems for Markov Processes and Chains

M. Mahbubur Rahman
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ABSTRACT We provide a detailed derivation for the approximation of an integral Markov process arising in the approximation of stochastic differential equations. The result extends an existing formula by Skorokhod [1] from continuous time process to discrete-time case with arbitrary steps and a new energy interpretation is also given.

Keywords Central limit theorem; Markov process, chain.

1. Introduction

A realization of a stochastic process θ determines a realization of the process

$$\xi(t) := t^{-1/2}\int_0^t \varphi(\theta(s))ds \tag{1.1}$$

where φ is a given real function. A discrete-time equivalent of (1.1) for a chain $\{\theta_k\}_{k\geq 0}$ whose state changes every unit time is

$$\xi_N := N^{-1/2}\sum_{n=0}^{N-1}\varphi(\theta_n). \tag{1.2}$$

Expressions of the form (1.1) or (1.2) arise in the approximation of stochastic differential equations with parametric noise. In this context the asymptotic behavior of $\xi(t)$ as $t \to \infty$ or ξ_N as $N \to \infty$ is of particular interest.

A large amount of work has been dedicated to this question in particular when θ is a Markov process/chain. A good start are the papers by Bhattacharya [3] for (1.1) and Gordin & Lifsic [5] for (1.2). More recent contributions have aimed in general at relaxing the assumptions on θ [8, 1]. Typically, an estimate of the form

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Generalized Asymmetry Model for Cumulative Probabilities and its Decomposition for Square Contingency Tables

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ABSTRACT For the analysis of square contingency tables with ordered categories, the present paper proposes a generalized asymmetry model, which has the structure of asymmetry for cumulative probabilities that an observation will fall in row (column) category i or below and column (row) category j ($> i$) or above. It also gives the theorem of decomposing the new model into the cumulative extended quasi-symmetry model and the generalized marginal homogeneity model. An example is given.

Keywords Cumulative quasi-symmetry; Decomposition; Generalized marginal homogeneity; Linear diagonals-parameter symmetry; Square contingency table.

1. Introduction

For the $R \times R$ square contingency table with the same row and column classifications, let p_{ij} denote the probability that an observation will fall in the ith row and jth column of the table ($i = 1, \ldots, R; j = 1, \ldots, R$). The symmetry (S) model is defined by

$$p_{ij} = p_{ji} \ (i \neq j)$$

(see e.g., Bowker [3]; Bishop, Fienberg and Holland [2], p.282).

Let

$$G_{ij} = \sum_{s=1}^{i} \sum_{t=j}^{R} p_{st} \ (i < j),$$

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An Optimal Combination between two Ratio Estimators

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ABSTRACT The goal of this paper is to estimate the ratio, or the total, of finite populations. A family of estimators for estimating the population ratio, under general sampling design, is proposed. The advantages of the proposed family are coming from the fact that it is a generalization of different well known estimators proposed in the literature, exact and an unbiased variance estimator of this family are obtained, and works well under different sampling designs. Further, another version of Murthy and Nanjamma [9] estimator is proposed. Simulation results from real data set show that the performance of the proposed family is better than well known estimators proposed in the literature and has a negligible bias. The new version of Murthy and Nanjamma [9] estimator works better than the original one of Murthy and Nanjamma [9].

Keywords General sampling designs; Mean and variance; Mean squared error; Stratified sampling design.

1. Introduction

Consider a finite population U of units $\{1, 2, \cdots, N\}$. For the ith unit, let y_i and x_i be the values of the variable of interest and the auxiliary variable respectively. One of the interest is to estimate the population ratio $\theta = t_y / t_x$, where

$$t_y = \sum_{i \in U} y_i,$$

the population total for the variable of interest, and

$$t_x = \sum_{i \in U} x_i,$$

the population total for the auxiliary variable. Another interest is to estimate the population total, t_y, by $\hat{\theta} \cdot t_x$, where t_x is assumed to be known and $\hat{\theta}$ is an estimator of θ.

Gupta and Shabbir [3] have suggested an alternative form of ratio-type estimators for estimating the mean of finite population under simple random sampling design, and they assumed

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Utilizing Ordered Statistics in Lifetime Distributions Production: A New Life-time Distribution and Applications

Ayman M. Abd-Elrahman
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ABSTRACT Usually, ordered statistics and their related moments are used for analyzing data from some known lifetime distribution. In this paper, we utilized ordered statistics in lifetime distributions production, where families of distributions for the median of an independent random sample from some arbitrary lifetime distribution with survival function are introduced in a simple closed-form each. As a special case, we obtained a new lifetime distribution. We gave this new lifetime distribution a name, the *Bilal*(μ) distribution, (the name of my youngest son). We show that this distribution is a member of the class of new better than average renewal failure rates. A comprehensive mathematical treatment of the proposed distribution is provided. Furthermore, we proved the existence and uniqueness of the maximum likelihood (ML) estimate. Interval estimation are also provided. We showed that, the moment (M) estimate for the parameter μ exists in a simple closed-form. Its e±ciency with respect to (w.r.t.) the *minimum variance unbiased estimate* (MVUE) of μ is equal to 99.9165 %. For illustration purpose, two applications to real data sets are presented. A simulation study is performed to show the performance of ML and M estimates. Finally, some concluding remarks are presented.

Keywords Order statistics; New better than average renewal failure rate distributions; Quantile; Fisher's information measure; Shanon measure of entropy; Simulation.

1. Introduction

Introductory probability and statistical textbooks typically introduce common univariate distributions individually. Leemis and Mcqueston [16] presented a figure involves fifty seven

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Availability of *K*-out-of-*N*: G System and Its Indices with *M* Failure Modes Subject to General Shut-off Rules

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ABSTRACT This paper presents an analytical method to obtain closed form expressions of steady state system availability, the mean time between system failures (MTBF), the mean time to first system failure (MTTFF), and the mean time to repair the system (MTTR) for *K*-out-of-*N*: G systems with limited number of repairmen subject to *M* exponential failure modes. The status of the non-failed components when the system is down which is known as the shut-off rule is general and is described by a number L $(0 \le L \le K-1)$ of component being suspended when system is down. A numerical example is provided to illustrate the applicability of the expressions that are obtained throughout the paper.

Keywords *K*-out-of-*N*: G system; Availability; MTBF; MTTFF; MTTR; Shut-off rules; *M* failure modes.

1. Introduction

A *K*-out-of-*N*: G system is a general redundant system which works if and only if at least *K* components work, or at most *N*-*K* components fail. If K = 1, the system is reduced to a series system, while if $K = N$ it is reduced to parallel system. The availability of repairable *K*-out- of-*N*: G system depends mainly on whether the components are identical or not-identical, the number of repair facility, distribution for failure times and repair times, and the status of the non-failed components when the system is down which are known as shut-off rules [7, 13]. The commonly used shut-off rules are continuous operation (CO) which allows failures of all non-failed components when the system is down, i.e., further components may fail when the system is down and suspended animation (SA) which eliminates the possibility of additional failures of non-failed components when the system is down, i.e., all working components are suspended when the system is down which means that the aging process of the non-failed components is suspended. Kullstam [9] has obtained closed form expressions of the availability, MTBF and

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Analysis of the Hybrid Censored Data from the Logistic Distribution

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ABSTRACT Among the different censoring schemes, the hybrid censoring scheme has received a considerable attention in the last few years, particularly in reliability and life-testing experiments. The hybrid censoring scheme is a mixture of the conventional Type-I and Type-II censoring schemes. This paper considers the analysis of the hybrid censored data when the lifetime distributions of the items follow two-parameter logistic distribution. It is observed that the maximum likelihood estimators (MLEs) of the unknown parameters can not be obtained in closed forms. Here we propose the approximate MLEs (AMLEs) by appropriately approximating the likelihood equations. Asymptotic distributions of the MLEs and the approximate MLEs are used to construct approximate confidence intervals of the unknown parameters. We also present a simulation study and a data analysis to illustrate the results.

Keywords Logistic distribution; Hybrid censoring; Maximum likelihood estimators; Type-I censoring; Type-II censoring.

1. Introduction

Censoring is very common in most of the life testing experiments. The two most common and popular censoring schemes are Type-I and Type-II censoring. Let us consider n units placed on a life-test at time 0. In conventional Type-I censoring, the experiment continues up to a pre-specified time T. Any failure that occurs after time T is not observed. The termination point T of the experiment is assumed to be independent of the failure times. In conventional Type-II censoring, the experimenter decides to terminate the experiment after a pre-specified number of units $R \leq n$ fail. In this scenario, only the smallest lifetimes are observed. In Type-I

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The Distribution of Annual Maximum Earthquake Magnitude in Southern California

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ABSTRACT Structural engineers use the extreme values of earthquake magnitude or wind speed with return periods such as 25 years for structures having no human occupants or where there is a negligible risk to human life, 50 years for most permanent structures, and 100 years for structures with an unusually high degree of hazard of life and property in case of failure. The data of 80 annual maximum earthquake magnitudes in Southern California from the year of 1932 to 2011 were analyzed and modeled. Three extreme value models for the data were considered and compared. Subsequently, using the proposed distributions, the required design value with a given return period of exceedance was obtained. The recurrence probability for an earthquake with magnitude greater than 7.5 and 8.0 Richter scale respectively in a one-year period were also obtained.

Keywords Anderson-Darling test; Design value; Fréchet distribution; Generalized extreme value distribution; Goodness-of-fit; Gumbel distribution; Kolmogorov-Smirnov test; Return period.

1. Introduction

An earthquake may cause injury and loss of life as well as pose a threat to the integrity of structures such as roads, bridges, and buildings. It may cause general property damage which may or may not be covered by earthquake insurance and collapse or destabilization of buildings. The aftermath may bring diseases, lack of basic necessities, and higher insurance premiums. A properly engineered structure does not necessarily have to be extremely strong or expensive. It has to be properly designed to withstand the seismic effects while sustaining an acceptable level of damage. The scientific community has spent a large effort in trying to forecast the occurrence of earthquake, especially the catastrophic ones [9, 14]. However, the nature of

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