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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, are all welcomed for publication consideration. 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.

Finally, I would like to take this opportunity to express my deep thanks to all the supporters of the former journal *JPPS* and hope that you will be able to support this new journal *JPSS* as well.

Kuang-Chao Chang
Founding Editor of *JPSS* and *JPPS*

Taipei, Taiwan, ROC
February, 2004

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Journal of Probability and Statistical Science
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Success Runs with Branches: Distribution of Renewal Epoch

Ahmad Reza Soltani and Abdul Hamid Al-Ibrahim
Kuwait University

ABSTRACT In this article we present two Markov chains based on a *success run model*, that are called here *success runs with branches*. For each model including the success run itself we present closed forms for the distribution of the renewal epoch at zero. In special cases, these families of distributions give rise to interesting negative binomial type discrete probability mass points. Certain insurance policies, and treatment stages of certain cancers can be modeled by branches of success runs. It is demonstrated how to model treatment stages of the prostate cancer disease.

Keywords: Markov chains; The *k*th visit; Success runs; Negative binomial type distributions.

1. Introduction

A success run, considered in this article, is a Markov chain with state space {0, 1, 2, …} that only states 0, $i + 1$ can be visited from the state I in each transition with probabilities p_i and q_i respectively, $p_i + q_i = 1$. Thus at each stage if the chain does not proceed one step forward it falls back to zero. A success run presents the length of the current run of successes at time n in trials that the outcome of each trial is either success or failure. The model has various applications in applied fields. Customarily a success run is applied as a probability model for the age of a newly installed device. For very recent works on success runs see [1, 2, 4]. The model is well explained in [3].

In this article we generalize a success run in two ways. For clarification, let us call the set of states $i \geq 0$ the "the main stem". The generalization is to allow the chain, at each state

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An M/G/∞ Queue in Series

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ABSTRACT This paper is concerned with an M/G/∞ queue in which servers are lined in series. Because of the tandem structure of servers, customers may be blocked when they finish their services. We first derive the joint probability of the number customers in service and the number in blocking. The distributions of the delay time and blocking time are also obtained. Closed form distributions of delay and blocking times for M/M/∞ queues are explicitly derived.

Keywords：Order statistics; Queue length; Waiting time.

1. Introduction

In a queue with multiple servers, it is usually assumed that service times are independent, identically distributed (i.i.d.) random variables. Once a service is completed, the customer leaves the system immediately without any delay. This kind of queue has many applications in telecommunication, computer sciences, among other systems. In this paper, we consider a queueing system in which customers after being served may have to wait. This is the case when customers have to leave the system in the same order as their arrivals. This is also the situation where the servers are in a tandem structure due to physical limitation or other constraints; servers are lined up in series. As an example of application, consider a production line where jobs request a service from one of group of workers and then leave in the same order as their arrivals. Consequently, customers may still have to wait even after their service is completed (not before the service). In this case, we say a customer is blocked.

In a regular M/G/∞ queue (no blocking), customers arrive to the system in accordance with a Poisson process of rate λ. Each customer requests a random amount of service time

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Four Confidence Intervals of Rate Difference under Poisson Distribution

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ABSTRACT When the underlying disease is rare and the length of follow-up time varies between groups in cohort studies, we commonly assume a Poisson model for the number of case occurrences. In this paper, we focus interval estimation on the rate difference between two comparison groups. We consider four interval estimators, including the most frequently used interval estimator using Wald's statistic, the two test-based interval estimators developed here with and without accounting for the constraint under the null hypothesis, and the interval estimator using the asymptotic likelihood ratio test. To evaluate and compare the performance of these interval estimators, we employ Monte Carlo simulation. We find that the interval estimator using Wald's statistic may frequently have the coverage probability less than the desired confidence level when the underlying disease rate is rare. Both test-based interval estimators developed here can generally improve the coverage probability of interval estimator using Wald's statistic. Further, the interval estimator incorporating the constraint under the null hypothesis not only outperforms the interval estimator without accounting for the constraint, but also is essentially as efficient as the interval estimator using the likelihood ratio test. An example regarding the hormone use in postmenopausal women to illustrate the practical usefulness of these estimators is provided. For completeness, the SAS program for using Monte Carlo simulation to evaluate the performance of interval estimators in a variety of situations is also included.

Keywords：Confidence interval; Poisson distribution; Rate difference; Likelihood ratio test; Coverage probability; Efficiency.

1. Introduction

When investigating the effect of a risk factor on the incidence rate of a chronic disease, such as cancer (Fleiss [10], Rosner [18]) or cardiovascular disease (Doll and Hill [9]), we often

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On Adaptive Cluster Sampling and Generalized Regression Method of Estimating Localized Elements

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ABSTRACT Adaptive cluster sampling introduced by Thompson [9] and further developed by Thompson [10] and Thompson and Seber [11], Chaudhuri [1], Salehi and Seber ([7], [8]), Chaudhuri, Bose, and Ghosh [2] among others is a promising sample selection procedure to capture relevant population elements concentrated in unknown locations in a specified geographical territory. Chaudhuri [1], in particular, has shown that if any initially chosen sampling scheme provides an unbiased estimator for a finite population total along with an unbiased estimator for its variance, then it is capable of yielding a revised adaptive cluster sampling scheme providing an alternative unbiased estimator for the total with an unbiased variance-estimator, possibly with a higher accuracy and an assured increase in the information content. Since analogously a generalized regression (greg) predictor or estimator based on an initial design is Asymptotically Design Unbiased (ADU) and equivalently Asymptotically Design Consistent (ADC) and continues to be so when revised on being based on an extended adaptive cluster sampling initiated therefrom with an achievable increase in information, we illustrate how it fares in different situations when the initial sample-size is modest. Our findings are numerically illustrated through simulations from live data concerning earners through rural small-scale industries in the unorganized sector that are sparsely scattered in a given district in West Bengal, India. We also numerically illustrate how our procedure fares vis-à-vis a comparable single stage conventional cluster sampling employing the classical regression estimator.

***Keywords*：** Adaptive cluster sampling; Conventional cluster sampling; Generalized regression estimator; Mean square error; Two-stage Rao-Hartley-Cochran scheme; Unbiased variance estimation.

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Some Nonparametric Tests for Spherical Symmetry

Yonghong Gao
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ABSTRACT Some tests based on spatial sign data and rank data are proposed for testing null hypothesis of spherical symmetry. The asymptotic distributions of the proposed tests are all chi-squared. A small simulation study of the empirical power is conducted to compare the performance of the proposed tests with the normal theory likelihood ratio test.

***Keywords*:** Correlation coefficient; Depth function; Sign data; Spherical symmetry; Rank data; Runs test.

1. Introduction

A $p \times 1$ random vector X is said to have a spherical symmetric distribution if $X - \lambda$ and $g(X - \lambda)$ have the same distribution for all $p \times p$ orthogonal matrices g and for some $p \times 1$ vector λ. The normal theory based test for spherical symmetry is likelihood ratio test. Baringhaus [1] proposed a von Mises type consistent test for spherical symmetry. The robust test introduced by Kariya and Eaton [6] is uniformly most powerful when the alternative distribution is elliptical symmetry. The majority of the nonnormal theory based tests are not convenient in practice. In this paper we propose three simple and easy to implement tests based on spatial signs and ranks of the data. The bases for our tests are some well-known facts about the spherical symmetry distribution. One fact is that if the distribution of X is spherical symmetric about the origin then $\|X\|$ and $S(X) = \|X\|^{-1} X$ are independent and $S(X)$ is uniformly distributed on S_p, the unit hypersphere in p-dimensional space. Another fact is about the structure of the covariance matrices $\Sigma = Var(X)$ and $\Sigma_S = Var(S(X))$ when the distribution is spherical symmetry. The matrices Σ and Σ_S are both kI_p-type, where I_p denotes the p-dimensional identity matrix. In section 2 we use multivariate correlation coefficient to test the independence of $\|X\|$ and $S(X)$. In section 3 depth-based test is discussed using the structure of Σ_S. In section 4 we study a reordered multivariate runs test. The idea of reordering the observations

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Detecting a Change Point in a Sequence of Extreme Value Observations

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ABSTRACT In this paper, we present a case study of detecting a change point in a sequence of maximum value observations. We frequently encounter maximum observations in our daily life. In such cases, we may be concerned whether there has been a change in the location parameter of these maximum observations. The Schwartz Information Criterior (SIC) procedure and a Mann-Whitney-based sign test are recommended for such a change point detection problem. For multiple change points detection, a binary segmentation procedure combined with the Mann-Whitney-based sign test is presented. The methods are applied to a simulated data set and a daily maximum temperature data set secured from Kansas City, USA, for analysis of change points.

Keywords：Change point; Model selection; Information criterion; SIC; Sign test.

1. Introduction

Change point analysis is an on-going active topic in statistical studies after the first paper concerning a change point was published by Page [5]. The major reason for this continued is that change point analysis has wide range of applications not only in the statistical literature but also in many practical areas such as quality controls, weather forecasting, applied finance, medical studies, and so on. Sen and Srivastava [7] considered the single change point problem for mean vector in a sequense of multivariate Gaussian observations. Later, Srivastava

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Shrinkage Estimation of Pr($X < Y$) in the Normal Case

Ayman Baklizi
Yarmouk University

ABSTRACT We consider the problem of estimating R = Pr(X<Y) in the normal case. The cases of paired data from a bivariate normal distribution as well as two independent samples of possibly unequal sizes from two normal populations are considered. We develop various shrinkage estimators of R that incorporate the prior information R_0. The shrinkage factors are determined by utilizing the p-value of testing $H_0 : R = R_0$ and its distribution in the alternative parameter space. Another shrinkage factor is derived by minimizing the mean squared error of the corresponding shrinkage estimator. The performance of the new estimators is investigated and compared with the maximum likelihood estimator using Monte Carlo methods. It is found that some of these estimators are very successful in taking advantage of the prior available estimate.

Keywords：Shrinkage estimation, Bivariate normal distribution, P-value, Stress-strength model.

1. Introduction

The problem of making inference about $R = \Pr(X < Y)$ has received a considerable attention in literature. This problem arises naturally in the context of mechanical reliability of a system with strength X and stress Y. The system fails any time its strength is exceeded by the stress applied to it. Another interpretation of R is that it measures the effect of the treatment when X is the response for a control group and Y refers to the treatment group. Various versions of this problem have been discussed in literature. Owen *et al.* [10] considered this problem for paired observations on jointly distributed random variables having equal variances. Inference procedures are discussed in Church and Harris [1] and

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The Analysis of Large Hospital Admissions Databases Using Fundamental Regression

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Winnipeg Regional Health Authority

ABSTRACT Consider a finite human population part of which is selected, by some event, into a subset. Such subsets of populations, for example mortalities due to car accidents or annual hospital admissions, can be considered as non-random samples where non-randomness originates with some attribute(s) of the population rather than from self-selection or systematic pre-selection by the sampler. A common difficulty is that non-randomness usually distorts and biases a statistical comparison between samples. Thus variables such as age and gender must often be controlled for when attempting to determine whether hospital use is related to socio-economic variables such as income, education, occupation, and so forth. In the present paper we use the nonparametric classical regression model to compute a regression relation between annual hospital stays and demographic age and gender variables. The conditional expectations can then be used for control purposes or as an aid for future forecasting of hospital use.

Keywords : Nonparametric regression; Age-gender adjustment; Conditional expectations; Conditional variance; Correlation ratio; Variable transformation; Inpatient length of stay; Socio-economic status; Winnipeg Regional Health Authority.

1. Introduction

The demand for hospital services is an important variable when dealing with the management and planning of health requirements of a given population. Thus it is of some interest to be able to compare the health status of residents of different areas, cultural or socio-economic backgrounds and so forth who use health resources. Such studies are at times carried out by a direct comparison of indicators of health status and services by utilizing

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A Comparison and Contrast of Some Methods for Sample Quartiles

Anwar H. Joarder and Raja M. Latif
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ABSTRACT A remainder representation of the sample size $n = 4m + r$ ($r = 0, 1, 2, 3$) is exploited to write out the ranks of quartiles exhaustively which in turn help compare ranks for quartiles provided by different methods available in the literature. The criterion of the equisegmentation property that the number of integer ranks below the first quartile, that between the consecutive quartiles, and that above the third quartile are the same, has been used to compare and contrast different methods. Four segmentation identities can be obtained for each method of quartiles which show clearly the number of observations in each of the four quarters if the observations are distinct. The Halving Method and the Remainder Method have been proposed for the calculation of sample quartiles. The quartiles provided by each of these two methods satisfy the equi-segmentation property if the observations are distinct. More interestingly, in these two methods r also represents the number of quartiles having integer ranks.

Keywords：Quartiles; Remainders; Modulus; Quantiles.

1. Introduction

Quartiles, deciles, percentiles or more generally fractiles are uniquely determined for continuous random variables. A p^{th} quantile of a random variable X (continuous or discrete) is a value x_p such that $P(X < x_p) \le p$ and $P(X \le x_p) \ge p$. Let X be a continuous or discrete random variable with probability function $f(x)$ and the cumulative distribution function $F(x) = P(X \le x)$. If the distribution is continuous, then $P(X < x_p) = p$ and $P(X \le x_p) = p$ since $P(X = x_p) = 0$. Therefore, for the continuous case, $F(x_p) = p$.

The quartiles $Q_1 = x_{0.25}$, $Q_2 = x_{0.50}$ and $Q_3 = x_{0.75}$ for a continuous random variable with cumulative distribution function $F(x)$ are defined by $F(x_{0.25}) = 0.25$, $F(x_{0.50}) = 0.50$ and

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Testing the Efficiency of Emerging Markets: the Case of the Baltic States

Virmantas Kvedaras
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Olivier Basdevant
World Bank

ABSTRACT There is little evidence on the efficiency of the early stage capital market in transition countries, although market structure developments and the learning process could define the framework for efficient markets. Are financial markets efficient and, if not, are there any signs of evolving to the efficient capital market in the three Baltic States? This article is designated to answer this question by combining the methodology for testing the efficiency of capital market using the variance ratio robust to heteroscedasticity with the state-space representation, which enables us to use an efficient filtering technique – the Kalman filter – to get time varying autocorrelations. The official Estonian, Latvian, and Lithuanian Stock Exchange market indices TALSE, DJRSE, and LITIN comprising the most liquid part of the stock market in a respective country are analysed. The main conclusion that can be drawn is that financial markets in the Baltic States with some turbulence are approaching a weak form efficiency, at least when the linear price forecasting rules are used.

Keywords：Kalman filter; Market efficiency; Variance ratio; Time varying autocorrelation.

1. Introduction

The question of efficiency of the financial market is crucial for transitional economies, as, in general, efficiency will determine the financial market capacity to allocate free capital efficiently (see Fama [20], Grossman [26], Stiglitz [58]). This article explores whether financial markets in the three Baltic States are efficient.

The major original contribution of this article is the analysis of the efficiency during the transition process. To be more precise, after general testing for linearity of the conditional

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