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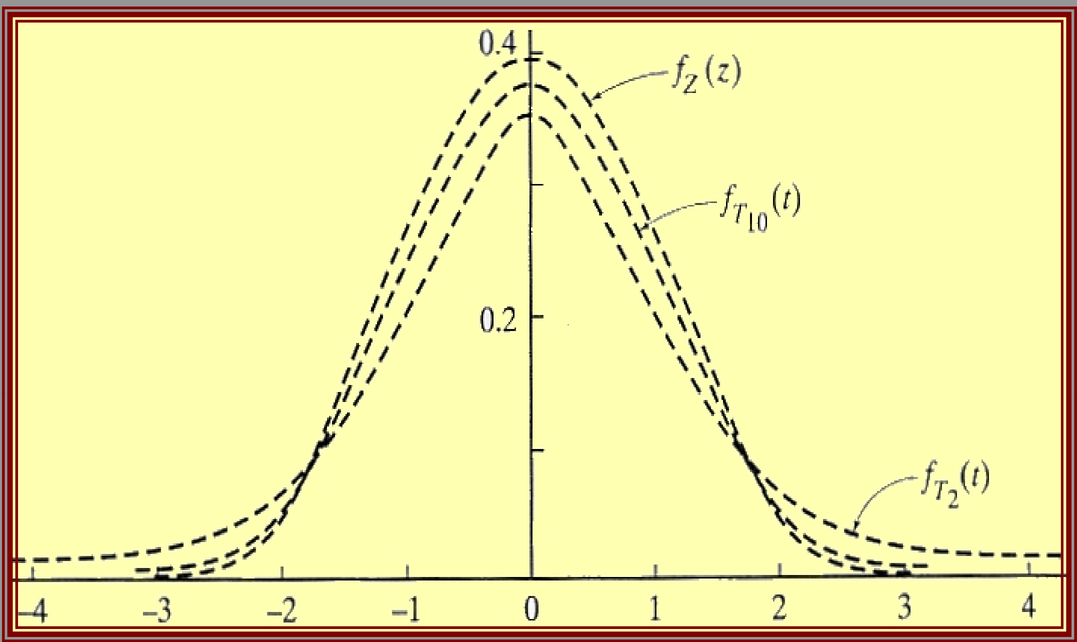
A comprehensive journal of probability and statistics
for theorists, methodologists, practitioners, teachers, and others



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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, statistics and biostatistics.

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Editorial Note

There are nine articles on the theories, methods and applications in this issue. Most of them are on the distributional theories and their properties along with applications. The first article discusses the characterization of Fréchet and Weibull Max Domains under Power Normalization. The second article gives an overview on Moran's Index by a simulation experiment where the local Moran values are computed and a time variable is added to a spatial Poisson point process. Changes in the Moran statistics over the neighboring areas are investigated and ideas on how to perform the analysis are proposed. The third article models the distribution of the charge emitted during the partial discharge process. A collection of observations on the electric charge emissions during the partial discharge activity is taken and is modelled with the density function so that the results developed are scientifically verified. A new class of transmuted weighted Weibull distribution by using the quadratic rank transmutation map technique is studied in article four. Some structural properties of the proposed distribution are discussed. Maximum likelihood method is used to estimate the model parameters. Article five proposes a new family of distributions, called the Marshall-Olkin Lomax distribution and studied some of its important properties. It also developed count models with Lomax inter arrival time distributions. The model is applied to a set of real data on inter arrival times of four wheeler vehicles in a city in India. The characterizations of the transmuted Lindley distribution for modelling survival data is presented in article six. Some structural properties of the transmuted Lindley distribution are also discussed. In article seven, a family of continuous probability distributions which integrates recently introduced Marshall-Olkin-Kumaraswamy-G family and Beta Marshall-Olkin-G family of distributions is proposed. Probability density function, cumulative distribution function, moment generating function, moments and probability density function of order statistics of the proposed family are expressed as linear mixture of the corresponding functions of Kumaraswamy-G distribution. Article eight considers distributions which generated from exponential-class lifetime distributions by taking positive real powers (greater than 1) of the exponential-class c.d.f. It also considers the asymptotic behavior of the MLE's for the parameters of these distributions. A recurrence relations for single and product moments is outlined in article nine. It characterizes the extension of exponential distribution using these recurrence relations based on general progressively Type-II right censored order statistics and using relation between probability density function and distribution function.

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16(1), 1-9, Feb. 2018

On a Characterization of Fréchet and Weibull Max Domains under Power Normalization

A. S. Praveena[1] and S. Ravi[2]
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ABSTRACT Max domain of attraction of the Gumbel law under linear normalization has been studied extensively in the literature. It is known that all distribution functions belonging to the max domain of attraction of the Gumbel law under linear normalization belong to either the max domain of attraction of the Fréchet law or that of the Weibull law under power normalization. The objective of this article is to state and prove the characterization results of max domains of attraction of Fréchet and Weibull laws under power normalization. Some illustrative examples are also discussed.

Keywords Characterization; Fréchet law; Gumbel law; Linear normalization; Max domains of attraction; Power normalization; Slowly varying function; Weibull law.

1. Introduction

A distribution function (df) F is said to belong to the max domain of attraction of the Gumbel law, denoted by $F \in D_l(\Lambda)$, if there exist norming constants $a_n > 0$, $b_n \in R$, the real line, such that

$$\lim_{n\to\infty} P\left(\frac{M_n - b_n}{a_n} \le x\right) = \lim_{n\to\infty} F^n(a_n x + b_n) = \Lambda(x) = e^{-e^{-x}}, \quad x \in R, \tag{1.1}$$

where $M_n = \max(X_1, X_2, \cdots, X_n)$, $n \ge 1$, and $X_1, X_2, \cdots, X_n$ are independent identically distributed (iid) random variables (rvs) with common df F. Along with the Gumbel law, the

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New Approaches to Model Simulated Spatio-Temporal Moran's Index

Nhan Bu Jennifer Lorio Norou Diawara Kumer Das Lance Waller
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ABSTRACT The Moran's index is a statistic that measures spatial autocorrelation; it quantifies the degree of dispersion (or clustering) of objects in space. However, when investigating data over a general area, a single global Moran statistic may not give a sufficient summary of the spread, behavior, features or latent surfaces shared by neighboring areas; rather, by partitioning the area and taking the Moran statistic of each divided subareas, we can discover patterns of the local neighbors not otherwise apparent. In this paper, we present a simulation experiment where the local Moran values are computed and a time variable is added to a spatial Poisson point process. Changes in the Moran statistics over the neighboring areas are investigated and ideas on how to perform the analysis are proposed.

Keywords Extreme value distribution; Moran's index; Simulated processes; Spatio-temporal model.

1. Introduction

In the era of big data, we rely on modeling correlation between features of data to make inference. One such correlation in spatial data is the Moran's Index. As first described by Moran [16], when given a set of variates (x, y) (defined on some two-dimensional discrete area) we may want to investigate whether there is any evidence that spatial autocorrelation is present overall or in neighboring clusters based on selected features. Applications of such spatial statistics can be found in many areas, for example, in agricultural research, specific plots of land may influence in several aspects the production of nearby plots. Defining random variables with spatial components as described in Vaillant *et al*. [21] can further advance the understanding of

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Partial Discharge Analysis via the Pathway Model

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ABSTRACT We conduct a study on partial discharge phenomena in the field of electrical engineering, using statistical techniques. Partial discharges are localized electrical discharges that behave as a sequence of electrical stress concentrations in insulation material or on the surface of the insulation. We use the pathway probability model for the statistical analysis. The density function of the amplitude of the pulses which are emitted during the partial discharge process, expressed in units of charge, is obtained. A real data analysis is made in order to corroborate the results developed. A statistical study on the location of the partial discharge, measured at different time points, is carried out, a graphical representation of its distribution for the different values of the parameters is provided and based on that, a new generalized integral form of the density function of the amplitude of the pulses is defined.

Keywords H-function; Laplace transform; Partial discharge; Pathway model.

1. Introduction

Statistical distribution theory is concerned with the properties of random variables, with the emphasis on the distributional aspects of the random variables frequently used in the theory and application of statistical methods. It is of great interest to theory-orientated statisticians because of their great number of special features and to practitioners because of its adaptability for vast applications, especially to fit to data from various fields, ranging from life data to weather data or observations made in economics, physics, hydrology, biology or in the engineering sciences. Thousands of research papers regarding the distribution theory are available in the literature, see for examples Birnbaum and Vincze [2], Castellares *et al*. [5], Mathai [14], Nadarajah [21], Provost and Rudiuk [22], Rocke [23] and Thomas [25].

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A New Class of Transmuted Weighted Weibull Distribution

Muhammad Shuaib Khan   Robert King   Irene Lena Hudson
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ABSTRACT This article introduces a new class of transmuted weighted Weibull distribution by using the quadratic rank transmutation map technique studied by Shaw and Buckley [15]. This new class of distribution generalizes the eleven lifetime distributions as special cases. Some structural properties of the transmuted weighted Weibull distribution are discussed. The method of maximum likelihood is used for estimating the model parameters. We illustrate the use of transmuted weighted Weibull distribution with an application to survival data.

Keywords Maximum likelihood estimation; Moment estimation; Weighted Weibull distribution.

1. Introduction

The effect of transmuting parameter plays a dynamic role in the transmuted family of lifetime distributions and is very useful technique to examine lifetime data. The ability of the quadratic rank transmutation map technique proposed by Shaw and Buckley [15] proved to be a versatile modelling technique to characterize the impact of lifetime data on new extended model. There are several methods available in statistics literature to develop new Weibull family of lifetime distribution. Recently there was introduced a new family called the transmuted generated family of lifetime distribution, which is very flexible for adding a new parameter by using quadratic rank transmutation map procedure. The transmuted family of distributions have proved to be a better method in exploring tail properties and in improving the goodness-of-fit statistics. This article introduces a new class of distribution called the transmuted weighted Weibull distribution, which can be used in modelling survival data, reliability problems and fatigue fracture life testing problems. The proposed model includes

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Marshall-Olkin Max-Min Lomax Processes and Count Models

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ABSTRACT In this paper a new family of distributions called the Marshall-Olkin Lomax distribution is introduced and studied in detail. Different autoregressive max-min processes are introduced and their properties are studied. It is also extended to *k*-th order. We also introduce a new count model with Lomax inter-arrival time distribution. The model is applied to a real data on inter arrival times of vehicles in Cochin, India.

Keywords Autoregressive models; Lomax count model; Lomax distribution; Marshall-Olkin Lomax distribution; Minification processes.

1. Introduction

Recently there has been great interest in extending distributions to develop more general families for wider use and applications. Marshall and Olkin [30] developed a new family which has been applied to various distributions developing Marshall-Olkin extended distributions. Marshall-Olkin distributions with Weibull and Logistic marginals were introduced by Alice and Jose [2]-[3]. A detailed study of Marshall-Olkin Weibull distribution is given by Jose *et al*. [19] and Githany *et al*. [11]. An extended form of Marshall-Olkin distributions based on Lomax model is introduced by Githany *et al*. [12]. Sankaran and Jayakumar [39] gave a physical interpretation of the Marshall-Olkin extended family of distributons using proportional odds model. The applications in time series analysis and reliability analysis of Marshall-Olkin extended semi Burr and Marshall-Olkin extended Burr distributions are introduced and studied by Jayakumar and Mathew [17]. Parikh *et al*. [32] discussed both estimation and testing problems along with numerical examples of Marshall-Olkin generalized exponential distribution. Jose *et al*. [22] introduced Marshall-Olkin beta distribution and studied

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Some Structural Properties of the Transmuted Lindley Distribution with Application to Women's Anxiety Data

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The University of Newcastle *Swinburne University of Technology*

ABSTRACT This paper presents some characterizations of the transmuted Lindley distribution for modelling survival data. The transmuted Lindley distribution can be obtained by using quadratic rank transmutation map technique. We obtain the analytic shapes of the density and hazard functions. Some structural properties of the transmuted Lindley distribution are discussed. The method of maximum likelihood is used for estimating the model parameters. We illustrate the use of this model with an application to women's anxiety data.

Keywords Maximum likelihood estimation; Moment estimation; Reliability functions.

1. Introduction

Lindley [10] introduced the one parameter distribution in the context of the Bayes modelling, known as Lindley distribution. Lindley [11] has also discussed this distribution from Bayesian point of view. The Lindley distribution is the mixture of exponential (β) and gamma (2, β) distributions. The Lindley distribution has been used for modelling lifetime data, when the system or process follows the increasing hazard function. A random variable X is said to have Lindley distribution, if its cumulative distribution function (cdf) is given by

$$G(x;\beta)=1-\frac{\beta+1+\beta x}{\beta+1}\exp\{-\beta x\} \qquad (1)$$

and the corresponding probability density function (pdf) is given by

$$g(x;\beta)=\frac{\beta^2}{\beta+1}(1+x)\exp\{-\beta x\} \qquad (2)$$

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A New Family Which Integrates Beta Marshall-Olkin-G and Marshall-Olkin-Kumaraswamy-G Families of Distributions

Subrata Chakraborty   Laba Handique   M. Masoom Ali
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ABSTRACT A family of continuous probability distributions which integrates recently introduced Marshall-Olkin-Kumaraswamy-G family and Beta Marshall-Olkin-G family of distributions is proposed. Probability density function, cumulative distribution function, moment generating function, moments and probability density function of order statistics of the proposed family are expressed as linear mixture of the corresponding functions of Kumaraswamy-G distribution. The Rényi entropy, quantile function, random sample generation, shapes, reliability and stochastic ordering are studied. Maximum likelihood estimation of parameters and real life data modeling for comparative assessment with immediate sub families are carried out. Different model selection criteria and likelihood ratio test have revealed the advantage of applying the proposed family over its sub families.

Keywords AIC; Exponentiated family; K-S test; Maximum Likelihood; Power Weighted Moments.

1. Introduction

Generalized classes of univariate continuous distributions through introduction of additional shape parameter(s) to a baseline distribution have attracted a lot of attention in recent times. Some recent developments in this research area include beta exponential Fréchet distribution (Mead *et al*. [22]), Marshall-Olkin-Kumaraswamy-G family (Handique *et al*. [16]), Kumaraswamy Marshall-Olkin-G family (Alizadeh *et al*. [2]), Kumaraswamy generalized Marshall-Olkin-G family (Chakraborty and Handique [7]), Beta Marshall-Olkin-G family (Alizadeh *et al*. [3]), beta generated Kumaraswamy-G family (Handique *et al*. [17]), beta

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Asymptotic Properties of MLE's of Parameters of Exponentiated Exponential Class Lifetime Distributions

James U. Gleaton and Sami Hamid
University of North Florida

ABSTRACT The properties of exponential-class distributions are well-known, including asymptotic properties of MLE's. We consider distributions generated from exponential-class lifetime distributions by taking positive real powers (greater than 1) of the exponential-class c.d.f. We then consider the asymptotic behavior of the MLE's for the parameters of these distributions.

Keywords Asymptotic behavior of MLE's; Exponentiated exponential-class distribution families.

1. Introduction

Gupta and Kundu [2, 3] introduced the family of generalized exponential (GE) distributions, involving an exponential transformation of the c.d.f. of an exponential distribution. The new distribution has c.d.f.

$$F_\alpha(x) = \begin{cases} \left(1 - e^{-(x-\mu)/\beta}\right)^\alpha & \text{for } x > \mu \\ 0, & \text{otherwise} \end{cases}.$$

Here $\alpha > 0$ is the transformation parameter, $\mu > 0$ is the location parameter, and $\beta > 0$ is a scale parameter. Gupta and Kundu [2, 3] examined the form of the hazard rate function for the new family of distributions, obtained the moment generating function and moments of the distributions, and found the distribution of the sum and of extreme values for such random variables. In addition, they derived the normal equations for the MLE's of the parameters, and, for a particular data set, compared the fits of a GE distribution, a Gamma distribution, and a Weibull distribution, finding that the GE distribution had a slightly better fit to the data.

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Recurrence Relations for Single and Product Moments for the Extension of Exponential Distribution Based on General Progressively Type-II Right Censored Order Statistics and Characterization

Marwa M. Mohie El-Din and A. M. Sharawy
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ABSTRACT In this article, we establish recurrence relations for single and product moments. Moreover we characterize the extension of exponential distribution using these recurrence relations based on general progressively Type-II right censored order statistics (GPTIIC) and using relation between probability density function and distribution function.

Keywords Characterization; Extension of exponential distribution; General progressively type-II right censored order statistics; Recurrence relations; Single and product moments.

1. Introduction

Progressively censored samples have been considered, among others, by Balakrishnan *et al*. [5], Balakrishnan and Sandhu [6] and Davis and Feldstein [7]. Singh *et al*. [11] derived classical and Bayesian inference for an extension of the exponential distribution under progressive Type-II censored data with binomial removals. Nadarajah and Haghighi [10] derived an extension of the exponential distribution. Aggarwala and Balakrishnan [3] derived recurrence relations for single and product moments of progressive Type-II right censored order statistics from exponential, Pareto and power function distributions and their truncated forms. Abd El-Aty and Mohie El-Din [1] derived recurrence relations for single and double moments of generalized order statisticsfrom the inverted linear exponential distribution and any continuous function. Athar *et al*. [4] discussed some new moments of progressively Type-II right

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Appendix

1. **Acknowledgements**
2. **On the 55th Birthday of Professor B. M. Golam Kibria**

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On the 55th Birthday of Professor B. M. Golam Kibria

Kuang-Chao Chang
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1. Introduction

Professor B. M. Golam Kibria recently celebrated his 55th birthday on February 1, 2018. As a good friend of Professor Kibria, I wish to celebrate his birthday by publishing this article in the *Journal of Probability and Statistical Science* (***JPSS***), where he has been dedicated himself for many years. I also take this opportunity to express my thankfulness to Professor Kibria for all of his outstanding work as an *Associate Editor*, *Coordinating Editor* and finally *Editor-in-Chief* of ***JPSS***.

Professor B. M. Golam Kibria on his 55th birthday

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Professor Kibria is presently a tenured faculty member in the Department of Mathematics and Statistics at the Florida International University (FIU), Miami, FL 33199, USA. Besides serving for ***JPSS***, Professor Kibria has been serving as an associate editor and editorial member of many international statistical, mathematical and biostatistical journals. Detailed academic background of Professor Kibria and his contributions to statistics will be given in Sections 2 and 3 respectively. Awards, Honors and recognition will be given in Section 4. A list of his publications is given in Section 5. Finally, some concluding remarks are given in Section 6.

2. Academic Background

Professor B. M. Golam Kibria was born on February 1, 1963 in the District of Faridpur, Bangladesh. He was the youngest child in the family and had a pleasant and wonderful personality. After the completion of his S.S.C and H.S.C. degrees from Faridpur, he was admitted to the Jahangirnagar University, Dhaka, Bangladesh in 1981. He has completed his B. Sc Honors and M. Sc. in Statistics with distinctions from the Jahangirnagar University in 1986 and 1988 respectively. As an extraordinary student, he has received several awards/ scholarships: (a) *1986 Chancellor Award*, awarded by the President, People's republic of Bangladesh, (b) *1986 Government Talent Pool Scholarship*, for scoring the highest marks in honors level among the students of Jahangirnagar University, (c) *1986 Asadul Kabir Scholar- ship and Gold Medal*, for scoring the highest marks in honors and subsidiary levels among the students of Jahangirnagar University, Dhaka, Bangladesh. Professor Kibria was awarded the *Canadian Commonwealth Scholarship* at Carleton University, Ontario, Canada, where he earned his M. Sc. in Mathematical Statistics in 1993. He was also awarded the *Canadian Commonwealth Scholarship* at the University of Western Ontario, Ontario, Canada where he has earned his Ph. D. in Statistics. Prior to joining at Florida International University (FIU) in August 2000, he was working as an Assistant Professor in the Department of Statistics, University of British Columbia (UBC), Canada in 1998-2000, and in the Department of Statistical and Actuarial Science at the University of Western Ontario (UWO), Ontario, Canada in 1997. He had also worked as a lecturer in the Department of Statistics at Jahangirnagar University, Dhaka, Bangladesh in 1988-1991. He has taught a variety number of undergraduate and graduate level courses in different universities. Professor Kibria single or jointly supervised 2 Ph.D. and 19 masters students at Florida International University. He has been involved with the committees of 17 master's thesis and 16 Ph. D. dissertation at FIU. He also has served as an external examiners of 13 Ph. D. and M. Phil theses at different universities in the world.

3. Research Contributions to Statistics

Professor Kibria has made significant contributions in various fields of statistics. He is well known in the world for his research on "*ridge regression*". Since 1993, he has about 160 research papers that are published in peer reviewed journals such as *Journal of the American Statistical Association*, *Journal of Multivariate Analysis*, *IEEE Transactions on Reliability*, *Stochastic Environmental Research & Risk Assessment*, *Communications in Statistics-Theory and Methods*, *Journal of Statistical Computation and Simulation*, *Metrika*, *Journal of Statistical Planning and Inference*, and *Statistical Papers among others*. His researches have a wide application in the fields of environmental, health science, physical sciences and transportation engineering. Professor Kibria is a co-author of a book entitled "Normal and Student´s *t* Distributions and Their Applications, Atlantis Press, Paris, France". The current citations of his papers is 1540, which certainly reflect his magnificent research work in statistics and related fileds. A complete list of Professor Kibria's publications is given in Section 5.

4. Awards, Honors and Recognition

Professor Kibria awarded the FIU Top Scholar Award in 2016 and the College of Arts, Science and Education Research Award in 2016. He has been awarded summer research awards (2001, 2002, 2003, 2005 and 2007) from the College of Arts and Science at FIU. He is an affiliated faculty in the Department of Environmental Studies and was affiliated researcher in the Lehman Center for Transportation Research (LCTR) at FIU. He is the dissertation advisor in the Department of Mathematics & Statistics and a member of the Graduate Faculty at FIU. He has been working as the principle statistician and a research faculty for the *Hurricane Loss Model Project* funded by the Florida Office of Insurance Regulation. Professor Kibria has served as the secretary, the treasurer, Vice President and the President of South Florida Chapter of ASA in 2004, 2005, 2006 and 2007 respectively. He has received *2005 Chapter Service Recognition Award* in recognition of outstanding and devoted service to the South Florida Chapter of American Statistical Association. He has presented numerous research papers as an invited as well contributor in several universities, statistical conferences and seminars. Besides serving the ***JPSS*** and Overseas Managing Editor for the *Journal of Statistical Research*, Professor Kibria is an editorial member of *more than twenty five international statistical*, *mathematical and biostatistical journals*. He is also a reviewer for the *Mathematical Reviews.* In addition, he is a member of the *American Statistical Association*, *Statistical Society of Canada and Life member of Bangladesh Statistical Association.* Professor Kibria is an elected member of *International Statistical Institute* (*ISI*) and an elected **Fellow of the Royal Statistical Society** (**FRSS**).

5. Publications

5.1 Refereed Journal Publications of Professor Kibria

1. Saleh, A. K. Md. E., Kibria, B. M. G. and George, F. (2018). Simultaneous Estimation of Several CDF's: Homogeneity Constraint, *Communication in Statistics-Theory and Methods*, **47**(12), 2813-2826.
2. Mansson, K, Shukur, G. and Kibria, B. M. G. (2018). Performance of Some Ridge

Regression Estimators for the Multinomial Logit Model, *Communications in Statistics-Theory and Methods*, **47**(12), 2795-2804.

3. Sneh, G., Hamid, S., Kibria, B. M. G., and George, F. (2017). Probable Maximum Loss for The Florida Public Hurricane Loss Model: A comparison, *Journal of Risk and Uncertainty in Engineering Systems*, **3**(4).
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11. Oxenyuk, V., Gulati, S., and Kibria, B. M. G. (2017). Distribution Fits for Various Parameters in the Florida Public Hurricane Loss Model. *Journal of Modern Applied Statistical Methods*, **16**(1), 481-497.
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15. Mansson, K., Kibria, B. M. G, and Shukur, G. (2016). A Restricted Liu Estimator for Binary Regression Models and Its Application to an Applied Demand System, *Journal of Applied Statistics*, **43**(6), 1119-1127.

16. Shakil, M., Kibria, B. M. G., and Singh, J. N. (2016). Characterization of a New Class of Generalized Pearson Distribution by Truncated Moment, *International Journal of Computational and Theoretical Statistics (IJCTS*), **3**(2), 91-100.
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22. Kibria, B. M. G. and Banik, S. (2016). Some Ridge Regression Estimators and Their Performances, *Journal of Modern Applied Statistical Methods*, **15**(1), 206-238.
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32. Kristofer, M., Kibria, B. M. G., and Shukur, G. (2014). Performance of Some Weighted Liu Type Estimators for Logit Regression Model: An Application to Swedish Accident Data, *Communications in Statistics – Theory and Methods*, **44**(2), 363-375.
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5.2. Non Refereed Publications

1. Shakil, M. and Kibria, B. M. G. (2016). A Short Biography of Professor M. Ahsanullah. *Journal of Applied Statistical Sciences* (*JASS*), **22**(3-4), 209-225.
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5.3 Publication in Proceedings

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6. Summary and Concluding Remarks

Professor Kibria’s contributions in the statistical research and in profession are invaluable. He is one of the top researchers in the area of ridge regression and leading researcher in the world. I am very confident that both graduate students and researchers will be benefitted by knowing his research work. I sincerely wish his healthy and long life.