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Poisson Xgamma distribution: A discrete model for count data analysis

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Abstract. In this article, we attempt to introduce a count data model which is obtained by compounding Poisson distribution with Xgamma distribution. Important mathematical and statistical properties of the distribution have been derived and discussed. Parameter estimation is discussed using the maximum likelihood method of estimation followed by Monte Carlo simulation to investigate the behavior of the ML estimators. Finally, two real-life data sets are analyzed to investigate the suitability of the proposed distribution in modeling count data.

Keywords: Poisson distribution, Xgamma distribution, compounding, count data

1. Introduction

Researchers obtain plethora of probability models for the sake of analyzing many types of data from various fields, such as medicine, transport, engineering, agriculture and so on. Lots of well known techniques are employed to serve the purpose of constructing new probability distributions. Some well known techniques like discretization, T-X family, and compounding technique provides a very powerful way to extend common parametric families of distributions to fit data sets not adequately fit by classical distributions. Regarding the compound of probability distributions, the work has been done in this particular area since 1920. It is well known that Greenwood and Yule (1920) established a relationship between Poisson distribution and a negative binomial distribution through compounding mechanism by treating the rate parameter in Poisson distribution as a gamma variate. Skellam (1948) derived a probability distribution from the binomial distribution by regarding the probability of success as a beta variable between sets of trials. Lindley (1958) suggested a one parameter distribution to illustrate the difference between fiducial distribution and posterior distribution. Dubey (1970) derived a compound gamma, beta and F distribution by compounding a gamma distribution with another gamma distribution and reduced it to the beta 1^{st} and beta 2^{nd} kind and to the F distribution by suitable transformations. Gerstenkorn (1993, 1996) proposed several compound distributions, he obtained compound of gamma distribution with exponential distribution by treating the parameter of gamma distribution as an exponential variate and also obtained compound of Pólya with beta distribution. Mahmoudi et al. (2010) generalized the Poisson-Lindley distribution of Sankaran (1970) and showed that their generalized distribution has more flexibility in analyzing count data. Zamani and Ismail (2010) constructed a new compound distribution by compounding negative binomial with one parameter Lindley distribution that provides good fit for count data where the probability at zero has a large value. A new generalized negative binomial distribution was proposed by Gupta and Ong (2004), this distribution arises from Poisson distribution if the rate parameter follows generalized gamma distribution; the resulting distribution so obtained was applied to various data sets and can be used as better

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