Fuzzy E-Bayesian and Hierarchical Bayesian Estimations on the Kumaraswamy Distribution Using Censoring Data

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ABSTRACT

The main purpose of this paper is to provide a methodology for discussing the fuzzy. This approach will be used to create the fuzzy E-Bayesian and Hierarchical Bayesian estimations of Kumaraswamy Distribution under censoring data by introducing and applying a theorem called “Resolution Identity” for fuzzy sets. In other words, model parameters are assumed to be fuzzy random variables. The authors also use computational methods Wu (2003). For this purpose, the original problem is transformed into a nonlinear programming problem which is then divided up into four sub-problems to simplify computations. Finally, the results obtained for the sub-problems can be used to determine the membership functions of the fuzzy E-Bayesian and Hierarchical Bayesian estimations.

KEYWORDS

Censoring Data, E-Bayesian Estimation, Fuzzy Real Numbers, Hierarchical Bayesian Estimation, Kumaraswamy Distribution

1. INTRODUCTION

Our understanding of most physical processes is based largely on vague concepts and imprecise human reasoning. This imprecision is nonetheless a form of information that can be quite useful to humans in decision making, control processes, prediction, etc. Imprecision can be used to describe certain kinds of uncertainty associated with linguistic information or intuitive information. Examples of imprecise information are that the product quality is “good”, or that the lifetime of a lamp is “approximately 2,000 h”, or that the necessary dose of a certain chemical material in a drug must be “about 20%”.

The occurrence of fuzzy random variable makes the combination of randomness and fuzziness more persuasive, since the probability theory can be used to model uncertainty and the fuzzy sets theory can be used to model imprecision. In a complex system, the number of failures and failure times may be recorded imprecisely due to equipment and human errors. For such cases this imprecision also should be quantified in the calculation. Here fuzzy set theory is used to quantify the uncertainty of imprecision. Researchers have stated that probability theory can be used in concert with fuzzy set theory for the modelling of complex systems Zadeh (1995), Barrett and Woodall (1997), Ross, Booker, and Parkinson (2003), and Singpurwalla and Booker (2004).

Several researchers then pay attention to applying the fuzzy set theory to the Bayes approach in lifetime data (Wu 2004; Taheri 2011; Viertl and Gurker 1995; Huang et al. 2006; Viertl 2009; for
Bayes approaches in fuzzy environments see, for example, Taheri 2003; Taheri and Behboodian 2001; Vierlt and Hule 1991).

The main goal of the Bayesian approach, Obtain lifetime estimates under a squared error loss function in fuzzy environment. Fuzzy Bayesian reliability method developed by Wu (2004). We develop models E-Bayesian and Hierarchical Bayesian estimations under censoring data in fuzzy environment. Han Ming gives the definition of E-Bayesian estimation of estate probability and the formulas of E-Bayesian estimation, engineering forecast model and its applications in security investment at (2005) and also Lindley and Smith (1972) first introduced the idea of hierarchical prior distribution. Han (1997) developed methods to construct hierarchical prior distribution and also he (2009) discussed about E-Bayesian estimation and hierarchical Bayesian estimation of failure rate. Zeinhum F. Jaheen, Hassan M. Okasha (2011) obtained E-Bayesian estimation for the Burr type XII model based on type-2 censoring.

The purpose of this study is to obtain estimates fuzzy E-Bayesian and Hierarchical Bayesian under censoring data, when we have observed \( m \) censors from the two parameter Kumaraswamy’s distribution. Kumaraswamy distribution has many of the same properties as the beta distribution but has some advantages in terms of tractability, its density is

\[
f_T(t) = \rho \lambda t^{\rho-1} (1-t^\rho)^{\lambda-1}, 0 < t < 1; \rho, \lambda > 0
\]  

(1.1)

Where \( \rho \) and \( \lambda \) are shape parameters, respectively. Here we assume that \( \rho \) parameter is known. The distribution function \( (c.d.f) \) is:

\[
F_T(t) = 1 - (1-t^\rho)^\lambda, 0 < t < 1, \rho, \lambda > 0
\]  

(1.2)

The reliability and Hazard functions of Kumaraswamy distribution are given respectively, by

\[
R(t) = (1-t^\rho)^\lambda, 0 < t < 1, \rho, \lambda > 0
\]  

(1.3)

and

\[
H(t) = \frac{\rho \lambda t^{\rho-1}}{1-t^\rho}, 0 < t < 1; \rho, \lambda > 0
\]  

(1.4)

Kumaraswamy (1976, 1978) has showed that the well-known probability distribution functions such as the normal, log-normal, beta and empirical distributions such as Johnson’s and polynomial-transformed-normal, etc., do not fit well hydrological data, such as daily rainfall, daily stream flow, etc. and developed a new probability density function known as the sine-power probability density function. Jones (2009) explored the background and genesis of the Kumaraswamy distribution and, more importantly, made clear some similarities and differences between the beta and Kumaraswamy distribution. According to Nadarajah (2008), many papers in the hydrological literature have used this distribution because it is deemed as a ‘better alternative’ to the beta distribution (2009). Also
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