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Residual Lifetime Estimation for Weibull Distribution by Fusing Expert Judgements and Censored Data

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Abstract : The residual lifetime of a product is the operation time between the current time and the time point when the failure happens. The residual lifetime estimation is rather important in reliability analysis. To predict the residual lifetime, it is necessary to assume or verify a particular distribution that the lifetime of the product follows. And the two-parameter Weibull distribution is frequently adopted to describe the lifetime in reliability engineering. Due to the time constraint and cost reduction, a life testing experiment is usually terminated before all the units have failed. Then the censored data is usually collected. In addition, other information could also be obtained for reliability analysis. The expert judgements are considered as it is common that the experts could present some useful information concerning the reliability. Therefore, the residual lifetime is estimated for Weibull distribution by fusing the censored data and expert judgements in this paper. First, the closed-forms concerning the point estimate and confidence interval for the residual lifetime under the Weibull distribution are both presented. Next, the expert judgements are regarded as the prior information and how to determine the prior distribution of Weibull parameters is developed. For completeness, the cases that there is only one, and there are more than two expert judgements are both focused on. Further, the posterior distribution of Weibull parameters is derived. Considering that it is difficult to derive the posterior distribution of residual lifetime, a sample-based method is proposed to generate the posterior samples of Weibull parameters based on the Monte Carlo Markov Chain (MCMC) method. And these samples are used to obtain the Bayes estimation and credible interval for the residual lifetime. Finally, an illustrative example is discussed to show the application. It demonstrates that the proposed method is rather simple, satisfactory, and robust.

Keywords : expert judgements, information fusion, residual lifetime, Weibull distribution
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