An imperfect repair model based on reduction of virtual age

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Abstract

In this paper we discussed the parameter estimation of a general repair model (Last and Szekli (1998)) using a Weibull intensity. This intensity is especially used as a failure model analyzing the reliability of different types of systems and can characterize the probabilistic behavior of a large number of real phenomena. We consider an incomplete repair model with the impact of repair after failure is not minimal as in the nonhomogeneous Poisson process and not "as good as new" as in renewal process but lies between these boundary cases. We assume that all repair times are small and can be neglected and the failure intensity at a point in time depends on the history of repairs. We assume that maintenance actions affected the failure intensity and served to adjust the virtual age of the system in a Kijima-type manner. Kijima proposed two repair effect models. In his first model he assumed that repairs served only to remove damage created in last sojourn and in his second model the repair action could remove all damage accumulated up to that point in time.

Most of the models concerning the stochastic behavior of repairable systems identify the minimal repair and the imperfect repair. The advantages of the new studied model is when the system fails, a repair is allowed performed with special cases perfect, minimal and imperfect repair. Imperfect repair can make the state of the system immediately after repair intermediate between that of a new system and that obtained by minimal repair.

This model is very interesting since it generalizes many usual imperfect repair models. Moreover repairs affect the failure intensity at any instant via a virtual age process. When the system fails, a repair is allowed performed with a degree of repair including as special cases perfect, minimal and imperfect repair models. The maximum likelihood estimator is considered for determining the estimations of the model parameters. The estimation of the Fisher information matrix is given. Simultaneous confidence regions based on the likelihood ratio statistics are developed for the estimators of the shape and the scale parameter of the Weibull intensity. The theoretical results presented in this paper have been applied on sets of simulated data. Furthermore, for illustrative purpose a well known and much discussed data on airplane air conditioning failures on a fleet of Boeing aircraft (Plane 7914) have been analyzed to see how the model works in practice.

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