Inference for the Progressively Type-I Censored Step-stress Accelerated Life Test under Interval Monitoring

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**Objectives**

In this work, we considered a step-stress accelerated life test under progressive Type-I censoring when a continuous monitoring of failures is infeasible but inspections at particular time points is possible. In addition to the accelerated failure time model to explain the effect of stress changes, a general scale family of distributions was considered for flexible modeling by allowing different lifetime distributions at different stress levels. When the inspection points align with the stress-change time points, the maximum likelihood estimators of the scale parameters and their conditional density functions could be derived explicitly. If the inspection points do not align with the stress-change time points, the parameter estimates can be obtained numerically.

1. Obtain and compare the MLEs
2. The exact CIs, the bootstrap CIs and the approximate CIs
3. Compare the simulation results

**Method**

The maximum likelihood estimator can be obtained by solving the following equations, (2) is the likelihood equation for the case with the intermediate inspection points and (3) is the likelihood equation for the case without the intermediate inspection points.

\[
\sum_{i=1}^{n} \left[ \ln \left( \frac{g_i(\tau_i)}{g_i(\tau_{i-1})} \right) - \ln \left( \frac{g_i(\tau_{i-1})}{g_i(\tau_{i-2})} \right) \right] = 0
\]

(2)

\[
\hat{\theta}_i = \frac{g_i(\tau_i) - g_i(\tau_{i-1})}{\ln(N_i) - \ln(N_{i-1})}
\]

(3)

In Table 1, some particular choices of distribution functions are shown.

**Simulation & Results**

The procedure to generate the data is shown as in Figure 3.

The simulation are based on 1000 Monte Carlo simulations with \( n = 20 \), \( \theta_1 = 12.18125 \) and \( \theta_2 = 4.4817 \), \( c_1 = 2.1, \tau_1 = 5, \tau_2 = 9 \) and \( R = 1000 \) bootstrap replications for each simulation. The results are listed in Table 2 and Table 3.

**Illustration**

A two-level step-stress test was conducted under progressive Type-I censoring in order to assess the reliability characteristics of a solar lighting device. The experiment data are listed in Table 4.

The maximum likelihood estimates of the parameters \( \theta_1 \) and \( \theta_2 \) for all the data sets in Table 4 are given in Table 5.

**Conclusion**

The interval monitoring can be an option if the continuous monitoring is impossible.

- Our estimates are competitive in terms of accuracy.
- The exact CI performs better than approximate CI and bootstrap CI in terms of coverage probability.

**References**
