Degradation in common dynamic environments

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Abstract: Degradation studies are often used to assess reliability of products subject to degradation-induced soft failures. Because of limited test resources, several test subjects may have to share a test rig and have their degradation measured by the same operator. The common environments experienced by subjects in the same group introduce significant inter-individual correlations in their degradation, which is known as the block effect. In the present paper, the Wiener process is used to model product degradation, and the group-specific random environments are captured using a stochastic time scale. Both semiparametric and parametric estimation procedures are developed for the model. Maximum likelihood estimations of the model parameters for both the semiparametric and parametric models are obtained using an inexact block coordinate descent algorithm. Performance of the maximum likelihood estimators is validated through large sample asymptotics and small sample simulations. The proposed models are illustrated by an application to lumen maintenance data of blue light-emitting diodes.