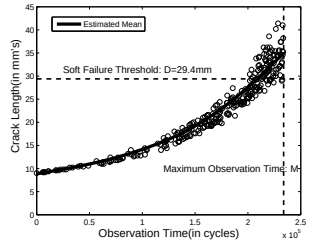
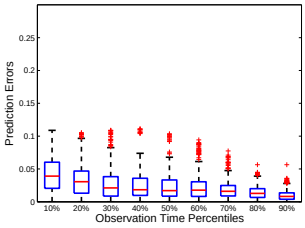
Supplementary Materials

Additional Results of Crack growth data study

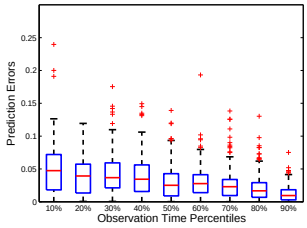
This section provides prediction results for the real data used in the accompanying paper with a different soft failure threshold $D = 29.4$ mm. The prediction results are illustrated in Figure 1. The plots are organized in the same order as those in Section 6. Based on these plots, our findings are consistent with the ones reported in Section 6 in the main paper.



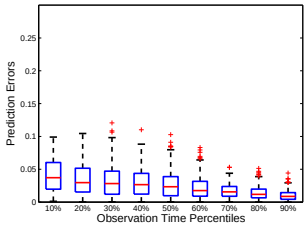
(a) Examples of Degradation Signals



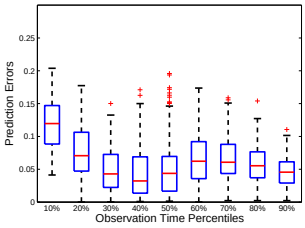
(b) Complete: Non-parametric Model



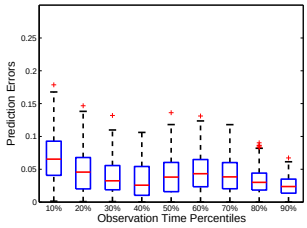
(c) Fragmented: Non-parametric Model



(d) Sparse: Non-parametric Model



(e) Sparse: Log-linear

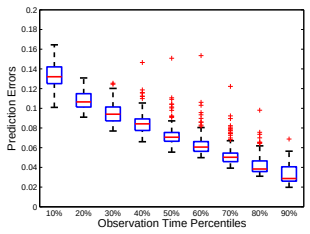


(f) Sparse: Log-log-linear

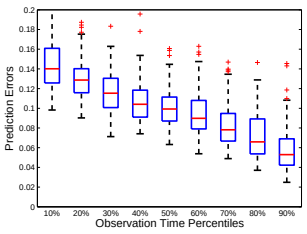
Figure 1: The prediction error of residual life prediction for the crack growth data.

Additional Results of Simulation Model 2

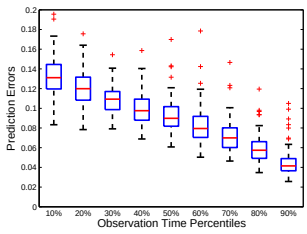
In the main paper we reported only the prediction errors comparing the non-parametric and parametric models under non-uniform sampling. In the supplemental plots in Figure 2, we provide additional results comparing the prediction errors for incomplete (sparse and fragmented) to complete signals and comparing the prediction errors under departures from the underlying model (e.g. t-distribution for the scores and t-distribution for the errors).



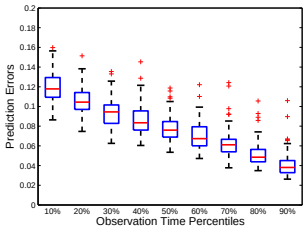
(a) Complete: Non-parametric Model



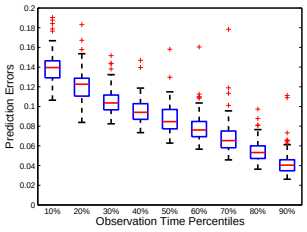
(b) Fragmented: Non-parametric Model



(c) Sparse: Non-parametric Model: Gamma Distribution for the Scores



(d) Sparse: Non-parametric Model: t-Distribution for the Scores

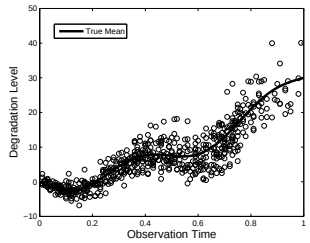


(e) Sparse: Non-parametric Model: t-Distribution for the Errors

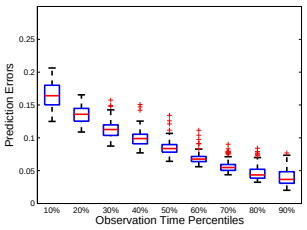
Figure 2: The prediction error of the residual life estimate for Model 2.

Results and Analysis of Simulation Model 3

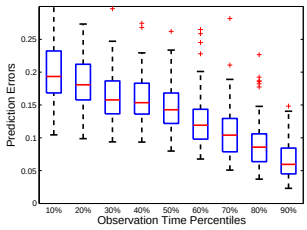
In this supplemental material we provide prediction error results for Model 3 described in Section 7 of the accompanying paper. In Figure 3(a), we show the simulated degradation observations sparsely sampled from different signals. The thick line in this plot represents the true mean degradation trend, which is non-monotone. In Figure 3(b-d), we compare the prediction errors for the non-parametric model under complete, sparse and fragmented scenarios. The low prediction errors indicate the flexibility of our model to apply to situations with non-monotonic degradation signals. Figure 3(e) shows the prediction errors when assuming that Model 1 is the underlying true parametric model of the degradation process (the results are based on sparse degradation signals). Figure 3(f-h) present the results of our model when its model assumptions are violated.



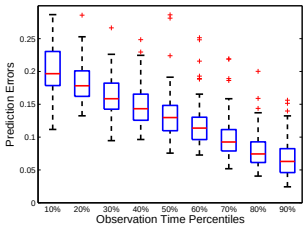
(a) Examples of Degradation Signals



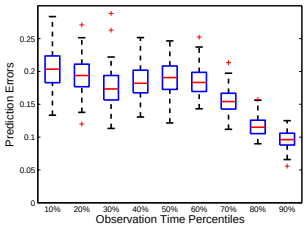
(b) Complete: Non-parametric Model



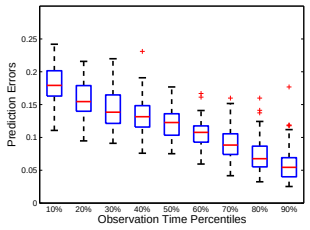
(c) Fragmented: Non-parametric Model



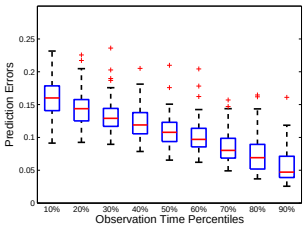
(d) Sparse: Non-parametric Model



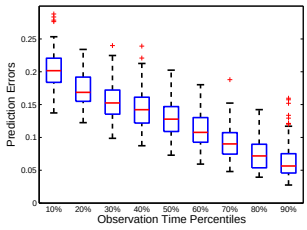
(e) Sparse: Parametric Model



(f) Sparse: Non-parametric Model: Gamma Distribution for the Scores



(g) Sparse: Non-parametric Model: t-Distribution for the Scores



(h) Sparse: Non-parametric Model: t-Distribution for the Errors

Figure 3: The prediction error of the residual life estimate for Model 3.