Closed-Form Degradation Modelling with Stochastic Failure Thresholds

Zhe Min Chia

# Problem Statement

Degradation modeling and reliability estimation while incorporating uncertainty on failure thresholds. The standardized techniques typically require a constant failure threshold to be determined beforehand and then used in conjunction with the degradation model to determine the estimates for the reliability estimates.

There is a paper by Wang and Coit (2007) titled “Reliability and Degradation Modeling with Random or Uncertain Failure Threshold” which proposes a generic method for handling randomness or uncertainty in failure thresholds by sampling many possible realizations of the failure threshold before using it to estimate the actual failure time and reliability estimates.

My focus for the project would be two-fold:

1. Explore which distributions, that when used to model the distribution of the failure threshold, can be combined with the model of the degradation path to provide a closed-form solution for the reliability estimates.
2. Explore the effectiveness of different sampling techniques used to approximate the reliability estimates, even when a closed-form solution is present.

# Data Sourcing

I plan to search for some degradation-related datasets that have variation in both (1) degradation path, and (2) failure threshold. If I am unable to find such a specific dataset, I will generate toy data (with added noise) in order to be able to conduct the above analysis. The time to generate such data should be minimal, as it would be simulated using simpler sampling heuristics instead of a complex simulation model.

# Plan of Work

* Writing out and solving for the closed-form solutions for the reliability estimates when modeling using common distributions for the (1) degradation path, and (2) the failure threshold.
* Sourcing for/creating data that resembles data coming from distributions in the previous point.
* Using sampling techniques to approximate the reliability estimates, and comparing the accuracy of it against the ground-truth, closed-form solutions.