Adaptive Degradation Modelling

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# Problem Statement

Traditional degradation modelling techniques often assume that an individual machine might undergo a somewhat homogenous rate of degradation over its lifetime. However, depending on the environmental conditions or the nature of the machine’s usage (i.e. extreme but temporary weather changes, increase in production output from the machine), a machine’s degradation pattern can change throughout its lifetime, whereby simplified degradation modelling techniques will fail to capture these variations in the model.

Several papers have examined how degradation models can adapt to these changes to the degradation patterns in a machine over its lifetime.

For my project, I will focus on the following:

1. Examine how these degradation patterns over a machine’s lifetime can be captured using a degradation model that accounts for different **“environment profiles”** that affect a machine’s rate of degradation. To simply the modelling, we will assume that:
   1. There are no shocks/jumps when switching between environment profiles
   2. The data follows a basic linear degradation model
   3. The switching between environment profiles is deterministic and known
   4. Environment profiles are discrete and limited to 3 types: High, medium, mild
2. Explore/discuss how these methods could apply to scenarios where the previous assumptions are relaxed/removed.

# Data Sourcing

Degradation path data from the 3 different environment profiles (high, medium, mild) will first be simulated using regression techniques. Thereafter, after simulating the possible switching between environment profiles during a machine’s lifetime (possibly using a simple 3 node Markov Chain), degradation data from the respective environment profiles will be chronologically stitched together based on the machine’s lifetime environmental conditions to generate a sample degradation path for a single machine. This will be repeated to generate an entire dataset of degradation paths.

# Plan of Work

* Build up the 3-environment linear degradation models, and the Markov Chain model for determining the switching between environment profiles during a machine’s lifetime.
* Generate the dataset of degradation paths, along with the data on the environment profiles for each degradation path.
* Build a model for re-estimating the parameters for the linear degradation models for the 3 different environment profiles from the dataset.
* Estimate the RUL for each machine.
* Explore how these techniques could be extended to other less constrained datasets.