Optimal Replacement using Logical Analysis of Data (LAD) and Dynamic Programming

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Abstract

This paper develops an optimum replacement model, in the context of Condition Based Maintenance (CBM), in order to minimize the long-term average cost of equipment, using Logical Analysis of Data (LAD). LAD has the advantage of not relying on any statistical theory, which enables it to overcome the conventional problems concerning the statistical properties of the datasets. LAD's main advantage is its straightforward procedure and self-explanatory results. In this paper, our main objective is to develop a method to minimize the long-term average cost of equipment maintenance, using LAD. We employ LAD's pattern generation procedure. Using the generated patterns, we estimate the equipment's survival probability. These probabilities are then used in a dynamic programming model to make optimum decision about when to replace a piece of equipment under condition monitoring. The proposed methods are applied on Prognostics and Health Management Challenge dataset, a condition monitoring dataset collected from mechanical equipment provided by NASA Ames Prognostics Data Repository. Analysis of performance of the proposed methods reveals that the methods provide reliable results that are greatly beneficial to maintenance practitioners. Optimum replacement cost obtained by the proposed methods are compared with that of Proportional Hazards Model (PHM).

Keywords
Optimal Replacement, Condition Based Maintenance (CBM), Logical Analysis of Data (LAD), Condition Monitoring, Dynamic Programming

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Biography

Alireza Ghasemi is an Assistant Professor, and Graduate studies coordinator in Industrial Engineering in Dalhousie University, Halifax, NS, Canada. He has got his B.Sc. from Isfahan University of Technology and his first M.Sc. from Sharif University of Technology in Iran. He got his second M.Sc. from Polytechnic of Montreal in Industrial Engineering. His focus in research was optimization in Condition Based Maintenance (CBM) with imperfect information. Applying dynamic programming and stochastic optimization methods, he introduced an optimal condition based maintenance policy for a system with unobservable states using Proportional Hazards Model (PH-Model).