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LAD-CBM: New data processing tool for Fault diagnosis in condition-based maintenance*

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Abstract

This paper investigates the application of data mining technique called Logical Analysis of Data (LAD) to Condition-Based Maintenance (CBM). In CBM, the existing classification techniques are mainly based on statistical analysis and modeling approaches. In this paper, we consider a classification technique that is based on Boolean logic for pattern recognition. This technique exploits the advancement in the computational capabilities of computers in order to discover patterns of failing equipment. We particularly treat the cases when the database is missing some data or that some data is incorrect. We conclude with an example of the application of LAD to CBM problems.

Key words: Data mining, Logical Analysis of Data (LAD), Condition-based maintenance (CBM), Boolean functions, Missing data.

1 Introduction

Condition-based maintenance (CBM) is a maintenance approach wherein equipment repair or replacement decisions are based on the current and projected future health of the equipment. The constituents and sub-processes within CBM include sensors and signal measurement and processing techniques that provide the mechanism for condition monitoring and decision support models. This paper attempts to fulfill the need for a diagnostic tool by proposing the LAD technique. In this context, LAD avoids the effort spent in modeling, finding all the model's parameters, and statistically validating the model found, by adopting a computational approach based on data mining and combinatorial enumeration technique. LAD finds patterns that characterize the failure state and those which characterize the normal state. After training or learning process, it can inspect any system or equipment and diagnoses its state.

In Section 2 we introduce the LAD-CBM methodology. In Section 3 we present the step of data processing, particularly if missing or incorrect data is present. The evaluation of the classification accuracy is presented in section 4, and an illustrative example is introduced in section 5. A conclusion is presented in Section 6.

1.1 Brief historical background

The LAD technique was introduced in the 1980's by the team of Professor Hammer at the Rutgers University Center for Operations Research (RUTCOR) in New Jersey (Hammer, 1986) [1]. This team developed Boolean functions for knowledge discovery. The first public presentation of those seminal ideas was made in a conference in Germany in 1986. Later, a procedure for transforming raw data into a Boolean format was created. It allowed LAD to handle arbitrary data instead of Boolean inputs only. Techniques for handling noise and missing data were added. In 1994, the creation of a software implementing LAD allowed the first empirical experiments

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