Health History Validation for Wind Turbine Maintenance

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Abstract

Condition Based Maintenance (CBM) increases the availability of wind turbines (WT). It requires prognostic models and these require the determination of the health history of the machinery. Health history data such as breakdowns and other maintenance activities are made available for the development of models that forecast breakdowns, facilitating preventative maintenance. Applications of the health history for CBM include probabilistic models, physics models and models developed using supervised machine learning methods. We present a set of methods, based on maintenance records and on a database of outages, for the determination of the health history of WTs and for its validation.
WT Health History is the result of joining records of maintenance and of outages. Other researchers have used event log data to determine outages [1]. Our new approach expands on previous approaches [2] where work orders (WO) are used to build a health history database.

Outages can be due to routine maintenance, to environmental conditions, to problems with the grid or to faults. Each outage is labelled with an alarm code indicative of the failure mode. By matching WOs to outages we enrich this health history, providing more information about the failure mode. This enriched health history can then be used by engineers and data scientists to develop more accurate prognostic models.

A second but more valuable application of the health history is troubleshooting. Health history records are used to diagnose the failure mode and the repair activity that is most likely to be effective. The enriched health history supplies more information about what parts might be required to repair a faulty WT for a given alarm code. This improves the probability that technicians have brought the correct parts to repair the fault.

We present eight metrics that compare each WO to each of a selected group of outages. Three metrics compare date stamps. One compares the type of maintenance, such as corrective or preventative. One considers whether the WT was in local operation. Three compare the failure mode. A technician applies their expertise to diagnose the fault. What parts are used provides independent validation of the fault diagnosis. We filter the pairs of linked records to find those matches that we are most confident in. These are used to train a model of what parts have been used to repair each failure mode. If the WO does contain parts that have in these training data been used to repair the outages failure mode then we have increased confidence that the match is true. The WO being tested is excluded from the training data.

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These metrics are used to predict the probability that the work order is correctly linked to the outage. The linked records are ranked in order of probability.

A clerical review identified a gold standard set of linked records. In the first validation meeting, 9 WOs were checked in 2 hours. In the second meeting, 5 WOs were checked in 1.5 hours. These were compared to the automatically generated results. Where the results differed, we investigated what caused the different results and considered altering our method.

The results validate the data that was used to develop the health history.

To predict the future, we need a detailed knowledge of the past. The methods presented determine and validate the health history of WTs.

Leahy et.al., 2018. A robust prescriptive framework and performance metric for diagnosing and predicting wind turbine faults based on SCADA and alarms data with case study Energies

Salo et.al., 2018. Value from free-text maintenance records: converting wind farm work orders into quantifiable, actionable information using text mining. Analysis of Operating Wind Farms

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