Machine Learning Benefits for the Maintenance Function

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1. INTRODUCTION

The current reality in the maintenance world has radically changed. Although the idea of using equipment until failure is not at all outdated, nowadays the need to predict when it fails as a way to extend its useful life is increasingly present.

One of the main problems that maintenance still faces today is breakdowns that arise unexpectedly. In certain cases, damage may compromise the proper functions of a production line or, in more extreme cases, may cause total shutdowns, which may have high associated costs from acquisition of spare parts to the complete replacement of the asset.

Today, it is still not possible to precisely predict a breakdown. However, there is new technology linked to Artificial Intelligence that can help predict failures by analyzing data collected from the equipment, thus predicting future breakdown scenarios. This technology, commonly known as Machine Learning (ML), allows not only to identify causes linked to breakdowns, but also to support decisions to reduce costs based on data forecasts.

The purpose of this article is to inform the reader about this technology, as well as the reasons why it is gaining notoriety in the area of maintenance and the benefits that may arise from its implementation.

2. WHAT IS MACHINE LEARNING?

As previously mentioned, ML integrates one of the branches of Artificial Intelligence, whose main focus is based on giving autonomy to computers to act and/or make decisions without being previously programmed to perform such actions.

With no need for human intervention, this technology stands out in its ability to learn only based on the experience it acquires. In particular cases, it can benefit from feedback given by the user.

The feedback will allow future comparisons to be made with accurate predictions, thus leading to the models being continuously improved.

This technology also makes use of its high data extraction capacity and algorithms to build analytical models that can be used to produce reliable and repetitive decisions. The Decision Tree, for example, is a well-known algorithm that Machine Learning makes use of, as it allows mapping and fault classification [1].

There are several ways to analyze data using different ML techniques. These three automated learning techniques are highlighted [2]:

• Supervised Learning

As its name suggests, this method uses an algorithm that needs external help to classify the collected data and is useful for when you know what the result of the analysis should be. The database provided is divided into two data sets, one where the algorithm will be trained and the other tested. In the training database, the algorithm is taught how to share or categorize the data provided, so that its effectiveness can be tested based on what it has learned.

• Unsupervised Learning

When faced with data that is not classified, the algorithm learns some characteristics present in the information and proceeds to classify them itself according to common characteristics found. This technique is useful when one does not know how the analysis result should be – that is, when there is no pre-defined classification that one intends to use, and in this way, classes are presented according to the analyzed information. Once a new database is provided,

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the algorithm proceeds to identify classifications based on characteristics previously found.

• Learning by Reinforcement

It is based on identifying patterns. Reinforced learning is useful when you want to make small and repetitive decisions without human intervention. This method uses algorithms that learn from the results and decide what action to take next. Unlike Supervised Learning – in which data classes are indicated – in this technique, initially, the actions are identified as correct, incorrect or neutral (or) not defined. It is therefore necessary that feedback is given when an action is taken by the algorithm, so that in the future it can improve its decisions based on its experience.

3. *MACHINE LEARNING* AND PREDICTIVE MAINTENANCE

When applied to the maintenance function, ML can act as a useful tool for maintenance strategies that are typically based on instrumentation and monitoring of equipment, called Predictive Maintenance.

According to the standard of maintenance terminology EN 13306 [3], Predictive Maintenance is understood as a "conditional maintenance carried out in accordance with the extrapolated forecasts of the analysis and evaluation of significant parameters of degradation of the good".

Thus, the implementation of Machine Learning allows this technology to act as a support tool for this maintenance strategy, allowing the achievement of objectives, both in the use of tool itself and in Predictive Maintenance, mainly: [4]:

- Estimate the remaining life of the equipment;
- Reduce operational risks;
- Recommend timely maintenance activity;
- Discover patterns linked to breakdowns;
- Control the cost of maintenance activities.

4. WHY USE MACHINE LEARNING?

Using this tool allows you to take advantage of the potential large amounts of data from maintenance actions, which are typically entered and stored without being properly analyzed.

Today, maintenance management systems – also known by the acronym, CMMS (Computerized Maintenance Management System) – plays an important role in asset management, presenting itself as a good source of data that Machine Learning can use to analyze the current status of the equipment. Currently, ML may make use of data stored in these systems in relation to [5]:

• Data related to equipment

The types of machines where the most problems arise and components that require the most attention.

• Maintenance history

The description of the interventions, the preventive maintenance actions carried out on the equipment, the corrective actions carried out to solve faults (with indication of symptoms and respective causes) and the record of spare parts used.

• Data from monitoring operating parameters

Analysis of parameters such as temperature, pressure, vibrations, among others, with the desired identification of outliers.

ML carries out a detailed analysis of all the data referred to above, it is therefore possible to discover information – often unnoticed by the control and analysis of technicians – that may become useful later, for decision making.

5. BENEFITS FOR MAINTENANCE

After implementing ML, it is possible to identify a set of benefits from this technology, some of which overlap with benefits of Predictive Maintenance, namely:

• Extension of the equipment life cycle

Through the creation of new forecast models, it is possible to extend the useful life of the equipment, allowing them to perform their functions for a longer period.

• Optimization of preventive maintenance actions

It is possible to redefine maintenance plans, either in terms of frequency or in terms of new tasks that are deemed necessary for the prevention of breakdowns, thus reducing future costs.

• Automatic data collection

Sensors that allow the collection of operating parameters in real time, promote greater control of the status of equipment, as well as the creation of alerts when faced with discrepant values.

• Organization of stored information

Once it makes use of data that has be stored, ML proceeds with its collection and analysis, so that later these can be identified and organized, thus making the forecasts more accurate, and their domain clearer.

6. FINAL CONSIDERATIONS

Due to its great importance in the prevention of breakdowns and in decision-making, Machine Learning becomes, for these reasons, a useful tool for most maintenance function.

However, it is also important to mention that for whatever purpose you intend to achieve using this tool, your predictions will be more accurate as you have bigger amounts of data and better quality of the information analyzed. Like many other technologies that are gaining traction today, ML, at the moment, does not have an answer to all the problems related to maintenance, since it is a technology that, and according to the author's opinion, still has a large margin for development and improvement.

This technology has a wide range of applicability, not only in the area of maintenance – the focus of this article – but also in many other areas of great relevance and interest, such as: medicine, through the medical diagnosis of patients; in voice recognition, present on any smartphone; and in the automobile sector, through the creation of vehicles that include self-driving capabilities.

Today, as a result of countless technological advances, it is possible to use Machine Learning – as well as many other similar technologies that use huge amounts of data to solve future problems companies may face. Artificial Intelligence will allow actions to keep equipment operational, as well as reduce the costs associated with most forms of maintenance.

BIBLIOGRAPHIC REFERENCES

[1] GONÇALVES, DA, ARAÚJO, HF, PINTO, JC, NASCIMENTO, RL & PINTO, VC (2017). Machine Learning for Predictive Maintenance. 14th National Congress on Maintenance. Castle of Maia, Portugal.

[2] SHARMA, N., SHARMA, R., & JINDAL, N. (2021). Machine Learning and Deep Learning Applications – A Vision. Global Transitions Proceedings.

[3] Portuguese Institute of Quality. (2007). NP EN 13306:2007.

[4] MOBLEY, RK (2002). An Introduction to Predictive Maintenance, 2nd Edition.

[5] CARDOSO, DER (2020). Application of predictive maintenance concepts with the application of Artificial Intelligence tools. Dissertation (Integrated Master in Mechanical Engineering) – Faculty of Engineering, University of Porto. Available at: https://hdl.handle.net/10216/128181