Moving Towards ZDM with Data Mining Methods

Value/Functionality of Enabler

We propose a digital enabler for Predictive Maintenance (PdM) based on the use of Quantitative Association Rule Mining (QARM) with the added benefit of the automatic detection on the fly of those sensors whose readings are most important for the accurate estimation of Remaining Useful Life (RUL) measured in parts to be made before a breakage occurs. The importance of this functionality has already been established in the Jaguar Land-Rover Use-Case of the PROPHESY [1] project that is coming to an end in September 2020, as well as in the QU4LITY [2] project that is still in its second year. The CHIST-ERA FIREMAN project [3] (in its 1st year of progress) has also showed the value of this approach in detecting faults and other rare events in the manufacturing process that can be of great importance in preventing defects in manufactured final products.

The data mining methods employed for the above task are the QARMA and R4RE family of algorithms [4-8] that allow mining of such rules in multi-dimensional datasets where the features in the dataset are in general numerical vectors of varying lengths per feature. QARMA operates in parallel using as many cores as there are available in a cluster of machines that can have hundreds of machines connected to it.

Possible Use in an Open Call Experiment

The enabler will work as a two step process. An outside manufacturing company must provide a dataset containing sensor measurements from one or more of its production machines and/or tools configured on those machines along with information about tool breakages and parts made since last breakage using a particular tool. This will comprise the input of the enabler. The dataset can be arbitrarily large, but cannot be arbitrarily small. A few thousand datapoints are needed for the models to be properly trained. Further, sparse datasets (few non-empty data attributes per instance) are likely better suited to the enabler than fully dense datasets (that are usually artificially created.) The QARMA family of algorithms will then run and the output predictions of the overall model will be made available via a REST API described immediately below.

Accessing the Enabler

A REST API on an INTRASOFT Intl URL will be defined once the open call experiment is approved.

Contact Point

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Links

[1] https://prophesy.eu/

[2] https://qu4lity-project.eu/

[3] https://fireman-project.eu/

[4] I.T. Christou, E. Amolochitis, Z.-H. Tan, "A Parallel/Distributed Algorithmic Framework for Mining All Quantitative Association Rules", *arXiv preprint arXiv:1804.06764,* Apr. 2018
[5] I.T. Christou, "Avoiding the Hay for the Needle in the Stack: Online Rule Pruning in Rare Events Detection", *IEEE Intl. Symp. On Wireless Communication Systems, Special Session, IoT in Energy Systems & Industrial Environments,* Oulu, Finland, Aug. 27-30, 2019.
[6] I.T. Christou, N. Kefalakis, A. Zalonis, J. Soldatos, R. Bruchler, "End-to-End Industrial IoT Platform for Actionable Predictive Maintenance*", 4th IFAC Workshop on Advanced Maintenance Engineering, Services and Technologies*, Cambridge, UK, Sep. 10-11, 2020
[7] I.T. Christou, N. Kefalakis, A. Zalonis, J. Soldatos, "Predictive and Explainable Machine Learning for Industrial Internet of Things Applications*", IEEE Distributed Computing on Sensor Systems Conf., Workshop on IoT Applications and Industry 4.0,* June 15-17, 2020.
[8] J. Soldatos and Ioannis T. Christou, "IoT Analytics: From Data Collection to Deployment and Operationalization", *in J. Soldatos (ed.) "Building Blocks for IoT Analytics"*, River Publishers, 2016.