Supporting Quality Assessment in Manufacturing by Machine Learning: First Results of PREFERML Project

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Machine learning (ML) algorithms have shown tremendous potentials in numerous fields. Our on-going research project PREFERML (Proactive Error Prevention in Manufacturing Based on Machine Learning) [1] aims to design and implement a machine learning system for the sake of generating prediction models with respect to quality checks and reducing faulty products in manufacturing processes. It is based on an industrial case study in cooperation with SICK AG. We will present first results of the project concerning a new process model for cooperating data scientists and quality engineers, a product testing model as knowledge base for machine learning computing and visual support of quality engineers in order to explain prediction results.

A typical production line consists of various test stations that conduct several measurements. Those measurements are processed by the system on the fly, to point out problematic products. Among the many challenges, one focus of the project is on support for quality engineers. Preparation of prediction models is usually done by data scientists. But the demand for data scientists is increasing too fast, when a big number of products, production lines and changing circumstances have to be considered. Hence, a software is needed which quality engineers can operate directly and leverage the results from prediction models.

Based on quality management and data science standard processes [2] [3] we created a reference process model for production error detection and correction which includes needed actors and associated tasks. With ML system and data scientist assistance we bolster the quality engineer in his work.

To support the ML system, we developed a product testing model which includes crucial information about a specific product. In this model we describe the relation to product specific features, test systems, production lines sequences etc. The idea behind this, is to provide metadata information which in turn is used by the ML system instead of individual script solutions for each product.

A ML model with good predictions has often a lack of information about the internal decisions. Therefore, it is beneficial to support the quality engineer with useful feature visualizations. By default, we support the quality engineer with 2D - 3D feature plots and histograms, in which the error distribution is visualized. On top, we developed further feature importance measures based

on SHAP values [4]. These can be used to get deeper insight for particular ML decisions to significant features which get lower ranked by standard feature importance measures.

References

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