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Abstract Title: Sensor Data Analytics based on DNV GL's Anomaly Detection Tool using Linear Regression Models

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In downstream installations and plants, more and more sensors are being installed that monitor all kinds of properties of a process, generating large numbers of data which are hard or impossible to monitor properly by a human. DNV GL developed an anomaly detection tool which is based on linear regression models. The purpose of the tool is to find anomalies in the 'big data' domain and to point the attention of the process engineer towards these anomalies. Meanwhile, this tool has been implemented at a large power station in The Netherlands, where the data of 200 sensors are being analyzed periodically. The analysis is supporting the process engineer in handling large numbers of data and predicting malfunctioning of equipment at an early stage.

How does it work?

The anomaly detection tool algorithm decides for every sensor if the behavior found within the sensor data in the selected time window matches with the behavior found within the subsequent time window. If behavior starts to deviate, a trend is detected and characterized by either increasing/decreasing values or an increasing/decreasing spread of the values, such as increasing outliers. The focus of the anomaly detection tool is rather on increasing/decreasing trends and trend breaks over longer periods of time: weeks, months and even years, rather than on anomalies developing suddenly over a short period of time. Figure 1 below shows the design of the algorithm. The input is sensor measurements of the selected sensor and measurements of the two independent variables, in this case for the Power Plant these were 'streamflow' and 'cooling tower temperature'.

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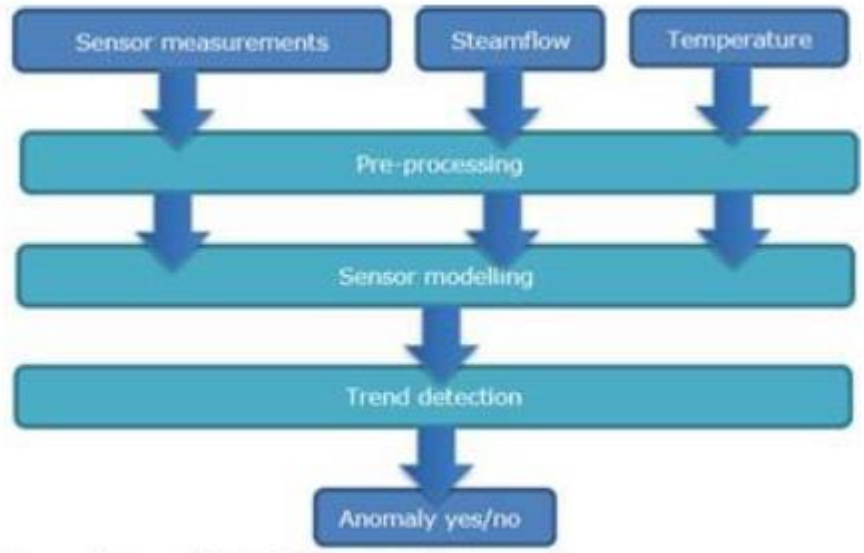

Figure 1 Anomaly detection algorithm overview.

Firstly, for the selected time window the data is smoothened according to the corresponding smoothing interval. Secondly, a linear regression model of the sensor based on the independent variables 'steam flow' and 'temperature' is created for every week/month/year in the time selection window. Finally, a trend detection test will decide whether the model is significantly changing over the weeks/months/years.

The algorithm is applied to all selected sensors in the plant's database at the same time. The analysis will run weekly, monthly and yearly on a fixed date and time. The Anomaly Detection Tool shows always the newest week, month and year analysis.
Furthermore, a handy tagging and reporting function have been added to the tool: this enables the process engineers to tag and document false positives (no real problem but detected as an anomaly) or anomalies that are known but not resolved yet.

Benefits to the plant owner

DNV GL's Anomoly Detection Tool is a big data analytics tool which enables the process engineers to strongly improve their detection of anomalies in the vast number of data generated by multiple sensors in the plant or facility they operate. This will reduce the plant owner's operation and maintenance costs considerably by preventing sudden malfunctioning of equipment and possible shutdown of the plant.