DyVerSIFy

Machine learning and semantics combined into next level process analytics

In process automation, two main predictive-maintenance approaches exist: machine learning and semantic technologies. Each of them having its specific strengths and limitations.

Where machine learning is ideally suited to detect anomalies or unknown patterns, it falls short in explaining their causes. In contrast, semantic technologies are dedicated to recognizing known events from an existing set of rules and deducing their causes, yet fail to detect anomalies that have not been modelled and preprogrammed.
Also, existing predictive-maintenance solutions are limited in their adaptation to upscaling and/or reconfiguration of the underlying sensor networks and in the optimization of the visualization dashboard towards the information that is relevant at a given moment.

Within the DyVerSIFy project, the strengths of machine learning and semantic technologies are being combined into a self-learning system. It can effectively and accurately detect anomalies and their interpretable causes from sensor monitoring streams, by enabling adaptive anomaly detection and root cause analysis through the fusion of semantics and machine learning. The solution can recognize known events as well as detect new and unexpected events. To analyze these events, it dynamically visualizes all the necessary information in a dashboard. When these events are relabeled by experts, the overall system optimizes its algorithms, shifts from anomaly to fault detection, and – by dynamically learning and adding new semantic rules – becomes increasingly intelligent. DyVerSIFy also developed a dynamic dashboard and scalable cloud architecture that automatically adapts to a growing or changing sensor network and gives the user full control over the configuration and visualization of relevant information.

THE OUTCOMES

1. Scalable and flexible smart architecture

The DyVerSIFy system is backed by a cloud-based and scalable architecture. It is optimized to upload sensor data at high frequencies and scales its capacity to the specific needs of the monitoring system. Thanks to historical data, it can semantically label new sensors as soon as they are added into the system. Also, it assists in detecting changes into the configuration of the sensor network and in adapting to them. The entire architecture is tuned to the interplay between machine learning, manual expert interventions and semantic technologies.

2. Fusion of machine learning and semantics demonstrated in concrete use cases

Thanks to the industrial partners, Renson and Televic, the DyVerSIFy technology was successfully demonstrated in two concrete use cases. Televic applied it in the railway sector. Whereby anomaly detection in the sensor data from the train was presented to an expert who recognized it as a train- or track-related event. Resulting in an updated semantic database for the system to extract knowledge from.

In the Renson case, the technology was applied for indoor ventilation systems. Allowing to, for example, detect when valves that are specifically designed for bathrooms are used for other room types, causing suboptimal ventilation. Or recognize events such as halo-effects of increased humidity in rooms that are adjacent to a bathroom after someone had taken a shower.

3. Dynamic dashboard technology

The third industrial partner, Cumul.io, took the lead in the development of a dynamic and smart dashboard. While generically applicable, it can be tuned to the needs of the specific application. For example, it automatically announces newly added sensors with their semantic ID and relevant parameters or zooms in on relevant parameters when analyzing a specific anomaly or event. Also, it gives the operator almost full control over the definition and mode of presentation of the information that he or she considers relevant. The dashboards can be integrated seamlessly within other platforms, apps and analytics portals.

NEXT STEPS

Steven Vandekerckhove, Renson Ventilation: “The outcomes of this project are important in the development of predictive maintenance as supporting pillar behind our ventilation-as-a-service business case. As we are a premium brand, the technology will help to improve the experience and satisfaction of our customers and consumers even further.”

Bruno Van Den Bossche, Televic Rail: “We plan to integrate this technology into Cosamira, our solution for railway fleet management, where it can help to optimize the cost structure of our clients. Also, it assists us to expand our existing client portfolio of train builders to the market segment of train operators.”

Sofie Van Hoecke, IDLab, an imec research group at UGent: “Follow-up research and validation is planned through for example the imec.icon RADIANCE in which we fuse machine learning with semantics to make anomaly detection context-aware, and the VLAIO proof-of-concept program Smart Maintenance in which we will validate the DyVerSIFy results for bearings faults .”

FACTS

NAME	DyVerSIFy
OBJECTIVE	Dynamic Visualization, adaptive analysis and Scalability for mining Sensor data with Integrated Feedback
TECHNOLOGIES USED	Machine learning, semantic technology, cloud architectures, predictive maintenance, Industry 4.0
TYPE	imec.icon project
DURATION	01/10/2017 – 30/09/2019
PROJECT LEAD	Bruno Van Den Bossche, Televic
RESEARCH LEAD	Sofie Van Hoecke, IDLab, an imec research group at UGent
BUDGET	1,749,747 euro
PROJECT PARTNERS	Cumul.io, Renson Ventilation, Televic Rail
RESEARCH GROUPS	IDLab, an imec research group at UGent

DyVerSIFy project partners:

Cumul.io RENSON televic GHENT UNIVERSITY

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AGENTSCHAP INNOVEREN & ONDERNEMEN Vlaanderen is ondernemen

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IMEC.ICON PROJECT?

The imec.icon research program equals demand-driven, cooperative research. The driving force behind imec.icon projects are multidisciplinary teams of imec researchers, industry partners and/or social-profit organizations. Together, they lay the foundation of digital solutions which find their way into the product portfolios of the participating partners.

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