

# ML-Based Analytics: Learn and Forecast How Machines Behave

## Understanding and Improving Machine Operation by Analyzing and Visualizing Multi-Sourced Production Data

### Background

In production facilities more and more machines are equipped with sensors as a major data source for monitoring, understanding, optimizing, and managing the machines and the production processes they are involved in. Those sensors measure various physical phenomena (e.g., temperature, mass, pressure, vibration) and other process parameters (e.g. material and energy consumption, number of produced products, product qualities). Together with additional operational information (e.g., about the products produced, process configurations, raw material characteristics, asset events, maintenance activities etc.) this sensor-based time-series data forms a promising data basis for learning and understanding the behavior of machines and for developing optimization strategies.

### Description

This master's project focuses on the technological challenges and opportunities arising from the combination of sensor data and additional operational data captured from industrial machines to derive information about machine states and dynamics. The key goal is to design and implement algorithms that allow us to fuse machine data from multiple sources and to systematically and automatically analyze and detect relevant information in this data about trends, seasonality, events, and anomalies and to automatically derive actual and future phenomena, including e.g., wearout processes, maintenance demands, and expected output qualities and rates. Production data from machines and related activities, in a sense, belong to the most promising application fields for deep learning as they are characterized by a certain degree of fuzziness and interference phenomena – all of which can be handled perfectly by deep learning approaches.

For this type of data, the project should investigate:

- Visual Analytics Techniques
  - Developing techniques for the combined visualization of machine data from multiple sources
  - Designing UIs for efficient data exploration and master data generation
- Understanding and Forecasting
  - Deep learning approaches for the automated detection of trends, seasonality, and anomalies in time-series data
  - Deep learning approaches for the automated forecasting of future phenomena in machine operations and production processes

The master's project refers to current research and software projects of the Computer Graphics Systems group. It is especially suited for further research in the context of a master's thesis or a future doctoral thesis. Further, the master's project can lay a foundation for working as a student assistant or software developer at our research partners.

### Contact

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**Figure:** Multi-turbine blasting machine equipped with multiple sensors measuring material and energy consumptions, material fill rates, wind speed, and more.