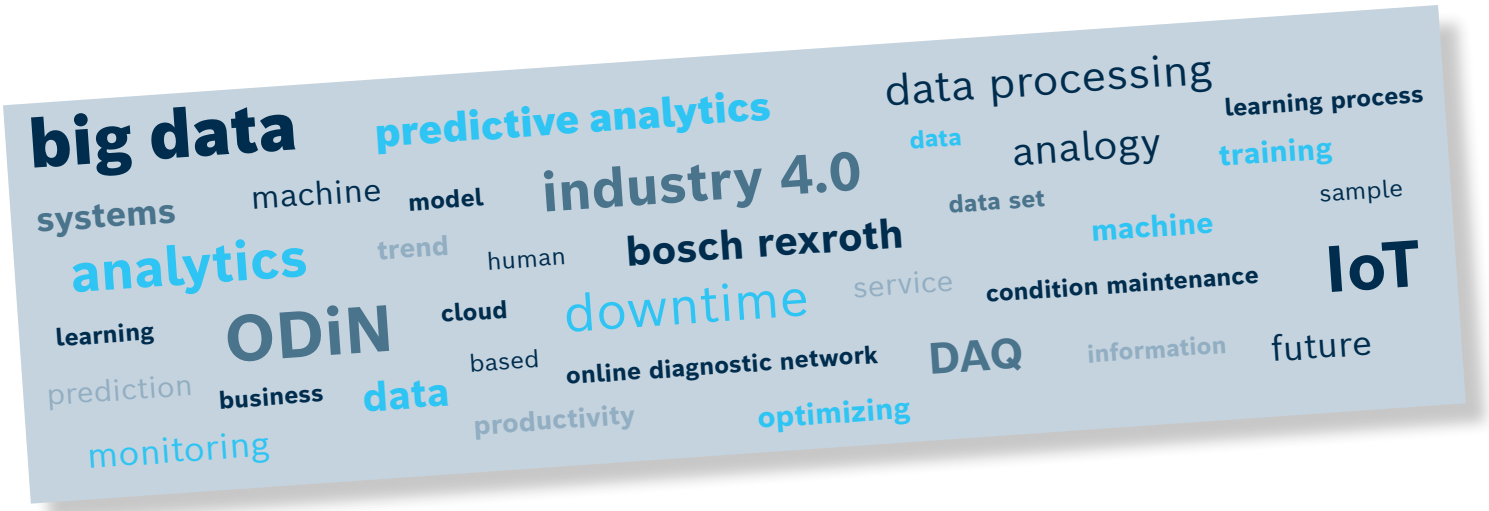
rexroth
A Bosch Company

Big Data & Machine Learning

Definition, context and relevance

Every day more than 2.5 quintillion bytes of data are generated worldwide. Ninety percent of data in the world has been created in the last two years and will continue to increase. This requires new ways of dealing with such large amounts of data. With the right tools we can efficiently store, manage, and analyze unprecedented data volumes. How we define Big Data and machine learning and how they relate to each other is covered in this whitepaper.

Machines are becoming more and more intelligent in modern industrial applications in order to manage increasingly complex manufacturing processes. This generates huge amounts of data. In order to improve these complex processes, the right tools are required because traditional approaches for data storage and processing are no longer sufficient. Furthermore, due to increasing complexity, an analytic (e.g. rule-based) approach for understanding the system is no longer feasible. Therefore, new tools like Big Data and Machine Learning are required.



HOW CAN BIG DATA BE DEFINED? HOW CAN BIG DATA HELP WITH PREDICTIVE MAINTENANCE?

Big Data is the key to manage large amounts of data beyond the capacity of traditional data processing applications. The data volume alone does not characterize big data, it also includes a high velocity and variety of data. Traditional databases cannot handle this type of data. They are not flexible enough or do not have sufficient performance. The software tools used to store and manage this type of data are very diverse and highly dependent on the use case.

In order to map the complex behavior of the machines, data must be recorded with high resolution. As the variety in data patterns is large under both normal and anomalous operating conditions, it is necessary to store the data in a central location in order to recognize reoccurring events. For Predictive Maintenance this means finding known error patterns on machines. The large amount of data also serves as a basis for the development of future services and business models in the Internet of Things (IoT).

WHAT IS MACHINE LEARNING?

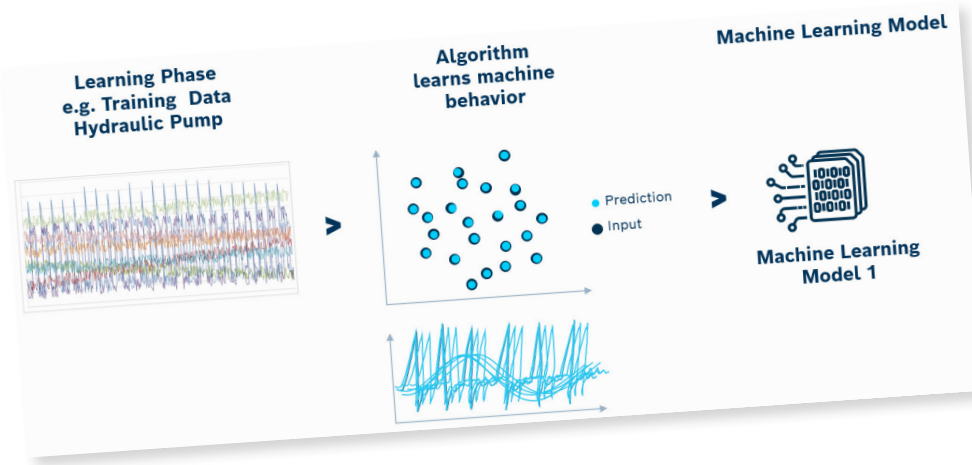
Machine Learning is a methodology from the field of artificial intelligence and is characterized by the fact that problems are solved implicitly using example data, in contrast to solving problems using explicitly programmed rules. This makes it possible to deal with problems that are difficult or impossible to describe analytically. The prerequisite for machine learning is the availability of example data.

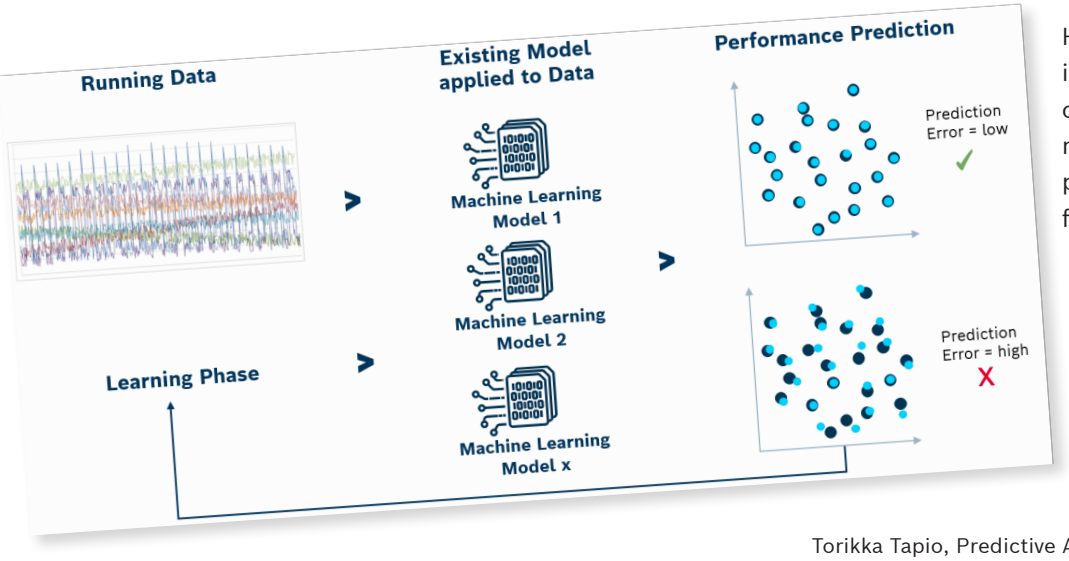
A distinction is made between supervised and unsupervised learning: Supervised learning works with the help of reference data that have been assigned to predefined categories (e.g. good or bad). In unsupervised learning, there are no predefined categories and the Machine Learning algorithm automatically groups the data into similar clusters.

HOW DOES MACHINE LEARNING WORK USING PREDICTIVE MAINTENANCE AS AN EXAMPLE?

Unsupervised learning is used to detect anomalous data patterns in measurement data, which can indicate a developing failure in machines during their operation. To detect these patterns in incoming data continuously, a learning phase is necessary to create a model based on example data, which is presented to the Machine Learning algorithm during the learning phase. It will create a compact mathematical model of this data. The learning phase begins with a random model. Continuous, small adjustments of the model parameters during the learning phase minimize the difference between the model predictions and the training data.

Once a set of parameters with a good fit of prediction and real behavior has been found, the model including the optimal parameters can be stored and is able to gointo production. In the production stage, the current incoming data from the machine is compared with training models. If there is a small deviation with known reference data patterns, no anomaly is indicated and the process phase continues.

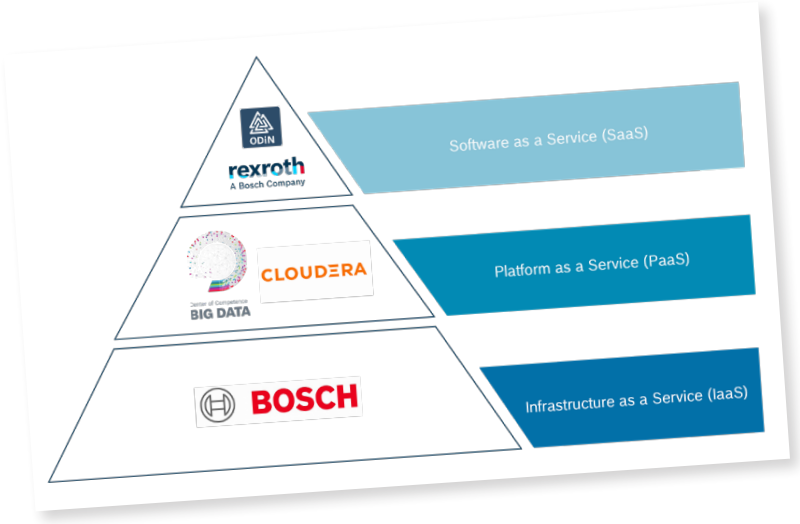




However, if the deviation is high, there is an anomaly and a new learning process starts to generate a model of the newly found data pattern. Thus, it is possible to identify this pattern in the future.

WHAT ARE THE BENEFITS OF MACHINE LEARNING IN PREDICTIVE MAINTENANCE?

Machine Learning helps to reduce manual work in Predictive Maintenance applications by eliminating the need for threshold setting for individual sensor signals and by condensing the complex incoming sensor data to a few metrics describing machine behavior. This enables those monitoring of the machines to access the essential information more quickly, identify anomalous machine behavior and plan required maintenance activities in advance.



HOW DOES REXROTH USE BIG DATA AND MACHINE LEARNING TO PROVIDE A PREDICTIVE MAINTENANCE SOLUTION?

Bosch, Cloudera and Rexroth have joined forces to offer customers a comprehensive predictive maintenance solution. Each of the individual partners focuses on its core competencies in order to achieve the greatest possible benefit. Bosch provides the appropriate server infrastructure that forms the basis of the system. The Bosch IT division ensures sufficient, smooth, and secure operation of the servers.

Cloudera as a leading provider of Big Data platforms has the necessary competence to provide a suitable platform, which is operated by CoC (Center of Competence) Big Data at CI/OST. Due to this, Rexroth is able to concentrate on the development of the Predictive Maintenance solution for customers, ODiN.

Bosch Rexroth AG
Predictive Analytics Services
odin@boschrexroth.com