

## MACHINE LEARNING – A PROMISING APPROACH

The digital transformation of the economy and society is increasingly being driven by the use of Artificial Intelligence. It is now found in everyday applications like route planners and voice assistants, but also in professional applications like industrial quality control, medical diagnostics, and autonomous vehicles. This innovation is mainly driven by Machine Learning techniques; in particular, Deep Learning or neural networks are responsible for significant progress along with the enormous increases in computing power and major investments in know-how.

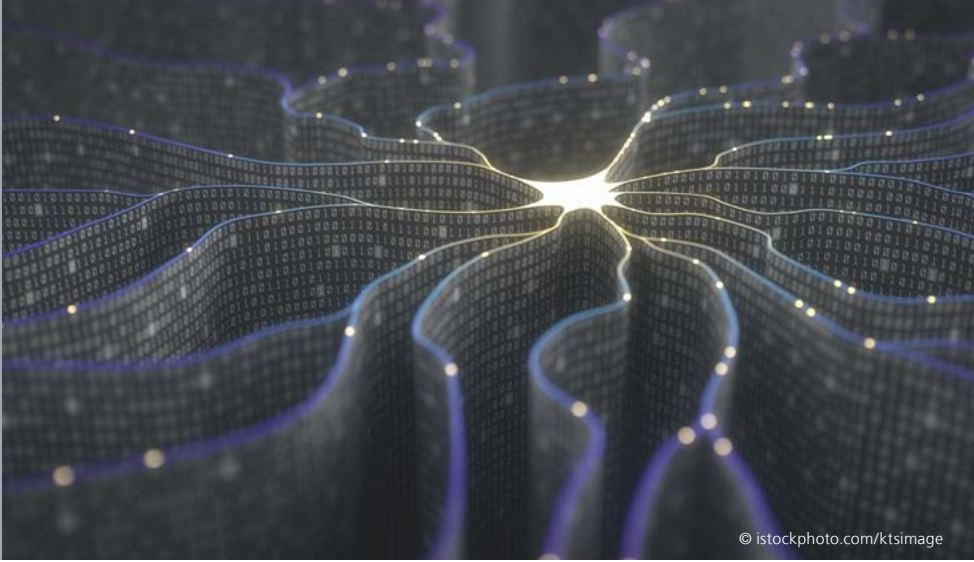
Machine Learning is now a routine technology, but every algorithm is only as good as the data used to train it. Often, large amounts of data are available in companies that want to leverage ML methods to optimize their processes and products, but rarely is this in a form easily used for Machine Learning. However, problems such as data reliability and robustness are now well understood and are being researched worldwide, including at our institute.

### **Hybrid approach: Expert knowledge combined with Machine Learning**

We want our joint venture partners in industry and business to have the software tools they need to improve their processes. This refers to customized software that enables fast comparisons of different alternatives to assist in identifying potential improvements. The modeling of real processes has to be highly realistic and reliable: reality must be so well represented that the proposed improvements are both feasible and quantifiably reliable. Machine Learning processes combine with the existing expert and physical models to provide answers to this challenge. Various methods, like neural networks or support-vector machines are trained and integrated using existing data. This technique ensures the model is accurate enough to identify substantial process improvements.

### **ML methods in action institute-wide**

At ITWM, nearly every department uses Machine Learning, mainly some hybrid simulation-based Machine Learning methods. For example, the System Analysis, Prognosis and Control department uses ML algorithms to create tools that analyze, interpret, and visualize biological medical data. ML methods are also used in a predictive maintenance context to predict the occurrence of unwanted operating states and events. The Transport Processes department develops a hybrid approach to design and optimize production processes in the textile industry using ML methods: the DensiSpul project focuses on the optimization of bobbin winding machines. Specifically, the research aim is to improve the dyeing of the yarn wound on the bobbins.



© istockphoto.com/ktsimage

ML methods have long been important in the field of image processing: just consider the major focus on the development of safe and stable algorithms for optical quality controls in production. Quality is not the main challenge here because in a well-functioning plant many images of fault-free products are available, rather the problem is insufficient data since only a few images of products with defects are available. One possible solution is data augmentation, that is, the creation of artificial error databases that are based on real error data. You can also prepare mathematical descriptions of the defects and train the image processing algorithms with the model. The department offers classic machine-learning solutions that can be used to automate the processing of vast amounts of image data that previously had to be classified manually.

### **Neural networks enable significant energy savings**

The Optimization Division successfully uses Machine Learning in process engineering and has created a new analytical tool to save significant amount of energy in the production of chemicals. Here, again a hybrid approach is used. Measured data such as pressure or temperature is collected with sensors in technical systems and serves as the basis of this approach. In the past, sensor data was used only for process monitoring; now it can be used for training neural networks. The development of the new tool was selected for the Fraunhofer Prize 2019.

### **Priority for High Performance Computing**

Machine Learning and data analysis have been declared a main research focus of the Competence Center for High Performance Computing. One of the tasks is the development of new algorithms for the distributed computation for the training of neural networks and realization on specialized hardware. The main focus is on the implementation of scalable optimization algorithms for the distributed parallelization of large Machine Learning problems. In fact, the basis for this was developed at CC HPC. It is HPC components like the parallel file system BeeGFS or the programming framework GPI2.0 that make the efficient implementation of new algorithms possible.

Fraunhofer ITWM has seen increased demand in recent years not only for its outstanding research activities, but also as a service provider of seminars on Machine Learning.