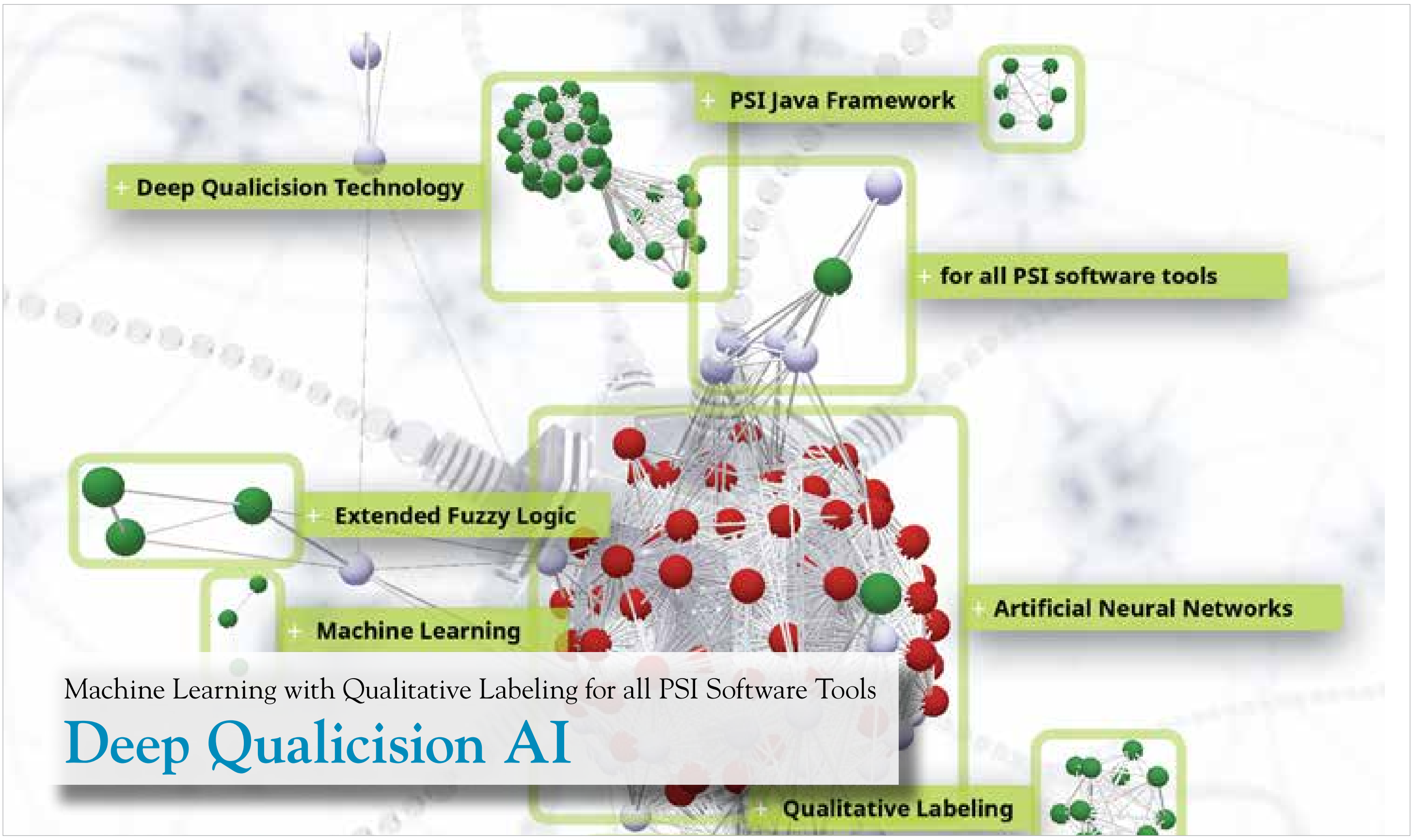


Machine Learning with Qualitative Labeling for all PSI Software Tools

Deep Qualicision AI

Deep Qualicision AI is the linking element between the AI decision engine Qualicision and machine learning. This solution concept efficiently learns how to set the parameters of optimization algorithms so that decisions that are based on data and optimization results automatically adjust themselves. It is available for all PSI software tools equipped with Qualicision and promotes the implementation of AI within the group of PSI solutions.

The core element of Deep Qualicision is its machine learning process based on the automatic detection of KPI goal conflicts in the data of business processes, which is done by means of extended fuzzy logic. The goal conflict analysis helps arranging the process data in such a way that the Deep Qualicision algorithm is able to detect what situations require which specific actions in order to plan and control the business processes in an optimal way.

Fascinatingly, for this purpose it is possible to use already established Qualicision optimizations: If business processes are optimized through Qualicision algorithms, labeling the process data is indispensable if AI solutions are to be applied. With Deep Qualicision, the process data can be labeled qualitatively using the known KPI-driven optimization. And this is done by Qualicision algorithms—in other words, the optimization itself.

Manual data labeling (for instance: millions of cat images placed in the web), that is the manual classification if the data at hand led to positive or negative KPI results in the process in question, is no longer necessary. This helps eliminating the known bottleneck of data preparation for AI methods.

Qualitative labeling by means of an automatic KPI labeling machine

In this way, any existing Qualicision solution can be understood as a KPI labeling machine and can be used for implementing efficient AI learning strategies. Qualitative labeling creates new perspectives for the application of Deep Learning in business processes because it provides qualitatively labeled status data, which are automatically generated via continuous fuzzy clustering of situationally dynamic process data.

These close the gap between the dynamics of process data and the necessity to operate with labeled data. Closing this gap is of such importance because for the first time the conditions are given to use artificial neural networks for optimizing business processes.

A simple introduction to Deep Qualicision

From the customer's point of view, the introduction into said scenario is quite simple. If Deep Qualicision AI is to be used for optimizing or analyzing a business process, we have to ask for those process indicators and criteria (KPIs) that allow evaluating and optimizing the business process' quality.

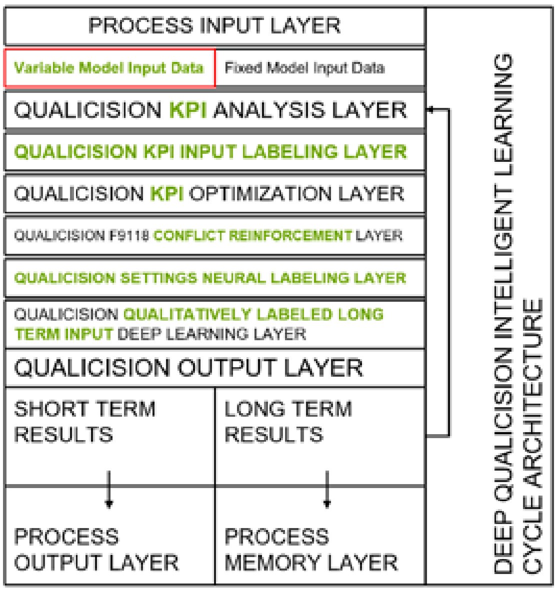
Classical KPIs in production processes are efficiency criteria like adherence to deadlines, resource utilization, capacity and material availability. Further criteria like employee satisfaction, even resource management or process stability could also be considered. Additionally, evaluations of product variations, diversification of the order structure and the development of the KPIs in the course of time (in the sense of usability of historical data) are considered. From the descriptions above follows, that collecting the information described above presents rather an organizational challenge, not a fundamental one. It is a known obligation in any project whose aim is to improve the workflow in a business process. The "icing on the cake" however are the automatisms of Deep Qualicision.

Business process data and KPI definitions are the only data to be entered

Once the KPIs are described and the raw data of the business process are available, Deep Qualicision starts applying its optimization algorithms for labeling the business process data, optimizing the processes and for using the optimized and learned labels for automated learning of the positive and negative rules inherent to the business process in question.

Using the automated labeling function allows saving the learned information directly in a neural network. Figure 1 shows the structure of a Deep Qualicision solution and its components (see the box).

Apparently, Deep Qualicision consists of the original Qualicision optimization solution, which now is used for the qualitative labeling of process data, too. Additionally, an intelligent goal conflict oriented cluster method is used for KPI-oriented reinforcement learning. Enhanced by a neural network component, Deep Qualicision is able to perform learning based on the qualitatively labeled process data. The outcome is positive and negative labeled process data and process situations. These data are the basis for machine learning aimed at decisions about how, in the future, the process optimization should react in certain process situations.



The architecture of Deep Qualicision.

Automatic Process of Qualitative Labeling

One of the advantages is that the labeling process described here is done automatically, controlled by the optimization itself, and that, except for the KPI definition, it doesn't require any human input. Another advantage is that the principle of Deep Qualicision applies to every business process that has already been optimized by Qualicision.

The second of the advantages mentioned above is of special importance because each existing Qualicision application can be equipped with the machine learning feature of Deep Qualicision. Particularly, all PSI software products equipped with Qualicision can be enhanced with the Deep Qualicision-based capacity of machine learning. Maybe, in some of these solutions additional KPIs would have to be defined, in order to perform qualitative labeling and machine learning in the future.

And this is a further advantage. In each of the PSI software products additional KPIs can be integrated and thanks to the Deep Qualicision framework, they can be used for improving or completing the already existing functionalities.

Sequencing in the Car Production

Among the first customer applications working with the basic principles of this method was the optimization of production sequences in the car production, based on the so-called planned times. The KPIs defined here are derived from the working times for specific activities and processes in each of the work stations along an assembly line. The cars to be produced

are to be ordered in a sequence in such a way, that none of the work time KPIs exceeds its capacity limit.
In case that exceeding the limit cannot be avoided at a certain station, a reduction of the work time has to be ensured immediately afterwards. This is done by planning the sequence in such a way that cars requiring complex assembly work are immediately followed by cars requiring less complex work. As this has to be ensured for all possible situations and for all order combinations, the optimization of production sequences is far more complex than certain strategic games like chess, go or poker.

Unknown Dynamics of Order Data is no Obstacle at all

Beyond the combinatorics, similar to all production processes sequencing, too, has to cope with the unknown regarding the composition of the order quantity and its dynamic diversity of variants. This raises the complexity of the optimization required here to an even higher level. Considering several thousands of production orders per day plus the astronomical number of equipment combinations plus more than 100 KPIs to be optimized, the complexity becomes apparent immediately. For the same reason the qualitative automatic labeling of process data is a must-do. Thanks to these data only it is possible to ensure both the learning capacity of Deep Qualicision solutions and the required process stability. The method described is already in productive use in several production lines of the automotive industry.

Field Force Management with PSIcommand

Another use case is the combination of Deep Qualicision with the software tool PSIcommand. Here Deep Qualicision is used for learning the parameter settings of the field force optimization for maintenance and emergency work in electric supply grids, and the KPIs describe the efficiency of the scheduled resource to job assignments. Again, the number of KPIs and auxiliary KPIs is about one hundred. For each year, more than one hundred thousand maintenance and emergency jobs have to be allocated to hundreds of technicians.

Machine Learning for all PSI Software Tools

In this case, Deep Qualicision is being used as an additional machine learning functionality that can be switched on or off. It is implemented as an outer layer to the PSIcommand solution which is already installed and running. From the technical and the content-related point of view, the activatable Deep Qualicision AI is the blueprint for integrating machine learning into all PSI software tools that are already equipped with the Qualicision optimization. Thus, thanks to the Deep Qualicision framework, machine learning is available for PSI products like PSIbms, PSIcommand, PSIsaso, PSIpenta/Leitstand/PSIasm, PSIwms and, of course, for all software products of PSI FLS.

The Deep Qualicision framework.

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