Product report: Deep Qualicision for automated optimization of business processes

Qualitative labeling of business process data

Using artificial intelligence to optimize business processes is part and parcel of digitalization strategies for many companies. However, applying AI methods from AI applications such as character or speech recognition to make, for example, decisions for production process optimization does not directly lead to the desired results.

AI applications such as character recognition, recognition of spoken language or gestures build on the stability of the detected pattern. It is true that the patterns vary significantly in terms of how they look. Yet, we can come up with a solid consensus from a semantic point of view about the meaning of the patterns because the meaning of the form of characters remains unchanged over time: obviously, we can write the sign for the number seven in different ways.

Nevertheless, a human being is able to reliably match the various ways of writing seven to the number seven stable over time. In AI jargon, this form of matching is called "labeling." If solid labeled patterns that are consistent in terms of meaning do not exist, it is not possible to directly apply neural networks (CNNs or RNNs) as an AI method. Unless labeling is conducted algorithmically.

Good-natured stable game process of Go allows to use calculations with combinatorial probabilities

The AI projects AlphaGo and AlphaGo Zero have become generally known over recent times. They automated the board game Go, where two opposing players each place white and black stones on the board's grid pattern with the idea being that a player captures as many of their opponent's stones as possible. Altogether AlphaGo and AlphaGo Zero solve the problem of labeling algorithmically. However, these solutions cannot be applied directly to production processes.

Although AlphaGo and AlphaGo Zero label algorithmically by using probabilistic estimation methods and reinforcement learning they put upon the non-problematic nature of the combinatorial reliability of the board game Go.

Despite the enormous combinatorics of scenarios during a game its situations arise according to a fixed set of unchangeable rules which guarantee that the analysis of the moves made in relation to Go remains completely reliable over time.

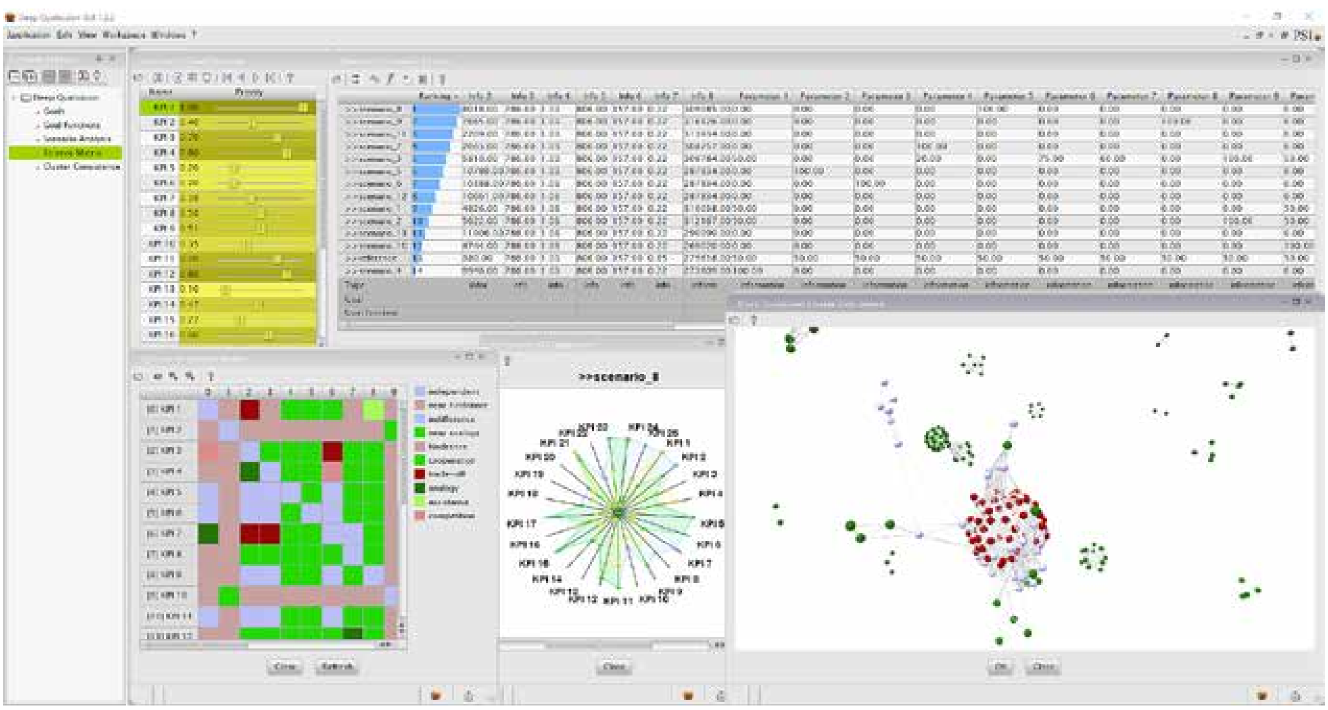

Figure 1: Qualitative labeling as a requirement for the automated optimization of business processes using Deep Qualicision.

When estimating the positive and negative consequences of the game scenarios, everything calculated up to a point in time probabilistically endures in the future.

Combinatorial probabilities are not transferable to production processes

In this regard, industrial production processes are not as stable as a board game: firstly, their rules need to be flexible. Process parameters such as production volume, performance profiles, availability of staff and equipment, work schedules or skills profiles of employees vary continuously. Secondly, the number of KPIs which control the processes, is variable and high. Cost and revenue models are faced with a KPI portfolio which due to the KPI goal conflicts cannot be conclusively pre-calculated over time in a combinatorial way using values of probability. Thirdly, there is a need to deal with continuous changes in the products themselves, because they are in a constant state of flux. As existing products run out, new ones are added.

As a result of goals being, consistent, qualitative labeling and KPI goal conflict analysis are more structurally robust

Compared to the board game Go, the situation is as if the number of stone types changed from game to game and as if we never knew exactly the number of dice sides when giving a random throw of the dice (Monte Carlo) in relation to the scenario to be labeled. Therefore, what we have learned during the last game might no longer hold for the next game. Hence, reinforcement learning to train an AI system that optimizes production processes needs to work differently.

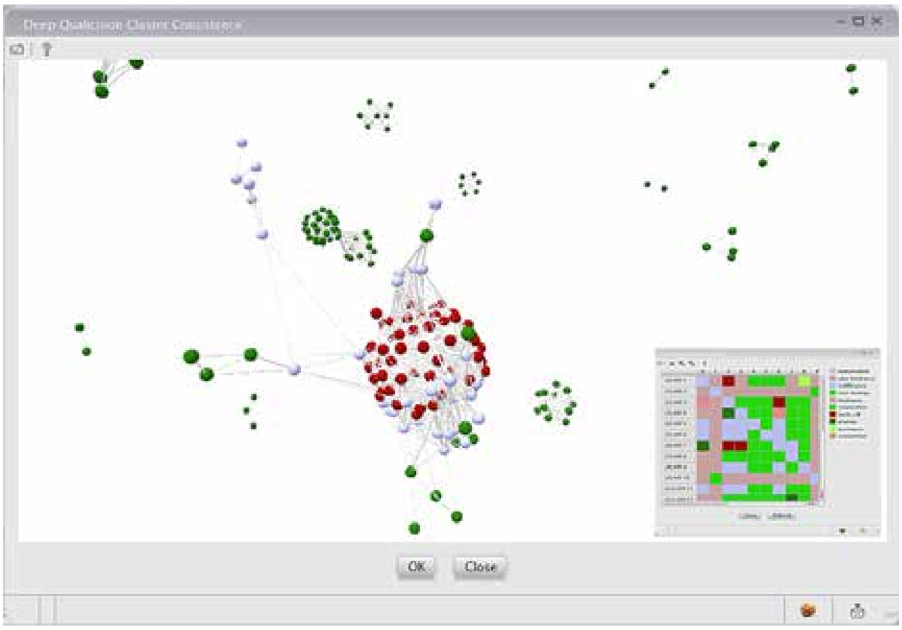

Figure 2: Positively and negatively labeled process data from a qualitative point of view in Deep Qualicision.

The solution is qualitative labeling. Due to the flexibility required by production processes, data needs to be labeled in a qualitative way based on process optimization rather than on combinatorial probabilities derived from randomly studied fixed rules.

Situation-based patterns arise as a result of KPI optimization algorithms

Situation-based patterns do not arise at random (Monte Carlo) but as a result of KPI optimization algorithms. Each of the KPIs that assess process quality is deemed to be an optimization criterion. In terms of achieving their goals, these KPIs are classified in graded rate ranges between -1 and 1.

Positive ratings represent advantageous, desirable situations and negative ratings warn of non-desirable situations. An algorithmic KPI goal conflict analysis is being used to optimize the production process by balancing the KPI goal conflict in line with the situation.

On one hand, the calculated evaluations control the optimization and, on the other hand, as qualitative translations of the dynamically varying quantitative process data they are also suitable for labeling.

Qualitative labeling as a core component of an automated learning method

As a qualitative copy of process data qualitative labels are consistent and more robust than the situation-specific data itself can ever be. Qualitative labeling is the core component of a machine learning process (see Figure 2) that has already proven its value in an industrial environment under the name Deep Qualicision.

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