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Paper title: Bringing light into the darkness - A systematic literature review on explainable predictive business process monitoring techniques.

Keywords specific to the paper: business process, prediction, interpretability, explainable artificial intelligence

Summary of the main contributions:

Predictive business process monitoring has become an essential part of digital transformation. Indeed, it enables companies to anticipate possible outcomes strategic decisions in real time. The integration of artificial intelligence and machine learning has revolutionized PBPM offering predictive accuracy that is still unrivalled today.
On the other hand, these technological and technical advances raise a major problem, that of explaining the models used. Since a model can be adopted by a company, an individual or a group of people, it is important that every mechanism underlying these techniques can be understood by all, so that it can be adopted by users.

Classification

These various PBPM techniques can be classified according to their approach to explicability. Models such as linear regression or decision trees allow for intrinsic interpretability, helping users to understand more quickly how predictions have been generated. Other models, on the other hand require so-called "post-hoc" methods to explain the logic behind the predictions. These include neural networks.

Intrinsic interpretability refers to machine learning models that are naturally designed to be easy to understand. This means that the internal workings and the way decisions are made are transparent and therefore easy for users to understand.
Post-hoc explanation looks at the different methods applied after the model has made a prediction. They help explain the result. Post-hoc explanations are often used with black-box models, such as deep neural models.
A black-box model refers to algorithms or models where models where the internal decision-making or prediction processes are hardly understandable by humans. In short, it gives the reasons for a decision after it has been made. Techniques such as SHAP and LIME can be used to analyse these models to provide insights into the contribution and importance of features to an accurate prediction.

Different monitoring techniques

Simple models

This article discusses several techniques for predictive monitoring of business processes. These methods are used to build models that predict near/future events in business processes. They can be used, for example, to predict the time remaining or to identify the next step in a process. These 4 methods have one thing in common: their ability to be transparent and easily explained. They rely on historical data, statistics, and mathematical principles to make their predictions.

The tree-based method: This technique uses tree structures to model decision-making. It predicts the outcome of a process based on a series of criteria. This model is very popular, as it makes it easy to understand how a decision was made by following the path from root to leaf. Tools such as random forests, which are a set of small decision trees put together, or XGBoost help to make better predictions. XGBoost is a technique that takes a dataset and builds a model prediction while learning from the mistakes that have been made at each stage. It starts with a simple model and corrects it as soon as it notices that a mistake has been made. By repeating this process many times, it creates a very accurate final model.
On the other hand, we find *probabilistic- based techniques*. This system uses a large amount of data to estimate the next step in a process. It offers a prediction based on probabilities calculated from previous sequences. To better understand this, we can take the example of a chess game, where we can predict the next move in a chess game by knowing the most probable moves. This method shows how each characteristic affects the prediction, enabling us to visualize the relationship between the different characteristics. In the case of a business process, for example, it can predict whether the objective will be achieved within the allotted time.
The regression method also uses a mathematical relationship between the input variables and the desired prediction to directly explain how each variable will impact on the prediction. This method makes it easy to understand the contribution of each factor, whether the model is made up of simple or complex variables.
There's also *the rule-based method*. In this technique, specific rules are created to aid decision-making. Each rule represents a logical condition which, if fulfilled, will lead to a specific conclusion. This method is very transparent about its conditions, making it easy to validate and adjust the model.

Complex models

The *neural network model* used in PBPM enables us to build highly accurate predictive models. The technique is inspired by the workings of the human brain. The model can be broken down into several variants. In contrast to other models, which deal with linear data, it can handle highly complex temporal sequences. This model is often used for classification, predictive processing, and pattern recognition. On the one hand, recurrent neural networks (RNN), and on the other, neural networks with long short-term memory. These can process time sequences and predict results for business processes.

Interpretability of results

Once these models have been created and applied, there are several different explanatory techniques. On the one hand, those specific to a model are created to work with a certain type of machine learning, to best exploit its internal structure to provide explanations. This method allows you to see exactly how the model has evolved through its structure or rules. On the other hand, so-called agnostic methods are suitable for any type of model, and require no knowledge of its internal workings, thus allowing flexibility for different models. So, if the user decides to apply several models, or if he or she wants the explanation method not to focus solely on one type of model, it is preferable to use an agnostic method. These methods do not replace the techniques of trees, probabilities etc., but complement them.
For post-hoc explanations, we distinguish between certain "special" techniques for explaining model decisions. On the one hand, visualization methods can be used to represent how the data supplied to the model will influence the decisions made by that same model. For example, during image recognition, which parts had the greatest influence on the results obtained. On the other hand, overgeneralized models explain how a complex model works, thanks to their simplicity.

Perspectives

The article argues that it is preferable to move towards approaches based on deep learning, since they offer superior predictive qualities despite the many challenges of explicability they present. According to the author, future research should focus on striking a balance between explicability and prediction quality. This would enable accessibility for all end-users without the need for in-depth technical expertise.