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A Semantic Rule-Based Approach Supported by Process Mining for Personalised Adaptive Learning

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Abstract

Currently, automated learning systems are widely used for educational and training purposes within various organisations including, schools, universities and further education centres. There has been a big gap between the extraction of useful patterns from data sources to knowledge, as it is crucial that data is made valid, novel, potentially useful and understandable. To meet the needs of intended users, there is requirement for learning systems to embody technologies that support learners in achieving their learning goals and this process don't happen automatically. This paper propose a novel approach for automated learning that is capable of detecting changing trends in learning behaviours and abilities through the use of process mining techniques. The goal is to discover user interaction patterns within learning processes, and respond by making decisions based on adaptive rules centred on captured user profiles. The approach applies semantic annotation of activity logs within the learning process in order to discover patterns automatically by means of semantic reasoning. Therefore, our proposed approach is grounded on Semantic Modelling and Process Mining techniques. To this end, it is possible to apply effective reasoning methods to make inferences over a Learning Process Knowledge-Base that leads to automated discovery of learning patterns or behaviour.

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1. Introduction

Privation of conformance and suitability of automated learning contents is having an increasingly debilitating impact on learning, which has a strong influence on expected learning outcomes [1]. Studies have shown that challenges in current information-rich world is not only to make information available for learners at any time or in any form, but should essentially offer the right content to the right user and in the right format [2, 3]. This is necessary to provide continuous intelligent recommendation of leaning patterns and feedback on learner's performance. The conceptual knowledge of monitored learning behaviour can be semantically annotated to adaptively suggest appropriate future learning paths, using user's profile information to improve the learning progression [4]. Events within a process can be related to exactly one case and assigned a case identifier [5] which results in automatic creation of workflow processes achieved by using a semantic annotation scheme to represent the event logs about the user.

In this paper, process mining is used to discover sets of recurrent behaviours that can be found within a learning process. As a result, suitable learning patterns are determined by means of semantic reasoning which can then be used to address the problem of adapting learning to the captured user profiles.

The rest of the paper is structured as follows; in Section 2, appropriate related work is analysed and discussed. Section 3, presents our proposed learning model to express user profiles as well as the representation of learning components. In addition, we discuss the generation of the learning process model and how we semantically annotate the process model describing in detail its ontological representation and reasoning using Ontology Web languages. Section 4 shows our approach to automated discovery of learning behaviours from the analysis of event logs and Actions. The prototype implementation and preliminary outcomes are discussed in Section 5. Finally, Section 6 concludes the paper and points out directions for future research.

2. Related Work

In recent years, several researches have been focused on applying process mining technologies to different aspects of business processes. Most of the developed systems use process mining techniques only for representation of business concepts, knowledge or data [5]. In our approach, we utilize process mining techniques to represent learning processes. Our focus is to further enhance this area of research by not only adapting the process mining tools but also present a way to relate semantic-based reasoning for adaptation within the learning process. Given a set of actions from event log of a learning process, our proposed approach automatically constructs process models capable of describing and enhancing observed behaviours.

Fahland and Van der Aalst [6] note that it is difficult to learn useful models from event logs following the characteristics of real-life events. However, process mining has been proved as one of the existing technologies that typically aim to extract non-trivial and useful information from event logs [3, 5]. Although, past study in these area argue that heuristic mining, genetic mining, and fuzzy mining [7] provide case-hardened process discovery techniques capable of constructing intuitive simple models to explain the most likely or common behaviours.

Process discovery, which lately has been seen as the most important and most visible intellectual challenge related to process mining aims to automatically construct a process model e.g., a Petri net or a BPMN model [5] and describes causal dependencies between activities [6]. In principle one could use process discovery to obtain a model that describes reality. The second type of process mining is conformance checking where, an existing process model is compared with an event log of the same process to check if in reality it conforms to the resulting model [8, 9]. Conformance check could imply that the model does not describe the executed process as observed in reality or is being executed in a different order. It could also mean that activities in the model are skipped in the log or that the log contains events not described by the model. Given this drawback, the last type of process mining; model enhancement

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