Data Requirements for Process Learning

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ABSTRACT

Process flexibility and adaptability is essential in environments where the processes are prompt to changes and variations. Process learning is a possible approach for automatically discovering from process log data those process paths that yielded good outcomes and suggesting appropriate process model modifications to enhance future process performance in such environments. The authors discuss and establish the data requirements for process learning, applicable to clinical process management. Their discussion extends a previously established learning process model (LPM) by providing a formal set of data requirements which enables the authors to accomplish effective learning. Learning data requirements are illustrated by walking through the application of the LPM framework to a clinical process.

Keywords: Context, Learning Requirements, Outcomes, Path, Process Learning, Soft-Goals

INTRODUCTION

Modern medicine, in its tendency towards evidence-based formalization of clinical knowledge and procedures, uses clinical guidelines in order to standardize health-care processes and use the most updated evidence based clinical knowledge. Many illnesses still have no guidelines at all, and whenever guidelines exist, for practical reasons, they do not refer to all possible patient case variations (e.g., the patient’s clinical condition, past diagnoses, current medications, etc.) – just the most frequent and important ones. Since guidelines address a limited set of patient groups, it is possible that process support is not optimized for some variants that are not addressed. Our research concerns identification of important groups of patient cases and recommendation of the best process paths for them that would yield best outcomes.

In a previous work we have established the fundamentals for a process learning framework, the Learning Process Model (LPM) (Ghattas, Soffer, & Peleg, 2008, 2010; Ghattas, Peleg, Soffer, & Denekamp, 2010). A major component of LPM addresses context learning (Ghattas, Soffer, & Peleg, 2008, 2010; Ghattas, Peleg, Soffer, & Denekamp, 2010). Context refers to the set of inputs provided by the environment

DOI: 10.4018/ijkbo.2013010101

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to the process (e.g., the patient’s initial conditions, sudden changes to the patient’s state). Particularly, we have developed a lifecycle approach to process learning from historical experience, based upon the premise that it is possible to group the variations in the execution of patient cases into groups – which we refer to as context groups. Each context group should be homogenous in the outcomes achieved for a clinical process execution. We demonstrated (Ghattas, Peleg, Soffer, & Denekamp, 2010) how through grouping process instances into context groups, we can predict for each context group a process path resulting in good outcomes. This prediction would lead the execution of similar process instances to the best known outcomes. Repeating this learning cycle, we should obtain a better specified process model, with improved performance for each context group.

As our approach is based on learning from past experience, we need to establish the data requirements for the process learning to be effective. These data requirements need to provide a methodic way for answering the following questions: When should data be collected? How should it be formatted and coded? What should be the frequency of data collection? How do we rank each data item’s importance for each context? Finally, given a case study, how can we evaluate a priori the feasibility of the required learning task?

In this paper, we provide insights to these questions by extending the LPM framework through the establishment of process learning data requirements.

The paper is structured as follows. We start by briefly describing the LPM framework. Next, we use the clinical urinary tract infection (UTI) disease management process to walk through LPM data requirements for the different components of the model. Later on, we discuss feasibility assessment of a specific learning task. Next, we review the literature and compare our model requirements to previous works. We conclude by summarizing the results of our research and presenting possible future lines of research.

THE LEARNING PROCESS MODEL (LPM)

Let us consider a clinical process; while diagnosing a patient, the clinical expert needs to consider the available data about the patient, including his current state, medical history, and any inputs that may be important for making decisions throughout the clinical process, including diagnosis and treatment.

The data required for the clinical expert to accomplish this task is provided in two different time periods: (a) initially available data from the patient records and from the initial examination of the patient; (b) data generated by external events during process execution, such as sudden changes in the state of the patient. External events, which are out of the clinical team’s control, may provide additional inputs, which may require some change to the patient treatment decided up to that moment. Together, the initial inputs and the external events data determine the overall path to be adopted and constitute what we call the process context.

We assume that patients who have similar values of contextual data (i.e., belong to the same context group) should go through similar treatment paths, and in principal would be expected to reach similar outcomes. In contrast, patients with different values of contextual data may be treated similarly but the treatment would not necessarily attain the same outcomes. There might be a certain grade of variation between different executions in a context group. When different process paths are followed they might lead to different levels of performance. We may learn from historical executions the different possible paths, and adopt for each context group the path that potentially provides the best outcomes for that group.

Based on this intuitive discussion, a generic LPM would basically include three major steps, schematized in Figure 1: (1) Context learning stage, whose objective is to identify ranges of contextual data items that would predict the outcomes of an applied process path; (2) Path learning stage: Once we identify the context groups, we learn the different variations of the
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