

Chapter 3.18

Sequential Patterns

Postprocessing for Structural Relation Patterns Mining

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ABSTRACT

Sequential patterns mining is an important data-mining technique used to identify frequently observed sequential occurrence of items across ordered transactions over time. It has been extensively studied in the literature, and there exists a diversity of algorithms. However, more complex structural patterns are often hidden behind sequences. This article begins with the introduction of a model for the representation of sequential patterns—Sequential Patterns Graph—which motivates the search for new structural relation

patterns. An integrative framework for the discovery of these patterns—Postsequential Patterns Mining—is then described which underpins the postprocessing of sequential patterns. A corresponding data-mining method based on sequential patterns postprocessing is proposed and shown to be effective in the search for concurrent patterns. From experiments conducted on three component algorithms, it is demonstrated that sequential patterns-based concurrent patterns mining provides an efficient method for structural knowledge discovery.

INTRODUCTION

Sequential patterns mining is an important data-mining and pattern-discovery technique that aims to find the relationships between occurrences of sequential events and to find if there are any specific orders within these occurrences. It has been extensively studied and several methods have been proposed (Agrawal & Srikant, 1995; Pei, Han, Mortazavi-Asl, & Pinto, 2001; Zaki 2001). However, there are still some challenges within the conventional framework: most methods mine the complete set of sequential patterns and, in many cases, a large set of sequential patterns is not intuitive and not necessarily very easy to understand or use. Also, questions that are usually asked with respect to sequential patterns mining are: What is the inherent relation among sequential patterns? Is there a general representation of sequential patterns? Are there any other novel patterns that can be discovered based on sequential patterns?

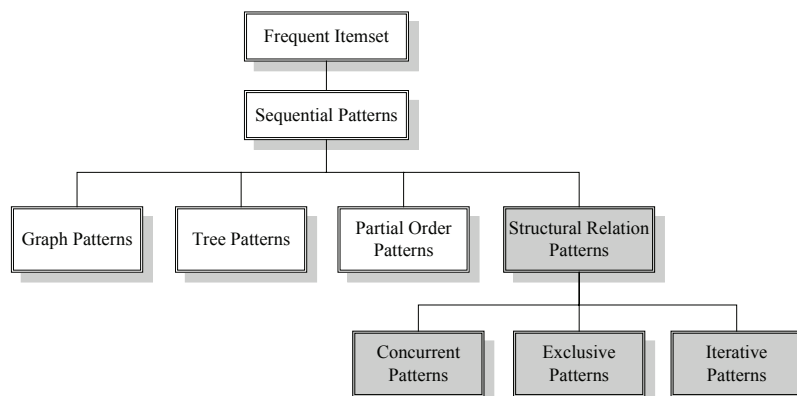
These questions pointed out some obstacles within conventional sequential patterns mining methods and indicated further research directions associated with sequential patterns mining that has inspired this work. Since each sequence can be viewed as a partial order of a subset of events, any partial order can be represented by a directed

acyclic graph (Mannila & Meek, 2000). It is then possible to describe a set of sequential patterns using a graphical model called Sequential Patterns Graph, or SPG (Lu, Adjei, Chen, & Liu, 2004; Lu, Adjei, Wang, & Hussain, 2004). SPG acts as a bridge between a discrete sequences set and a unified graphical structure. It is not only a minimal representation of sequential patterns mining results, but it also represents the potential interrelation among patterns such as *concurrent*, *exclusive* or *iterative* patterns. The framework for mining these new *structural relation patterns* has been called Postsequential Patterns Mining or PSPM (Lu, Wang, Adjei, & Hussain, 2004).

Figure 1 shows the levels of patterns ranging from a simple frequent itemset (Agrawal, Imielinski, & Swami, 1993), to sequential patterns (Agrawal & Srikant, 1995), to complex structures like graph patterns (Ivancsy & Vajk, 2005), tree patterns (Zaki 2002), partial order patterns (Mannila & Meek, 2000), and the proposed structural relation patterns. The shaded parts in the figure indicate the areas of new work in this article and elsewhere (Lu, Wang, et al., 2004; Lu 2006).

The objectives of the research, which has been undertaken (Lu, 2006), are as follows:

Figure 1. From frequent itemset to structural relation patterns



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