

HOSPITAL MANAGEMENT BASED ON SEMANTIC PROCESS MINING: A SYSTEMATIC REVIEW

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ABSTRACT

Introduction:

Semantic Process Mining is the extension field of process mining that is based on getting knowledge of conceptual event logs (based on ontologies) for analyzing frequent and rare processes. In the healthcare studies, semantic process mining has been used in different hospitals in order to improve processes.

Material and Methods:

A review of the usages of semantic process mining in hospitals is done. This review contains 65 articles from PubMed, dblp and Google scholar. It is searched from 2000 to 2017. One of them was duplicated and finally, we received 64 articles. Data were extracted according to PRISMA guidelines.

Results:

Out of 64 articles, 6 of them were related with inclusion and exclusion criteria. Most of them detect business process mining. In 80% of studies, the semantic process mining was useful and effective to improve hospital processes and improve its management.

Conclusion:

This review can show an overview the application of process mining in hospitals. It can help researchers to compare semantic process mining with other methods for improving processes in hospitals and finally, it shows the use of semantic process mining to enhance hospitals processes.

Keywords:

Process Mining, Semantic, Healthcare, Hospital, Ontology

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INTRODUCTION

The quality of hospitals depends on the true and well-organized processes. Hospital processes are a good work that is expected to analyze any maladies for improving a patient's wellbeing [1, 2]. It is clear that hospital processes are really complex multidisciplinary and many researchers are interested in analyzing and improving these processes. Enhanced hospital processes might have a high influence in the quality of patients' lives. However, improving these processes is a big trouble task and many challenges - usually present. There are dependably the needs to decrease the expenses of hospital processes, increase the abilities to take care of the demands, omitting patient's waiting times, and increment forms straightforwardness [3, 4].

Before, various procedures have been used to analyze the different processes in hospitals, like Business Process Redesign [5], Evidence Based Medicine [6], and Lean [7].- This review concentrates on using semantic web like ontologies that extracts false processes and tries enhance them, known as Semantic Process Mining [8].

Making a Value Stream Mapping of the hospital network is a hard job, because there are a lot of numbers and complexity in diseases. Semantic process mining by using ontology tries to overcome this issue. A structured knowledge by using ontology means the explanation of the logic behind the health services and different processes in hospitals [9-11].

Process mining is used in healthcare data for identification the processes and the meaningful

relationships between different activities and resources in complex processes. On the other hand, the ontology used in semantic process mining has two useful goals: first, modeling the entities and relationships in hospital network, and second, making the controlled vocabulary for merging different data in heterogeneous sources [10, 12-14].

Semantic process mining wants to bring the usual process mining methods from the level of label-based to the conceptual-based analysis. As we know, log is the starting part of mining algorithms and some methods can use a model as an input. Actually, the key idea in semantic process mining is to annotate different elements explicitly in a log with the concepts that are shown. It can be reached by connecting the elements to concepts in ontologies [3, 15].

Fig 1 shows a summary of the usage of semantic process mining. It also shows the information sources for semantic process mining [16].

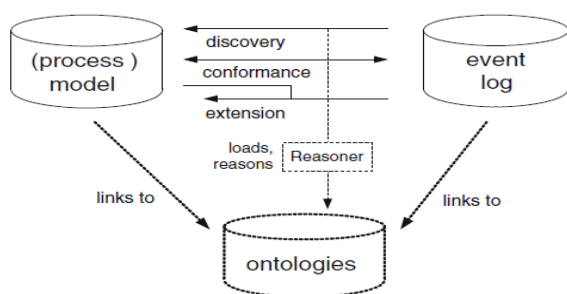


Fig 1: Semantic process mining in healthcare [16]

In other words, semantic process mining can empower process mining methods. Finally, using semantic information in event logs shows the process mining methods from the label-based to the concept-based. This feature allows to work with different levels of abstractions while getting feedback about processes and their properties in a special log [17-19]. Besides, it supports less demanding reuse of asking description over logs [17].

This study tries to identify and characterize the articles that semantic process mining has been used in the healthcare domain specially in hospitals, it also help researchers to follow the best path when they are using semantic process mining methods; and highlight some of the positive points of using this technique.

MATERIAL AND METHOD

Background and objectives

Regarding semantic process mining in healthcare, there is only a literature review and systematized literature review devoted to process mining [3]. However, there is no comprehensive study that gather, shows articles that semantic process mining has been used in the healthcare domain and hospitals.

This review has two main objectives:

First, identifying and describing existing articles that semantic process mining has been used to hospitals. Second, making a characterization of existing articles, like the description of the most applicable aspects, such as methods.

None of these objectives has been investigated in the previous papers, making this review an important goal to understanding the context of this domain and improving the future application of semantic process mining methods in hospitals.

Search process

The method used for this search was conducted in one stage. Fig 2 shows the ways implemented for the search in PRISMA. This stage covered the search for papers in PubMed, dblp and Google Scholar, using a combination of the keywords “process mining” or “semantic process mining”, “hospital” and “healthcare” and “ontology”. These keywords were used to make the highest amount of studies where semantic process mining has been used in hospitals. The search was done by the two authors, independently.

The inclusion characteristics are: all identified articles that include semantic process mining methods have been used in the hospital domain, all articles published until January 1, 2017 and publications in English were used [10, 20-25].

The exclusion characteristics are: articles that do not include a semantic process mining in healthcare were excluded and articles with only process mining were excluded. Finally, to support the quality of the search process a series of activities were done. The first extraction, analysis and evaluation of the articles from the web searches were done by the two authors. Any disagreements with the inclusion and exclusion of a study and data analysis were resolved through discussion.

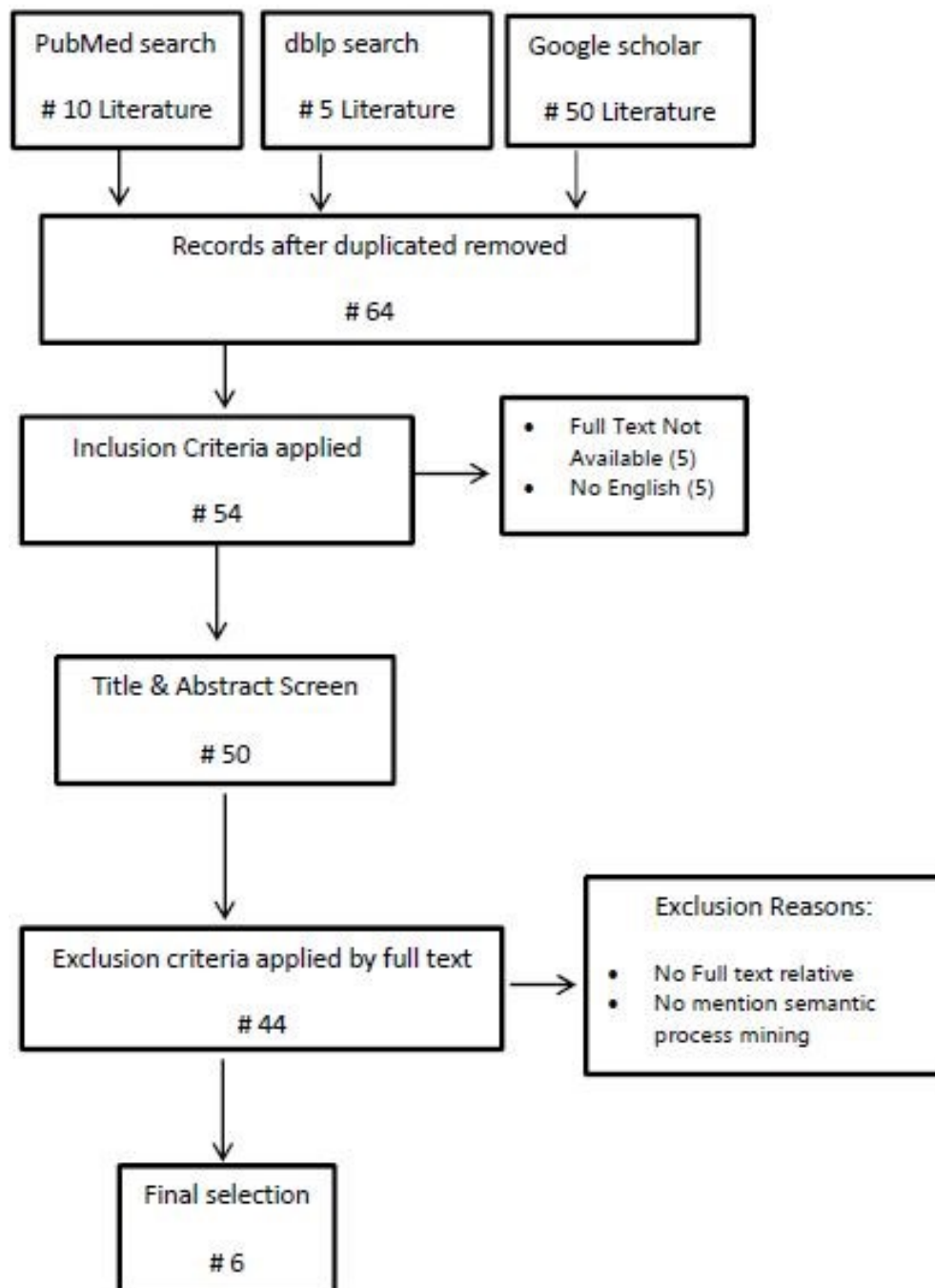


Fig 2: PRISMA Flowchart of included and excluded Studies

RESULTS

By analyzing the literatures showing the using of semantic process mining in hospitals, a content study

was done. This study characterized and classified the relevant aspects found on the articles. Table 1 shows a general view and a summary of only the most crucial characteristics of these aspects. The titles are shown as bellow.

Table 1: general view and a summary of related articles

Authors	Title	Ref.
Antonelli et al.	Application of Process Mining and Semantic Structuring Towards a Lean Healthcare Network	[22]
Detro et al.	Enhancing semantic interoperability in healthcare using semantic process mining	[23]
Dewandono et al.	Ontology and process mining for diabetic medical treatment sequencing	[24]
Grando et al.	Semantic Process Mining for the Verification of Medical Recommendations	[10]
Montani et al.	Knowledge-Based Trace Abstraction for Semantic Process Mining	[25]
KarlBaker et al.	Process mining routinely collected electronic health records to define real-life clinical pathways during chemotherapy	[26]

The classifications according to the tools and methods are shown in following sections.

Semantic process mining and ontology tools

There are groups of software that can use process mining methods to be used to an event log to make different models for analysis.

In healthcare, ProM (Process Mining tool) is the most common tool, which is an open source tool for process mining. ProM is a framework that supports a variety of process mining techniques in the form of plug-ins. It is implemented in Java, and can be downloaded freely [27, 28].

Additional tools can use in these studies like, Disco with a friendly interface for process mining. The improvement in process mining technology in Disco helps to make fantastic visual maps from process data in a short time [29].

Semantic process mining methods

Semantic technologies has gained an important interest with process mining [30, 31]. The advance is Semantic Process Mining which is being adopted and used as a tool for enhancement of processes, derived from logs created through old process mining.

Several mining algorithms has also been developed which practically have been shown to be practical in process analysis [17, 32]. To this effect, useful information about the connections of activities in a process environment has been made possible, and necessary for extracting models capable of making new knowledge. Process mining method can apply for mining of processes in events log sequences [17]. Existing Process mining methods depend on tags in event logs information, and therefore, to a certain extent are limited. It means that these methods do not gain from the real knowledge (semantics) that describe these tags. The challenge will pave way for Semantic Process Mining which takes the benefits of the semantics explained in event data of a process, and links them to concepts in ontology to extract applicable models by means of Semantic Reasoning. Semantic reasoning is supported due to the formal meaning of ontological idea and expression of

relationships that is between event logs of a process.

The technique uses the semantics of the sets of activities within a learning process to make rules and events relating to task, to discover automatically and improve the process model ontology in the information knowledge base through semantic annotation of the elements. One of the key usage provided by semantic process mining is the ability of explaining the semantics behind the tags in event logs for discovery of new knowledge. Semantic process mining is a new area in the field of process mining and there are few existing applications that shows the capabilities of this method [33].

DISCUSSION

According to this review, discussion has two different approaches: first, characterizing the aspect most useful in the studies like tools, medical field and results; and second, identifying the most important method for mining processes in hospitals.

More than 70% of the related articles for using semantic process mining in hospital management are after 2015. So it shows the effectiveness of semantic process mining method and its importance in these days.

ProM is the most common tool that is used in the semantic process mining and the most useful results are the positive point of ontology in process mining. In most of articles, ProM is called the best one for process mining [3, 34].

The process mining method is one of the important and useful among other methods that enable the processes analysis behavior for discovering, conformance checking and enhancing [35, 36]. However, the process mining approaches try to analyze the process based on the event log label strings, without considering the semantics behind the label. A semantic approach on the event logs could overcome this main problem and could enable the reuse and sharing of the knowledge [26, 30, 35, 36].

The key concept of semantic process mining is to annotate the log with the concept in ontology; this action will let the inference engine derive the new knowledge [10].

The use of the semantics and the processes together can help to exchange process knowledge between the applications in the best and true way. Ontologies are used to capture, show, use and exchange knowledge. The best definition for ontology was that it is an explicit characterization of a conceptualization, and is a description of the different ideas and connections in this domain [10, 11, 17].

The ontology is built, to share usual understanding of the information structure among software agents or people. The ontology can use to separate domain knowledge from the operational, to reuse and analyze domain knowledge to make assumptions about a domain explicit.

The future challenges in terms of semantic process mining in hospitals show its importance. One of the negative aspects of current process mining is the absence of the semantic part in process models and the results obtained, especially in complex and less-structured processes, such as those found in the hospitals.

CONCLUSIONS

The application of semantic process mining in hospitals with the goal of healthcare allows health providers to get the real execution of processes: discovering, checking conformance with guidelines or experts, and improvement. This article provides a review about the main approaches used to apply semantic process mining in hospitals. It includes the summary of related articles. Future challenges and trends have also been explained. The goal of this review is to serve as a reference for using semantic process mining for improving process in hospitals.

AUTHOR'S CONTRIBUTION

All the authors approved the final version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

FINANCIAL DISCLOSURE

No financial interests related to the material of this manuscript have been declared.

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