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A Comprehensive Review on Intents, Intention Mining and Intention Classification

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Abstract: ***The aim of this work is to conduct a literature review about Intents, Intention Mining and Intent Classification. Now a days, Intention Mining is widely used in the Information Systems Engineering field. This paper mainly focuses and discusses on the literature review algorithms, models and tools used in Intention Mining. We hope that this information will be useful for developing models to retrieve intentions from the traces of activities and developing various intention mining techniques, which will allow identifying the gaps between the prescribed processes and the actual processes of a business.***

Keywords: Intent, Intentions, Intention Mining, Intent Classifications, Intent Mining Algorithms, process models, Process Mining, BERT, Map Miner Method (MMM), event logs, Hidden Markov Models

1. Introduction

In today's digital world, we can't really think of much without the concept of 'mining'. It plays a very crucial role in computer sciences and it is the pillar of technological development.

Mining is the process of extracting patterns in large data sets involving methods at the intersection of Statistics, Machine Learning and Database Systems. It is an interdisciplinary subfield of computer sciences and statistics. The overall goal is to extract information from large datasets with the help of some intelligent methods and transform the information into a comprehensible structure for further use. Broadly, the mining concept is classified as Data Mining and Process Mining. When we read about these mining types, we come across many terms like Sentiment Analysis, Opinion Mining, Emotion Classification, Intention Mining etc.

This paper mainly focuses on the concept called as Intention Mining or Intent mining. The idea of Intention Mining has been introduced in the Ph.D. thesis of Dr. Ghazaleh Khodabandelou in 2014.

What are Intents?

Let's take one example to showcase the word 'Intent'.

E.g. Consider following statement:
"I want to visit the wonderful Ajanta Ellora Caves."

The sentiment classification focuses on positive feeling (adjective- "wonderful")

The intention classification puts a stress on the author's intended future action or goal i.e. going to visit the specified place.

So, nowadays, not only the sentiments, but intents behind the sentiments are being used in Data Mining. Intention Mining has grabbed lots of attention by recent researchers.

The main goal of this review paper is to discuss the work done by Dr. Ghazaleh Khodabandelou in the field of Intention Mining.

Rest of the paper is organized as follows, Section II contains the related work carried out in the area of Intention Mining by Dr. Ghazaleh Khodabandelou and Section III discusses about how all other researchers are contributing to this field. Finally, section IV concludes the paper.

2. Literature Survey

The notion of 'Intention Mining' has been presented in the Ph.D. thesis of Dr. Ghazaleh Khodabandelou in the year 2014. She has received the Ph.D. degree in the field of Artificial Intelligence from 'The University of Paris 1 Pantheon-Sorbonne' located in Paris, in which she introduced the Intention Mining concept.

Her thesis is about a novel approach of process mining, called Map Miner Method (MMM). This method is designed to automate the construction of intentional process models from traces. MMM uses Hidden Markov Models to model the relationship between users' activities and the strategies (i.e., the different ways to fulfill the intentions). The method also includes some specific algorithms developed to infer users' intentions and construct intentional process model (Map) respectively. MMM models the intentions as an oriented graph (with different levels of granularity) in order to have a better understanding of the human way of thinking.

Intention Mining:

Following section gives a systematic review about the work done by Dr. Ghazaleh Khodabandelou, in order to contribute the new concept called as 'Intention Mining'.

1) Supervised Intentional Process Models Discovery using Hidden Markov Models [1]

Since several decades, discovering process models is a subject of interest in the Information System (IS) community.

Approaches have been proposed to recover process models, based on the recorded sequential tasks (traces) done by IS's actors. However, these approaches only focused on activities and the process models identified are, in consequence, activity-oriented. Intentional process models focus on the intentions underlying activities rather than activities, in order to offer a better guidance through the processes. Unfortunately, the existing process-mining approaches do not take into account the hidden aspect of the intentions behind the recorded user activities. Authors thought that they could discover the intentional process models underlying user activities by using *Intention mining* techniques. The aim of this paper is to propose the use of probabilistic models to evaluate the most likely intentions behind traces of activities, namely Hidden Markov Models (HMMs). They focused on this paper on a supervised approach that allows discovering the intentions behind the user activities traces and to compare them to the prescribed intentional process model.

While process mining methods help to recover the sequences of activities and to extract information from those sequences, they overlook the hidden intentions that generate them.

However, discovering intentional process model from event logs is part of a whole new field of researches, which they called Intention Mining. As a matter of fact, if we know why an actor is performing some activities, we can have a better handling of what he/she may want to do on his next step and offer him/her better recommendations.

Methodologies used:
To rebuild the process model and evaluate the intentions, Hidden Markov Models (HMMs) are used

2) Process Mining Versus Intention Mining[2]
This paper discusses about process mining versus Intention Mining. Process mining aims to discover, enhance or check the conformance of activity oriented process models from event logs. A new field of research, called intention mining, recently emerged. This new field has the same objectives than process mining but specifically addresses intentional process models. This paper aims to highlight the differences between these two fields of re-search and illustrates the use of mining techniques on a dataset of event logs, to discover an activity process model as well as an intentional process model.

In this paper, some of the Process Mining algorithms were discussed like RNet, Ktail, Markov, α-algorithm, Hierarchical clustering, Genetic algorithm, Heuristic algorithm and Petrify algorithm.

In order to retrieve the intentions from the traces of actors' activities and due to the variability of traces in terms of length and nature, they proposed some algorithms based on probabilistic and statistical techniques. The probabilistic models provide the information about the nature of data (i.e. if the observed data is a harvest of hazard or an intended result). Moreover, they model the data taking into account their temporal aspect. Since the observed side of data could hide the latent one, the probabilistic models can also formalize this concealed side and extract the characteristics of both observed and latent data. Hidden Markov Models (HMMs) seems promising to mine intentions. They described some algorithms used in HMMs which help mining intentions: Viterbi Algorithm and Baume-Welch Algorithm.

3) Cots Products To Trace Method Enactment: Review and Selection [3]
This paper presented a review of trace-based tools that was undertaken to address the issue of recording information systems engineering methods enactment. Observing information systems projects shows that Information Systems Engineering (ISE) methods are underused. The Agile Method Framework (AMF) project, used in this paper, aims at (a) tracing stakeholders' activities to identify whether this statement is true and (b) proposing more efficient ISE methods. To trace stakeholders' activities, authors used a tool able to record any computerized actions - as opening applications, modifying documents, compiling programs, etc.

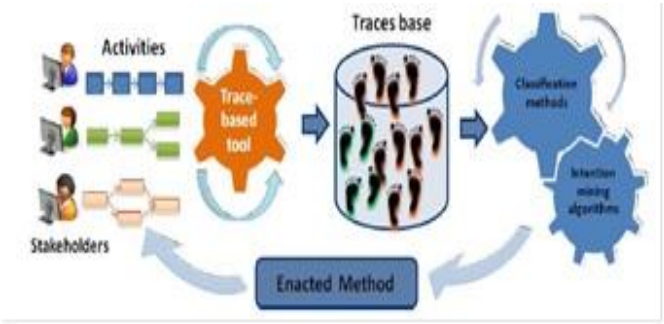

Figure 1: Representation of Agile Method Framework approach

Figure 1 shows the AMF approach used in this paper. As shown in the figure, trace-based tools allow recording the traces of ISE project activities of different stakeholders in a traces base. By applying intention mining algorithms and classification methods on these traces, authors discovered the real methods used in a given project.

4) Unsupervised discovery of intentional process models from event logs [4]
Mining software engineering processes from logs can be useful for understanding how people really work, analyzing how actual software engineering processes differ from the prescribed ones, and thereby improve software engineering methods and products.

As shown in the figure 2, this paper has presented the Map Miner Method (MMM). It is a method for automating the construction of an intentional process model from users' activities logs. To do so, MMM uses Hidden Markov Models to model users' activities logs in terms of users' strategies.

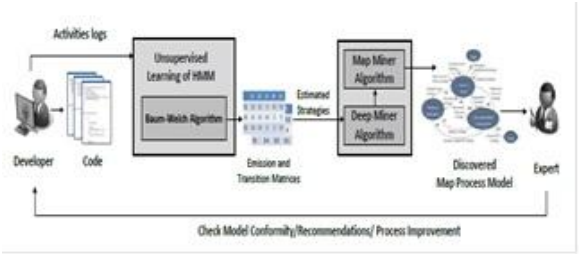

Figure 2: An Overview of the Map Miner Method

The contribution made in this paper is triple:

a) First, modeling the users' activities logs in terms of strategies using Hidden Markov Models (HMMs).
b) Second, using estimated strategies and Map formalism, authors developed Deep Miner and Map Miner algorithms to generate respectively, fine-grained and coarse-grained Map process model.
c) Finally, the entire proposed approach is applied on two practical datasets; first in a laboratory context, second in a large-scale case study by mining the Eclipse UDC (Usage Data Collector) developers' logs.

The resulting Maps provided a precious understanding of the processes followed by the students and the developers, and some feedback on the effectiveness and scalability of MMM.

5) A Novel Approach for Process Mining : Intentional Process Models Discovery [5]

This paper has presented a novel approach of process mining, called the Map Miner Method (MMM). The main contribution of this work is to build from theory a method, which fully constructs the topology of an intentional process model (Map), only based on users' activity logs. Whereas process mining techniques focus how a process is enacted, MMM focuses on why a process is enacted and what a process must do. MMM helps understanding the users' intentions and strategies while enacting processes. This allows discovering actual process models and checking the conformance of the models. MMM requires only users' traces of activities (event logs) as inputs. This makes the method easily applicable to any dataset.

6) Supervised vs. Unsupervised Learning for Intentional Process Model Discovery[6]

This paper compares the supervised and unsupervised learning approaches, in both theoretical and practical contexts, to understand which approach allows discovering underlying users' strategies optimally.

For this purpose, Hidden Markov Models (HMMs) are used to build intentional process models (Maps) from activity logs. Figure 3 depicts an overview of MMM framework, in which the focus of this paper is shown in the part of estimating users' strategies

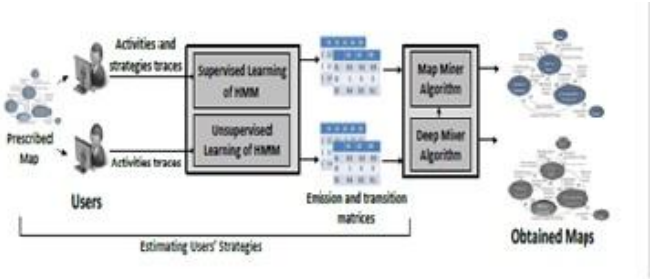

Figure 3: Supervised and unsupervised learning approaches of HMMs

Authors concluded that, the results demonstrated using supervised learning leads to a poor performance because it imposes binding conditions in terms of data labeling, introduces inherent humans' biases, provides unreliable results in the absence of ground truth, etc.

Instead, unsupervised learning obtains efficient Maps with a higher performance and lower humans' effort. Therefore unsupervised learning offers better results than supervised learning to discover intentional process models (Maps).

7) Intentional Process Mining: Discovering and Modeling the Goals Behind Processes using Supervised Learning[7]

This paper presented the Supervised Map Miner Method; an intentional process mining method that uses supervised learning and Hidden Markov Models to generate intentional models specified with the Map formalism.

Intentional process mining might help improving guidance, provide better recommendations, facilitate process modeling and process model quality assessment, identify the gap between prescribed business requirements and goals, help CEOs assess and monitor strategic goal implementation, etc.
This paper makes two contributions:

a) an original intention mining method, called Supervised Map Miner Method, that generates intentional models formalized with the Map meta model from traces of activities, and
b) a validation performed based on two controlled experiments; the validation evaluates the precision, recall and F-score of the results obtained with the Supervised Map Miner Method.

8) Mining Users' Intents from Logs [8]

The work proposed in this paper is a new vision of process mining by focusing on the intentional perspective of processes. This means discovering the actual processes from event logs and modeling them using intentional process model as Map. This method is called Map Miner Method (MMM), which models processes automatically in terms of users' intentions and strategies.

As shown in Figure 4, from a technical point of view, MMM consists of three stages:
(i) Estimating users' strategies
(ii) Deep Miner algorithm
(iii) Map Miner algorithm

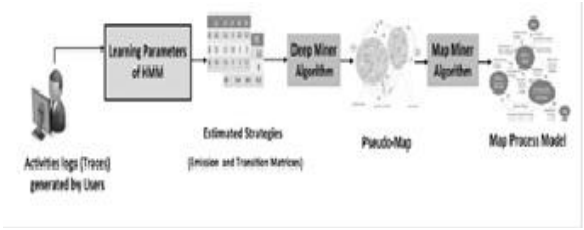

Figure 4: Three stages of Map Miner Method

Intentional process models permit modeling humans' cognition operators, i.e., thinking, reasoning and deciding during creative process, which is not possible with activity-oriented process models. The discovered Map process model answers to the problems of why a process is enacted. The proposed method finds the relationships between activities to discover the strategies and where they lead, i.e. the intentions. MMM is appropriate for recorded users' logs performing a process from the beginning to the end. In logs, activities should at least contain timestamp and the users' ID. It is also important to have a sufficiently large number of traces in order to capture all the possible behaviors users can have while enacting the process. The names of these strategies and intentions are still inferred manually in the sense that the proposed method is able to extract automatically some topics related to each strategy.

3. Discussions

Intention mining concept is very briefly discussed in section II. Many other authors have extended this concept and used in various applications . In this section, various applications of Intention Mining are given. Most of the work is done which focuses about intent classification or intention classification. Most of the work uses Classifier Models as SVM (support vector machine), MLP (multi-layer perceptron), CNN (convolutional neural Network), BERT (Bidirectional Encoder Representations from Transformers) etc.

Some of the the applications of Intention Mining are to retrieve intentions from traces of activities providing recommendations, identify the gap between a prescribed business requirements and actual information , facilitate process modeling , to monitor the intentions of users etc.

Following Table 1 shows some of the work done in this research area.

Table 1: Uses of Intention Mining in various applications

Sr. No.	Paper Title	Methodology Used	Work done in brief
1	Structural Scaffolds for Citation Intent Classification in Scientific Publications	bidirectional LSTM (Bi-LSTM	Identifying the intent of a citation in scientific papers (e.g., background information, use of methods, comparing results) is critical for machine reading of individual publications and automated analysis of the scientific literature. Authors proposed structural scaffolds, a multitask model to incorporate structural information of scientific papers into citations for effective classification of citation intents. [9]
2	Bi-Lingual Intent Classification of Twitter Posts: A roadmap	Naïve Bayes, and Support Vector Machine	The focus of this study is to develop a roadmap of a model for automatic bilingual intent classification of hate speech.[10]
3	BERT for Joint Intent Classification and Slot Filling	BERT	Intent classification and slot filling are two essential tasks for natural language understanding. They often suffer from small-scale human-labelled training data, resulting in poor generalization capability, especially for rare words. Recently a new language representation model, BERT (Bidirectional Encoder Representations from Transformers), facilitates pre-training deep bidirectional representations on large-scale unlabelled corpora, and has created state-of-the-art models for a wide variety of natural language processing tasks after simple fine-tuning[11]
4	Automating Intention Mining	CNN	Software Developers frequently discuss aspects of the systems they are developing online. The comments they post to discussions form a rich information source about the system. Intention mining, classifies sentences in developer discussions to enable further analysis. [12]
5	Churn Intent Detection in Multilingual Chatbot Conversations and Social Media	CNN and a bidirec-tional Gated Recurrent Unit (BiGRU)	Authors proposed a new method to detect when users express the intent to leave a service, also known as **churn.** While previous work focuses solely on social media, authors showed that this intent can be detected in chatbot conversations. As the only existing dataset is in English, authors published a novel dataset of German tweets. [13]

4. Conclusion

In recent days, intention mining is one of the emerging research fields. A lot of work is needed to develop various efficient algorithms using supervised / unsupervised learning approaches. Also the existing algorithms may be used to classify the intents. We believe that new applications will be found in the near future.

References

[1] Khodabandelou, Ghazaleh & Hug, Charlotte & Deneckère, Rébecca & Salinesi, Camille, "Supervised Intentional Process Models Discovery using Hidden Markov Models" , Proceedings - International Conference on Research Challenges in Information Science. 1-11. 10.1109/RCIS.2013.6577711 , 2013

[2] Khodabandelou, Ghazaleh & Hug, Charlotte & Deneckère, Rébecca & Salinesi, Camille, " Process Mining Versus Intention Mining" , Lecture Notes in Business Information Processing. 147. 466-480. 10.1007/978-3-642-38484-4_33 , 2013

[3] Khodabandelou, Ghazaleh & Hug, Charlotte & Deneckère, Rébecca & Salinesi, Camille & Bajec, Marko & Kornyshova, Elena & Jankovi'c, Marko , "Cots Products To Trace Method Enactment: Review And Selection", ECIS 2013 - Proceedings of the 21st European Conference on Information Systems , 2013
[4] Khodabandelou, Ghazaleh & Hug, Charlotte & Deneckère, Rébecca & Salinesi, Camille, " Unsupervised discovery of intentional process models from event logs", 11th Working Conference on Mining Software Repositories, MSR 2014 - Proceedings. 10.1145/2597073.2597101, 2014
[5] Khodabandelou, Ghazaleh & Hug, Charlotte & Salinesi, Camille , "A Novel Approach for Process Mining : Intentional Process Models Discovery" , Proceedings - International Conference on Research Challenges in Information Science. 1-12. 10.1109/RCIS.2014.6861040 , 2014
[6] Khodabandelou, Ghazaleh & Hug, Charlotte & Deneckère, Rébecca & Salinesi, Camille, " Supervised vs. Unsupervised Learning for Intentional Process Model Discovery" , 10.1007/978-3-662-43745-2_15 , 2014
[7] Deneckère, Rébecca & Hug, Charlotte & Khodabandelou, Ghazaleh & Salinesi, Camille , " Intentional Process Mining: Discovering and Modeling the Goals Behind Processes using Supervised Learning" , International Journal of Information System Modeling and Design. 5. 10.4018/ijismd.2014100102 , 2014
[8] Khodabandelou, Ghazaleh & Hug, Charlotte & Salinesi, Camille , "Mining Users' Intents from Logs" , International Journal of Information System Modeling and Design. 6. 43-71. 10.4018/IJISMD.2015040102 , 2015
[9] Cohan, Arman & Ammar, Waleed & Zuylen, Madeleine & Cady, Field , " Structural Scaffolds for Citation Intent Classification in Scientific Publications" , 3586-3596. 10.18653/v1/N19-1361 , 2019
[10] Adekotujo, Akinlolu & Lee, JooYoung & Enikuomehin, Ayokunle & Mazzara, Manuel & Aribisala, Benjamin ," Bi-lingual Intent Classification of Twitter Posts: A Roadmap" , 10.1007/978-3-030-14687-0_1 , 2020
[11] Chen, Qian & Zhuo, Zhu & Wang, Wen ," BERT for Joint Intent Classification and Slot Filling " , 2019
[12] Huang, Qiao & Xia, Xin & Lo, David & Murphy, Gail, " Automating Intention Mining" , IEEE Transactions on Software Engineering. PP. 1-1. 10.1109/TSE.2018.2876340 , 2018
[13] Abbet, Christian & M'hamdi, Meryem & Giannakopoulos, Athanasios & West, Robert & Hossmann, Andreea & Baeriswyl, Michael & Musat, Claudiu , "Churn Intent Detection in Multilingual Chatbot Conversations and Social Media" , 2018

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