Formalization of Business Rules in Decision Making Process

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I. EXTENDED ABSTRACT

This paper is focused on decision making process, used by complex event platforms (CEP), for processing of high frequency data. By the notion of high frequency data we understand data from multiple sources that occur in very short time intervals. These data can be e.g. transactions on trade markets or other financial transactions, other examples can be energy, telecommunication or pharmaceutical data. CEP are platforms for processing of high volume data from different sources and in different formats. The CEP technology detects relationships between series of simple events in real time. The processing runs on several levels of abstraction and each part conforms to the required level of interference. Decision making process for further prediction of data is included by one of the levels of CEP. Each level processes data in a different way. At the beginning data are preprocessed – data are classified, categorized and outlier values are removed from the data stream. The goal of the first level is to recognize relevant data in incoming event streams. During this part of processing the first behavioral patterns are distinguished in the data and we might correlate them according to desired requirements. During the second level patterns of events are extracted from data flow and initial impact assessment is made. During the assessment we might predict the trends in the data and estimate potential loss or opportunity in data. In the last phase of processing patterns of processes are extracted and we describe them by using business rules. These patterns are added to the set of rules recognized in the previous level of processing. This section was based on information from [1].

CEP can work with a historical set of data as well as with real time data. From the historical data rules and processes pattern can be extracted and they can be used for processing of actual (real time) data.

A decision making process in CEP is implemented as stateful. This means that we don't make decisions based just on the actual data that come to the system but we also take into account historical data sets. Decisions depend on other parameters like context of events, time, etc. CEP deals with relations between events of different situation types and thus can determine assessments and trends in data. The decision making engine uses predefined rules to identify situations [1].

The main idea of this paper is to aim on the decision making process and the formal description of the set of business rules by a formal grammar. A lot of grammars that can be used exist. We decided to simulate business rules by matrix grammar because the matrices of rules allow us to define the dependencies between the rules and to define groups of rules that have to be executed in given order. These grammar rules belong to the group of regulated grammars. Thanks to this characteristic of matrix grammar we can regulate the flow of data and predict them. Matrices allow us to model restrictions of a business process. In this step of processing other tools supporting decision making can be used e.g. decision tables, vocabulary support.

A number of approaches for formalization of business rules exist, but, as far as it is known to the authors of this paper, none of them use formalism of a matrix grammar or any formal grammar. To mention other approaches, in [2] authors present formalization of business rules based on ontology and UML modelling with the use of Object Constraint Language.

A newly designed method based on matrix grammar can be used in the field of formal verification of the CEP systems. This area is still not fully explored. As stated in [3] the utilization of formal analysis and verification is not as much considered as the support for modelling, debugging and testing of CEP applications.

In the proposed approach we want to take advantage of the main characteristics of matrix grammars – the generative power and clarity of use – user may update the set of rules as required without the need of a third party to control the decision making process. This grammar uses context-free grammar as its component but the generated language may be context sensitive. This is important and it is possible because of the second component of the matrix grammar – component that controls the use of rules. Formally, a matrix grammar is a pair $H = (G, M)$, where $G = (N, T, P, S)$ is a context free grammar and M is a finite language over P ($M \subset P^*$) – a sentence of this language is called a matrix. Further, for $u, v \in (N \cup T)^*$, $m = p_1 \dots p_n \in M$ we define $u \Rightarrow v\ [m]$ in H, if there are strings $x_0, \dots, x_n$, such that $u = x_0$, $v = x_n$, and for all $0 \leq i < n$, $x_i \Rightarrow x_{i+1}\ [p_{i+1}]$ in G. The language generated by H, denoted by $L(H)$, is defined as $L(H) = \{w\colon w \in T^*, S \Rightarrow^* w\}$. A component of context-free grammar (CFG) is defined as a quadruple $G = (N, T, P, S)$, where N is a finite set of nonterminals, T is a finite set of terminals, $N \cap T = \emptyset$, $P \subset N \times (N \cup T)^*$ is a finite set of rules, where $(u, v) \in P$ is written as $u \to v$, and $S \in N$ is the start symbol. Further, let $u, v \in (N \cup T)^*$ and $p = A \to x \in P$. Then, we say that uAv directly derives uxv according to p in G, written as $uAv \Rightarrow_G uxv\ [p]$, or simply $uAv \Rightarrow uxv$. We further define $\Rightarrow^+$ as the transitive closure and $\Rightarrow^*$ as the transitive and reflexive closure of $\Rightarrow$. The language generated by G, denoted by L(G), is defined as $L(G) = \{w: w \in T^*, S \Rightarrow^* w\}$. Definitions can be found in [4].

There are two ways to use the component M – for the simulation of parallel actions or for the simulation of the sequences of actions that have to be done in a specific order.

The newly proposed formalism will serve as a base for the decision management system. The main benefit of this approach should speedup of the decision making process in CEP platforms. After the implementation of the method to the complex platform experimental measurements will be done and evaluated. The rules for real time processing will be satisfied during the implementation – sum up of the basic requirements can be found in [6]. The advantage of the use of the proposed model will be to better predict the trends in data and to describe new behavioral patterns found in the data. The model is supposed to benefit the formal verification of the CEP system.

The recognition of business rules in the event flow in CEP is not done fully automatically. There are decisions that cannot be done without human interactions. But on the other hand there are a lot of situations and business opportunities or threats that can be detected by the use of historical data and known trends in data. In [5] a way to recognize business rules within an organization is described. This recognition is split into several parts. In the first part business analysts extract the rules statements in sentences of natural language. These sentences are then associated with a specific part of the business process. During the next phase analysts transform these rules into more structured and detailed statements, e.g. condition-action statements. The single rule statement can yield more condition-action rules. In the last phase we design and transform the rules into highly structured executable rules. Any statement that enforces a relation between data is considered a business rule.

Business rules approach manages the flow of events in the complex platform by using constraints or decision blocks. Business rules classify, compute, compare and control data to direct the flow. Business rules patterns can simulate following types of event behavior – logical operations, threshold patterns, subset selection patterns, modal patterns, time or spatial restrictions. Complex event platforms work with various types of business processes on its decision making level.

The system of rules supporting decision making is often a part of each system that uses business rules for decision making. Keeping the set of business rules and the logic of decision making in a separate system, which is then used by other systems as a service, is a better approach. With this solution the rules can be kept transparent and open to changes. We can change the structure of rules as well as add new rules in real time. With separate decision management component it is possible to analyze data and detect the trends in the data and thus find threats or opportunities. In comparison to the traditional approach, decision management systems store data to improve the results by running an analysis on historical data or learning and testing on sets of historical data. This paper introduced the way of formalization of business rules by formal grammar – matrix grammar. The flow of a business process is controlled by the matrices of this formal grammar. The next step in our research is to implement the decision management system [7, 8] according to requirements specified in this paper and to use it for prediction of high frequency data. We plan to integrate this system with existing solution of CEP platform.

In this paper we discussed the processing of high frequency data by complex event platforms. We focused on the decision-making model which is integrated into these platforms. At the start of the decision making process we have a set of business rules that describe the behavioral patterns extracted from the input events of the whole platform. We aim on the formalization of extracted rules by the rules of formal grammar – we choose matrix grammar. The rules and the sequences of rules (matrices) of these formal grammars with regulated rewriting let us control the data flow in the system by the definition of restrictions upon these data.

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References

[1] D. Luckham, Event processing for business: organizing the real-time enterprise, Hoboken, NJ: Wiley, 2012, xiii, 273 s. ISBN 978-0-470-53485-4.

[2] S. Lovrenčić, K. Rabuzin, R. Picek: Formal Modelling of Business Rules: What Kind of Tool to Use?, Journal of information and organizational sciences, Volume 30, Number 2, 2006.

[3] M. Weidlich, J. Mendling, A. Gal: Application and Theory of Petri Nets and Concurrency, Lecture Notes in Computer Science, Volume 7927. Springer, 2013. ISBN 978-3-642-38696-1, pp 270-290.

[4] G. Rozenberg, A. Salomaa and editors: Handbook of formal languages: Linear Modeling: Background and application, volume 2. Springer, 1997. ISBN 3- 540-60648-3, str. 528.

[5] B. Von Halle, "The business rule revolution: running business the right way". Cupertino, CA: Happy About, 2006, xxviii, 291 s. ISBN 978-1-60005-013-8.

[6] M. Stonebraker, U. Çetintemel., S. Zdonik: Newsletter, ACM SIGMOD Record, Volume 34 Issue 4, December 2005, Pages 42 - 47, ACM New York, NY, USA, [online, visited March 2015] <http://cs.brown.edu/~ugur/8rulesSigRec.pdf>

[7] T. James: Decision management systems: a practical guide to using business rules and predictive analytics. Upper Saddle River, NJ: IBM Press, c2012, xiii, 284 s. Information management. ISBN 978-0-13-288438-9.

[8] T. Debevoise: Business Process Management with a Business Rules Approach: Implementing, The Service Oriented Architecture, Canada, Business Knowledge Architects, 2005, ISBN 978-1419673689.