Business rule based data analysis for decision support and automation

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Abstract: *The paper analyses business rule based data analysis for decision support and automation possibilities using business rule transformations. A specific method has been proposed for business rule transformation to the executable instructions in data analysis software systems. The proposed method enables to take the business rules used for data analysis out of software system code and use them for automated decisions and decision support to allow immediate and adequate reaction to the business environment changes according to the internal and external influences such as changes in law, new competition etc.*

Key words: *Data analysis, Business rule transformation, Decision support, OLAP, MDX, XML.*

INTRODUCTION

During the last several years emerged new data analysis tools and software systems based on warehousing techniques and On-Line Analytical Processing (OLAP) technologies. Warehouse data based business analysis tools are widely used in enterprises for collecting large data sets from several enterprise information system (IS) databases (DB) such as Enterprise Resource Planning (ERP), Data mining, Expert & decision support, Customer Relationship Management (CRM), Production and etc.

The result of data analysis usually represents the information in form of especially designed reports and multidimensional visual representations. The information is used in business processes (BP) for various management purposes usually to track and evaluate the business situation according to the business strategy and tactics stated in business policy and represented as business rules. [6]

The information from data analysis is used for manual decision support and business process justification or improvement. It's usually done by responsible person changing business process parameters and\or the processing rules. Data analysis is one of the main sources of information for prediction of business system changes, evaluation of influence, risk analysis and decisions. Information needed for decision support is derived from captured data using available knowledge. Knowledge can be represented by business rules (BR) as well. Data analysis results can be a reason for business changes and influence the change of all the business system or some part of it. [7]

This paper discusses possibility of using business rules for dynamic data analysis and representation of the information for further automated decision making in business system. Paper state the goals of data analysis using BR approach and possible ways for solutions using automated XML transformations from business rules into dynamic XML and Multidimensional expression language (MDX) instructions.

The paper proposes a method for automated BR transformation to the executable MDX sentences - the multidimensional equivalent of SQL. Such MDX instructions according to the proposed method are used to define multidimensional data selections and calculations used for data analysis and representation of information in Microsoft™ OLAP API software systems according to the knowledge represented as business rules and the facts about current business system state discovered from current business data.

The rest of the paper proceeds as follows. Next Sections describes data analysis methods and business rule based data analysis approach, introduces information flow model describing decision processing and the method for automated business rule transformation into executable software system code for dynamic data analysis and information representation and automated decision support. The last section concludes the paper.

RELATED WORK

From the information system perspective, "...a business rule is a statement that defines or constrains some aspect of the business. It is intended to assert business structure, or to control or influence the behavior of the business." [2] There are another business rule definitions as well [3, 4]. Business rules are derived from business policy formulated by business strategy and tactics defined in enterprise mission. Implementation of BR empowers to achieve the objectives [7] and goals set by executive staff and stated in enterprise vision. Due to dynamic of its nature, business environment is changing frequently according to internal and external influences such as changes in law, new competition etc. Business requires immediate and adequate reaction to the changes. Otherwise there is big risk to fall off competition. This is the main reason not only for immediate analysis of the situation and decisions, but also for the need of continuous changes in business policy and business logics. Such changes challenge related changes in information and software systems.

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Usually doing data analysis we don't modify existing data model. We use different queries generating new views or generating data cubes in OLAP and slicing them from different perspectives as needed [5]. Data model in data analysis process is not changed. Users can manipulate using data elements as well directly from DBMS, but business user's can't see how it's corresponding business rules and business policy.

Such traditional "hard coded" implementation has few weaknesses from business point of view:

inertness: main changes of the business system can be allowed only taking reengineering cycle (or iteration) of the information systems and making changes to the code of all the software in enterprise from specification of requirements to the coding, testing and implementation. [7, 10]

"manual" decisions - impossible or complicated automation of decision making processes. The operator of the information system is responsible to decision making. [9]

inadequate decisions – there is leak and lag of information flow to the operator about changes in business system. New rules are still not implemented in to the software or rules are to complicated to follow them adequate. [10]

informality – there is freedom for rule interpretation by human operators.

unpredictability – usually there is no possibility to check how newly implemented business rules will influence the systems and preliminary resolve the conflicting implementations.

To avoid such problems new view into engineering process from business perspective is needed. The decision making action is one of business system processes, which follows rules too. Usually the part of business system is dedicated for data analysis processes to support decisions. The sources of data analysis rules are all the documents, legal requirements and laws. [1] From our experience we can state that there are additionally more sources of BR such as mutual agreements, business culture, limitations in various resources (people, software systems, hardware, etc.) and architecture, but most valuable of them is – experience based knowledge of the stuff. Sometimes such knowledge or part of it is embedded in reports or stored in various knowledge bases in enterprises, but mostly are gone after stuff is changed.

According to traditional system engineering the automation of business processes is done by transforming business rules to the functional requirements of platform

independent information system and translating it to the specification of platform dependent Software system. [8] The specifications are used later for coding of the final applications. Following such process the business rules are embedded in to code and lost forever. [1] The same is with analysis rules that are embedded in to traditional reporting and analysis SS.

We state that by creating requirements and specifications a lot of knowledge and business rules is captured. Part of captured BR are data analysis rules already or are transformed in to data analysis rules later. Although BR stated as requirements are stored and transformed statically and can't be changed later without all redesign cycle. Another big flaw is preprogrammed in traditional design processes from the beginning – it's different and mostly false interpretation of business rules stated as requirements or transformed in to specifications by analysts or another stuff and in to final software code by programmers. All this stuff directly involved in software application design and development is not involved in business directly. Such misinterpretations are replicated through all the design cycle and sometimes are not discovered even in testing phase, because of testing scenarios based on same requirements. Even it can be not discovered in already deployed software until some specific interference of various factors arises. It's very dangerous in large critical systems, because the corrections can't be done quickly and all the redesign process is needed.

INFORMATION FLOW MODEL FOR DECISION SUPPORT

Concluding analyzed information we've created business system information flow model (fig. 1). The proposed model represents information flow from the captured material processing data to the decision making and implementation of decisions. All the data carriers and transformation processes are grouped in to four columns by origin according to the method described in [11].

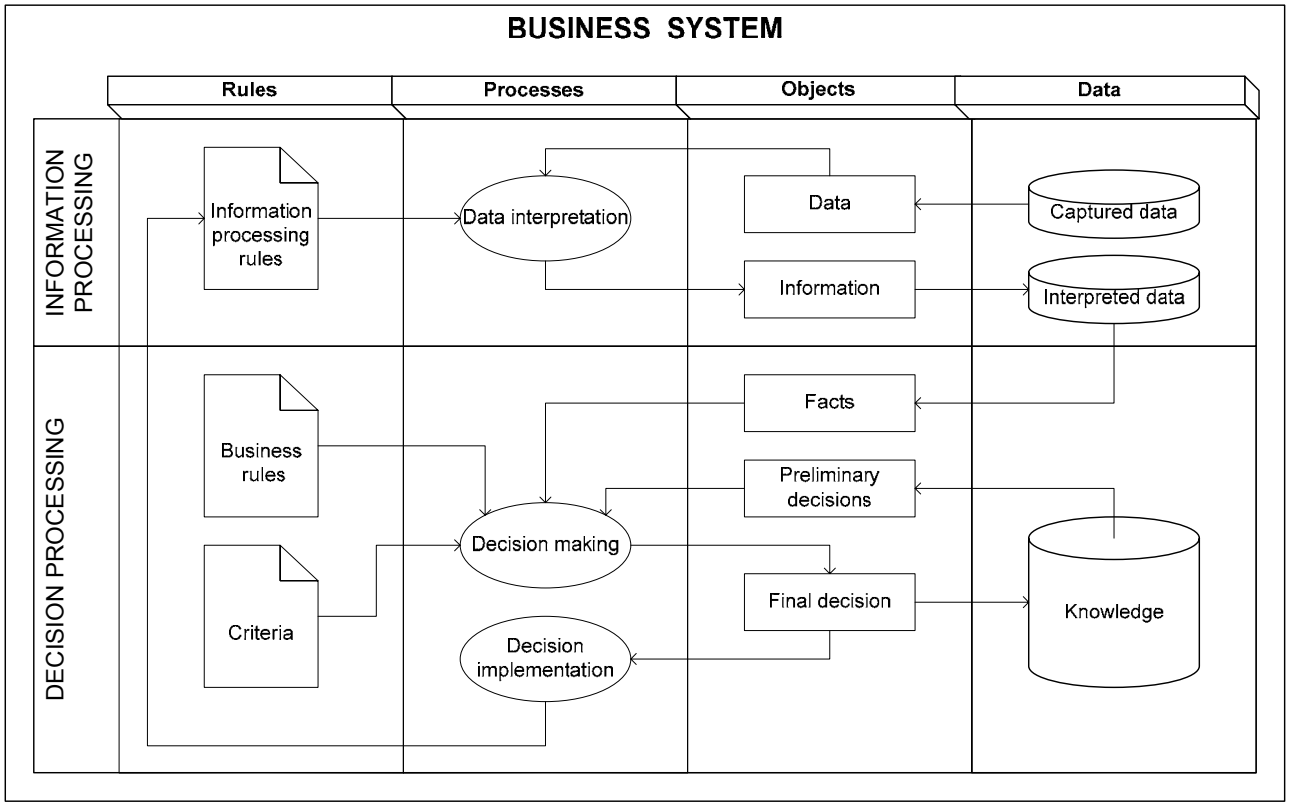

Fig. 1. Business system information flow model.

The data for Information processing is usually produced during material processing by processing material objects (from initial material to the final processing product). In

business it represents some machinery equipment for production of the windows from the wood for example. In this case the captured date will represent measured attributes like quality of the wood, color, price and etc.

The first layer of the model is dedicated for information processing. It's usually done in several information systems or at least hand written journals. It's represented in the model as captured data. Some captured data is usually used for data interpretation to get summarized information. It's usually done by creating reports (displayed as interpreted data) by predefined information processing rules implemented in information systems usually using relational databases and SQL queries, but can be done manually too.

The second layer is dedicated for decision processing – decision making and implementation of decisions. According to the proposed model decisions are made using facts (information from interpreted data), BR (legal regulations, instructions, business policy, etc.), preliminary decisions based on the knowledge and selected decision criteria. The final decision is the source for new knowledge. The final decision usually is implemented changing information processing rules. The decision implementation by changing BR or material processing rules is possible too, but it's out of our investigation scope.

The processes in the first layer are usually easy automated using today's software engineering techniques. The software systems implemented in the business system are dedicated to support decisions of the management staff. Although there are a lot of recurring decision tasks that need automation. Due to large uncertainty and frequent changes in business system it's still very problematic and complicated task.

THE METHOD FOR AUTOMATED DATA ANALYSIS AND DECISION SUPPORT

The above-formulated problem can be solved using BR transformations and logical derivations according to the method described below.

According to the proposed method we represent BR and predefined preliminary decisions in XML language and combine it into special rule sets. Together with facts got from current business data it is combined into one rule set. For generation of the data analysis instruction we need to have complete rule set and eliminate contradictions using logical derivations in decision processing subsystem (fig. 2). After logical derivations used for contradiction elimination we have complete decision and BR predicate set. This set is converted back into XML and transformed using predefined XSLT transformation schema into MDX executable OLAP data cube generation instruction used for data analysis representation in data analysis services engine. Further we describe the proposed method in details.

All the processes, data and rule sets following the method are divided according model described in previous section into information and decision processing subsystems.

Information processing subsystem consists of business data (data warehouse or data mart), data interpretation process used to get the fact set according predefined fact selection SQL sentences, the XML parser used for input rule set (represented in XML) transformation according to predefined XSLT transformation schema into executable MDX instruction used for representation of the implemented automated decision from decision processing subsystem and output of the data analysis result using Microsoft™ Data analysis services for dynamic representation of created OLAP data cube.

The decision processing subsystem consists of initial BR set represented in XML and the preliminary decision set as initial input and two main processes used for rule contradiction elimination – the inference processor and preliminary decision set selection process.

We assume that BR and the facts representing current business state are not changed during logical processing. The contradictions are eliminated from rule set loaded into knowledge base of the inference engine by changing preliminary decision set until we

get no contradiction in result of logical derivations of the inference engine. Contradictions in Knowledge base of inference engine are eliminated changing preliminary decision sets using two separate methods: by selecting next decision set or by adding new decision rules to the current decision set. The available preliminary decision sets are ordered and selected one by one according to the decision criteria and combined together with BR set and fact set, got from business data according to the predefined data interpretation instructions in SQL, into one XML document.

In our experiments we've used backward chaining based inference engine. The data (rule set) transformation into predicates process is using same XML transformation techniques according to the predefined XSLT transformation schema described in [11, 12].

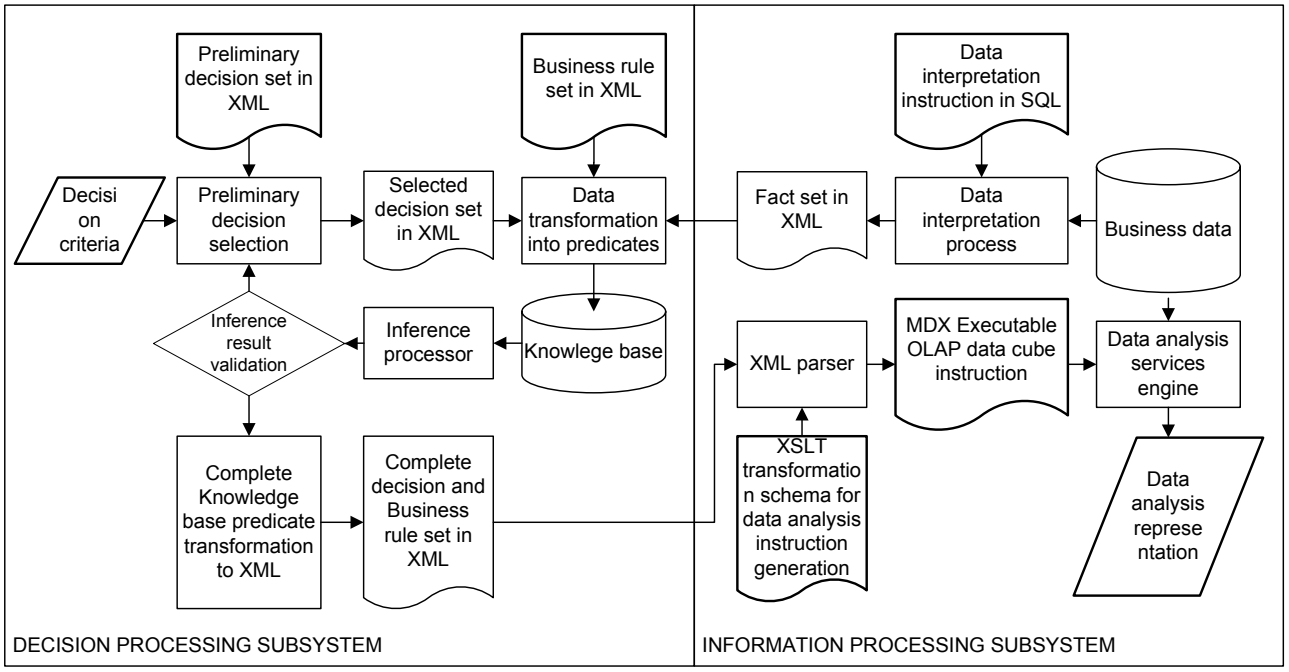

Fig. 2. Conceptual automated decision software system architecture.

According to the method evaluation in experiments we concluded, that proposed architecture (fig. 2) allows automation of decisions by influencing and automatically changing information processing rules used for data interpretation in information system according to the model described in previous section (fig. 1). In our experiments we have generated dynamically changing OLAP cubes by creating new dimensions and proposing drill downs according to the business situation evaluated by validation of current business data (facts) according to the business policy (business rules).

CONCLUSIONS AND FUTURE WORK

The practical experimentations using proposed information flow model and developed software system architecture for automated decision support in data analysis software systems has led to the following conclusions:

Business rules can be represented in XML and used for transformation using XSLT transformation schema into executable MDX instructions.

Proposed method and software system architecture allows dynamical implementation of automated decisions into information processing rules (MDX) of data interpretation process using OLAP data cube construction for Microsoft™ Data analysis services.

The changes in business environment can be easily implemented in designed software system by changing separately stored BR set. The possible decisions can be influenced by adding new decision rules or rule sets to the separately stored preliminary decision set or changing decision selection criteria. Dynamically generated facts, derived

using predefined SQL queries from current business data, empower dynamical business state evaluation based automated decisions.

During processed experiments validated MDX instructions according to the proposed method were used to define multidimensional data selections, dimensions and Drill through Actions used for data analysis and representation of information in Microsoft™ Data analysis service OLAP API software system although there are left unsolved problems of incomplete rule set resolution and ruleset transformation schema design for further research.

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