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Abstract

Business Rules are formal statements about the data and processes of an enterprise. In an enterprise, business rules are used to represent certain aspects of a business domain (static rules) or business policy (dynamic rules). Hence, regarding problem domains in the organization, business rules are classified into two groups: static and dynamic business rules. The paper introduces a new concept of business rules, Extended Dynamic Business Rule which contains the results of the occurrence of business rule's action. In this paper, we focus on such business rules and use Mineau's approach for modeling them. Mineau's approach is an extension of Conceptual Graph theory by John Sowa.

Keywords: Extended Dynamic Business Rules, Conceptual Graphs, Mineau's approach

Introduction

In the last decade, business rules have received a lot of attention in the information systems (IS) community. Business rules defined as statements about how the business is done. In an enterprise, business rules are used to represent certain aspects of a business domain or business policy (Demmy 2002). The former is called static rules whilst the latter is called dynamic rules. However, a number of open questions about business rules on the Information Systems development remain, and we believe they are still unresolved and thus present challenges for future research. For example:

- **Scope of business rules**: What exactly are business rules? How can those be classified?
- **Modeling of business rules**: How to represent business rules?
- **Acquisition of business rules**: How to acquire business rules?
- **Implementation of business rules**: How to implement business rules?
- **Management of business rules**: How to manage business rules for an entire organization?

To answer these questions, it has to be clear that the role of business rules should be precisely analyzed in each phase of the Information Systems development lifecycle. We are going to consider the former two topics in this paper as follow:

1. Definition and classification of business rules concerning a domain business,
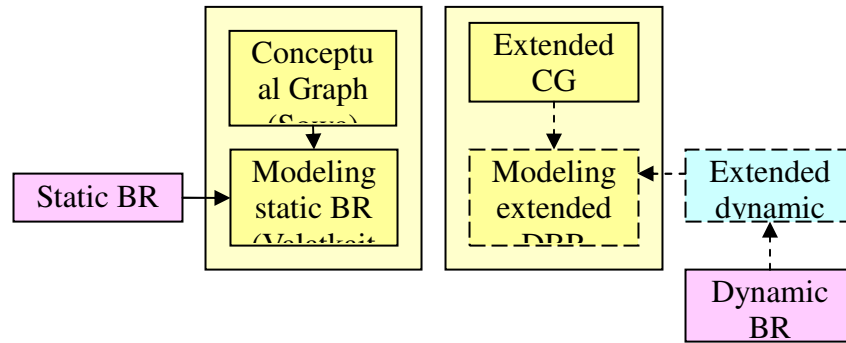2. Business rules modeling by using Mineau's Approach,

Figure 1: The general view of this research

As shown in Fig. 1, static business rules have been modeled by using conceptual graphs (created by Sowa). Conceptual graphs cannot represent dynamic business rules because they can only be used to represent static knowledge. In order to represent dynamic knowledge, Mineau extended the original conceptual graphs which proposed by Sowa. Hence, one purpose of this paper is to model dynamic business rules by Mineau's approach.

Thus, a business rule is seen as a means to transit from one state to another within a business process step. In this approach, process step is described by rules with pre- and post-conditions. So, in this paper, we focus on dynamic business rules and use Mineau's approach for modeling dynamic business rules. In the paper, we extend proposed dynamic business rules by Terry (Terry 2005) and add the postcondition component to such business rules.

The paper is organized as follows. In Section 2, we review the literature on business rules. A short brief of Mineau's approach and dynamic business rules modeling using Mineau's process are presented in Section 3. The case study that is related to Locomotive Maintenance's business rules is discussed in Section 4. Finally, the conclusion and future work are outlined in Section 5.

Business Rules

Our approach is related to initiatives in two different areas, namely business rules classification and business rules modeling. The former is mainly concerned with the approaches of business rules classification whilst the latter is concerned with the representation of business rules as structured.

Business Rules definition and classification

The term "business rule" has been used by different approaches in different ways. For example, business rules are "statements of goals, policies, or constraints on an enterprise's way of doing business" (Rosca 1997) or they are defined as "statements about how the business is done, i.e. about guidelines and restrictions with respect to states and processes in an organization" (Herbst 1997).

The Business Rules Group (BRG) classifies business rules into three main types: structural assertions, action assertions, and derivations (Hay 2000).

In general and from some business rule's researcher viewpoint, business rules can be *static* or *dynamic*. A *static business rule* is a *constraint (integrity)* or *derivation* rule that applies to each individual state of the business, taken one state at a time.

A *dynamic business rule* is a transition constraint that restricts how the business may change to new states. A kind of dynamic rules is the *dynamic action rule*. A dynamic action rule defines the conditions for invocation of an operation. Dynamic action rules have a three-part structure,

consisting of a *trigger*, a *precondition*, and an *action*. The trigger and preconditions describe the conditions under which a rule becomes active, whilst the action part of the rule generates messages to activate operations.

There is a lack of business rules classification based on the occurrence of the action. Considering the effects of the action after happening, it illustrates the need for another concept of dynamic business rules. Consider following example: Assume that the minimal amount for a withdrawal is $30. If the amount is greater than $30 or equal to it, a customer can withdraw the money. After withdrawing the money by customer (the action), the previous balance should be changed to new balance (Balance=pre@balance-amount). Thus, we propose an extension of dynamic business rule concept and introduce an *Extended Dynamic Business Rule* that has the results of the occurrence of the action. In order to consider those effects, we add another part to dynamic action business rules called a *Postcondition*. Therefore, in contrast with dynamic action rules, extended dynamic rules have four parts that consist of a trigger, a precondition, an action, and a postcondition. Postconditions happen after the action is ended. The general form of extended dynamic business rule is illustrated in Figure 2. In the figure, a Postcondition is described by *THEN DO*.

An extended dynamic business rule can also be called *Event-Condition-Action-Effect (ECAE) rules*. Figure 3 shows the previous example by using extended dynamic business rule classification.
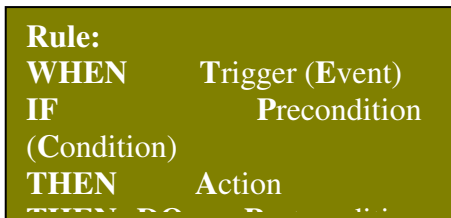
Rule:
WHEN   **T**rigger (**E**vent)
IF   **P**recondition (**C**ondition)
THEN   **A**ction

Figure 2: The Extended Dynamic Business Rule

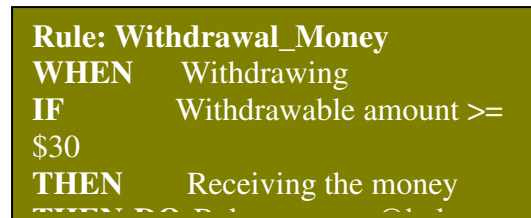| Rule: Withdrawal_Money |
| --- |
| **WHEN**   Withdrawing |
| **IF**   Withdrawable amount >= $30 |
| **THEN**   Receiving the money |

Figure3: The Withdraw_Money Business Rule

Business Rules Modeling

A number of languages and approaches were considered for the business rules modeling:

Using UML associated with OCL statements

The most popular modeling language is UML. In this approach, business rules modeling are fulfilled by the UML Object Constraint Language (OCL).

Although OCL is an expressive formal language, it does not have any graphical notation and thus is not understandable by business people. Moreover, it does not provide any methodological guidance for the collection of rules.

Ross Method

The Ross Method is one of the most complete methodologies which model business rules. Ross has created the original graphical notation to represent business rules in a data model. The method offers sufficient methodological guidance and specific constructs for each of the rules families together with a big number of accompanying constructs (Ross 1997).

However, these properties do not seem to be an advantage, as the complexity of the resulting diagrams and the vast amount of graphical symbols make the language quite complicated, at least for inexperienced users.

Conceptual Graphs

Conceptual graphs (CG) may be viewed as one of the suitable modeling languages. Conceptual

graphs (CG) created by Sowa are a knowledge representation language. Informally, a CG is a structure of concepts and conceptual relations where every arc links a concept node and a conceptual relation node (Sowa 1984; Sowa 2000). CGs are formal logic-based languages which can be used as a business rules modeling language because of their simple graphical and linear notations (Valatkaite 2003).

Although CGs are expressive formal languages because of their simple graphical and linear notations, they cannot represent dynamic business rules. However, Sowa's Theory can be used for expressing various kinds of static business rules.

Business Rules Modeling Using Mineau's Approach

Mineau (1998) proposed a representation for dynamic processes. This approach is more oriented toward the automatic translation of algorithms into an executable but declarative format.

In his paper (Mineau 1998), Mineau uses the idea of processes to represent dynamic knowledge. Basically, Mineau's processes are one kind of executable conceptual graph formalism. A process can be described as a sequence of state transitions. A transition transforms a system in such a way that its previous state gives way to a new state. These previous and new states can be described minimally by conditions, called respectively pre and postconditions, which characterize them. Thus, transitions can be represented by pairs of pre and postconditions. Thus, Mineau's approach is suitable for dynamic business rules modeling. The approach allows defining action and reaction rules using processes. Within each business process, there are a number of steps. Each step involves a different set of actors. Business process steps are an important construct in the approach to building business rules engines. So, business processes must be decomposed into business process steps, each of which representing a set of business rules.

Mineau's Approach

According to Mineau's approach, each of state transitions has three-part structure, consisting of a precondition, an actor, and a postcondition. Preconditions describe the conditions under which an actor becomes active, whilst the actor part of the state transition generates messages to activate postconditions. The actor is presented in linear form or graphical form. In linear form, an actor is defined by a list of its parameters (input and output parameters).The input parameters will appear in the preconditions of the actor; while the output parameters will appear in the postconditions of the actor. The actor can be presented in linear form as follows:

Actor name (in$_1$ u$_1$... in$_n$ u$_n$; out$_1$ u$_{n+1}$... out$_m$ u$_{m+n}$) is: u$_1$,...u$_n$,u$_{n+1}$,...u$_{m+n}$

In graphical form, the actor is represented by a double-lined diamond box labeled with the name of the actor. Figure 4 shows a simple graph of the actor, where u$_1$, u$_2$, u$_3$ and u$_4$ are conceptual graphs (Lukose and Mineau 1998).
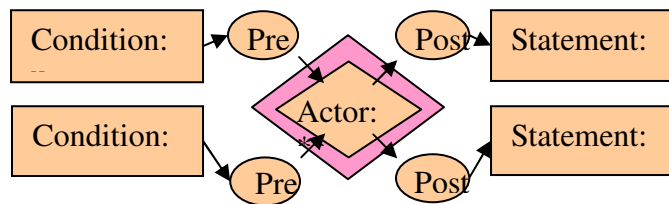

Figure 4: The graphical representation for an actor

Dynamic Business Rules Modeling Technique

As mentioned in the Section 2.1, *extended dynamic business rules* consist of four parts, a trigger (event), a precondition, an action, and a postcondition. In our approach, each business rule is considered as an actor and defined as a pair of pre and postcondition. So in order to model such business rules by using Mineau's approach, two additional elements are needed in order to model dynamic business rules clearly. The action (THEN part) and triggering (WHEN part) of the business rule should be considered as two important elements when using Mineau's approach. Figure 5 shows a simple aspect of *extended dynamic business rule* by using Mineau's approach. In the figure, *e, *pr, *a and *po are the referent fields for the trigger, the precondition, the action and the postcondition concepts.
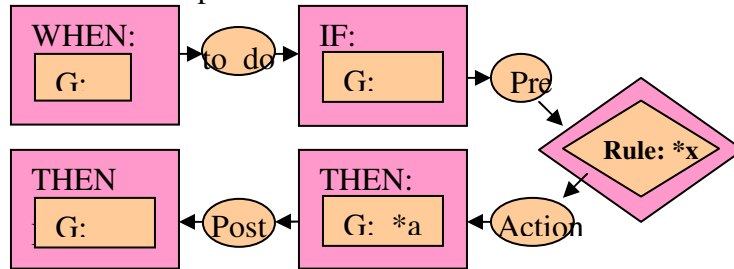
Figure 5: The presentation for Extended Dynamic Business

Rule using Mineau's Appr1oach

Case Study: The Locomotive Maintenance's Business Rules

To illustrate the discussion above, we introduce a subset of business rules which may be relevant to the Locomotive Maintenance & Repair's Business Rules in the Iranian Railway Company. A locomotive is a traction vehicle that pulls a train. The locomotive is repaired after the occurrence of a defect. Locomotive repairs are generally of three kinds: minor, special, or basic repairs. Basic repairs deal with all the locomotive's equipments, while special repairs are only repaired the defective parts. The repairs of diesel locomotives are carried out in two repair shops called the running shop and the workshop. The running shop is responsible for slight and minor repairs, whereas the workshop is in charge of basic and special repairs. If the initial inspection of the locomotive deems it irreparable by the diesel running shop, the locomotive is dispatched to the diesel workshop for basic or special repair. After all necessary repairs have been completed, the locomotive is ready to work ("Warm Locomotive" situation) for pulling the trains which carry goods and passengers. Figure 6 depicts the semantics of the locomotive repair's business rules that are explained using an event schema.

In our case study, we extract business rules from the existing system. Regarding the event schema, there are six rules that can be transformed into dynamic business rules form. The structure of rules1 and 5 related to the running shop and workshop is illustrated in Figure 7.
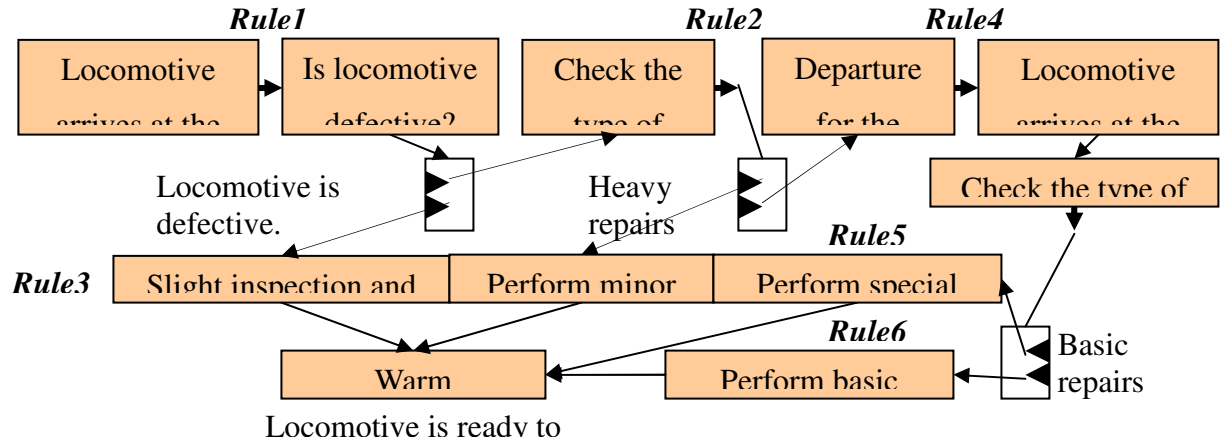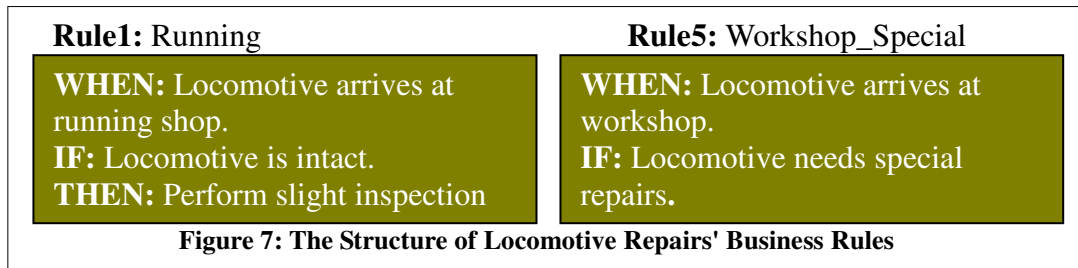
Figure 6: Locomotive Repairs' Business Rules using Event Schema

As mentioned, the trigger of the business rules depends on the arrival of the locomotive at the running shop or workshop. The above rules have an extended dynamic business rule form. The Postcondition of each business rule is the locomotive's readiness for dispatch. In Figure 8 the rule Workshop_Special Repairs is modeled in the graphical notation using Mineau's approach.

Rule1: Running

> **WHEN:** Locomotive arrives at running shop.
> **IF:** Locomotive is intact.
> **THEN:** Perform slight inspection

Rule5: Workshop_Special

> **WHEN:** Locomotive arrives at workshop.
> **IF:** Locomotive needs special repairs**.**

Figure 7: The Structure of Locomotive Repairs' Business Rules

Conclusion and Future work

In this paper, we focused on the dynamic business rules and introduced a new concept of dynamic business rules to consider the effects of an action after occurring it, extended dynamic business rules. They are modeled by using Mineau's approach and extended this idea by allowing a business rule to have a cg as input and output parameters (pre and postconditions). Although a number of languages were proposed, there is no consensus yet and the choice of a modeling language for the business rules is still an open question. Future work includes further development of the discussed dynamic business rule structuring and implementation mechanism with particular emphasis on the development of Institutionally-Dependent Business Rules.
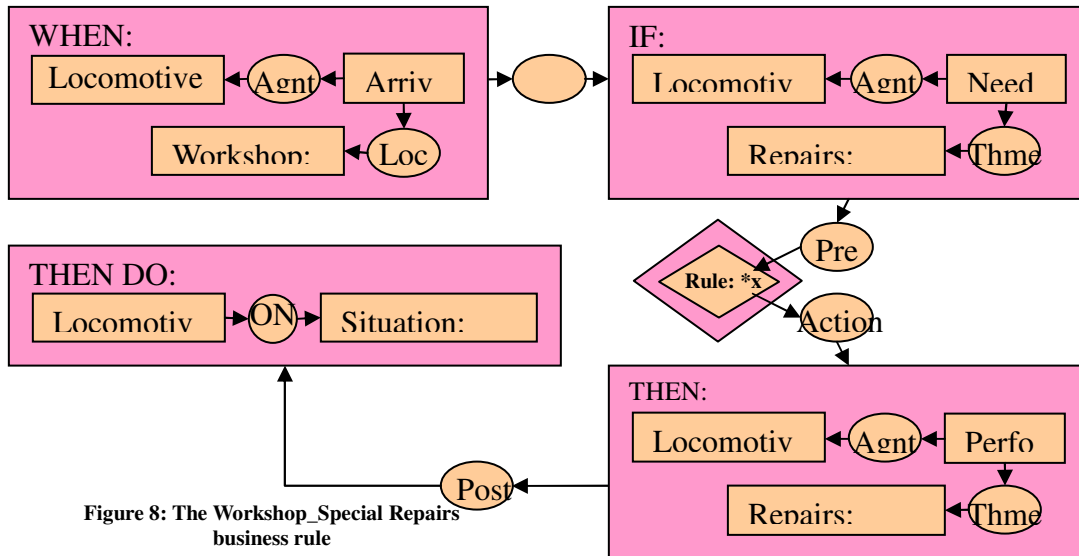
Figure 8: The Workshop_Special Repairs business rule

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