Chapter XXV
Languages and Tools for Rule Modeling

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ABSTRACT

This chapter presents selected practical issues of rule modeling. This field combines both classic artificial intelligence methods and software engineering. The chapter gives a concise presentation of selected relevant methods, and approaches, put in an engineering perspective. The modeling language used in the communication between business analysts and experts for analyzing the system requirements should not be too technical. It should allow for visual rule expressions, which can be understood by experts without an extensive technical training. The main goals of this chapter are: to summarize the formal foundations of rules found in the field of AI, including decision tables and trees; discuss main challenges in practical rule design, and modeling; introduce selected recent research in the field of rule design, focusing on visual modeling; and observe some important future trends in rule design and integration. In the chapter it is argued that efficient visual rule modeling methods are crucial for developing complex rule systems.

INTRODUCTION AND MOTIVATION

Designing rule-based systems is not a trivial task. Standard software design approaches cannot be used directly, due some fundamental differences between knowledge and software engineering. These include non-procedural declarative knowledge specification, as well as important semantic differences between the rule-based representation and conventional design and programming languages.

The motivation of this chapter is to present selected practical issues of rule modeling. This field combines both classic Artificial Intelligence (AI) (Russell & Norvig, 2003) methods and Software Engineering (SE) (Sommerville, 2004). In AI rules have been studied as a classic knowledge representation method (Brachman & Levesque, 2004, Ligęza, 2006, Harmelen & Lifschitz & Porter, 2007) for expert systems (Liebowitz, 1998, Giarratano & Riley, 2005). Some recent developments in Software Engineering, mainly in business rules systems make it use the AI experi-

ences, putting them in a new context. The chapter gives a concise presentation of selected relevant methods, and approaches, put in an engineering perspective.

Principal objectives of this chapter are:

- to summarize the formal foundations of rules, found in the field of AI, including decision tables and trees,
- discuss main challenges in practical rule design, and modeling,
- introduce selected recent research in the field of rule design, focusing on visual modeling,
- observe some important future trends in rule design and integration.

In this chapter it is argued that efficient visual rule modeling methods are crucial for developing complex rule systems.

BACKGROUND

Knowledge Representation

Rules are both prime and classic example of a *knowledge representation* method (Brachman & Levesque, 2004, Harmelen & Lifschitz & Porter, 2007). Such methods are developed within *knowledge engineering.* It is a field of Artificial Intelligence applied to building intelligent systems, systems that represent and process knowledge.

Knowledge is often defined as *justified true belief* (Torsun, 1995). So it is then a set of facts or true statements about a world. A representation in a broad sense may be defined as "*the symbolic representation of justified true beliefs or a model of some universe of discourse"*(Torsun, 1995).

It is widely recognized that there is no single formalism suitable to represent knowledge for all purposes. A variety of formalisms and structures is needed. In the field of expert systems (Liebowitz, 1998, Giarratano & Riley, 2005) the *knowledge representation method* is a systematic way of "encoding" what an expert knows about some domain (Jackson, 1999). However "encoding'' means here rather "describing" than "encrypting".

Some of the issues arising in a knowledge representation are: syntax, semantics, expressive adequacy, reasoning, completeness, real-world relevance, flexibility. Different representations address these issues in different ways. While there are numerous knowledge representation methods, the logic-based ones are essential to the theory and practice of expert systems and rule systems in general.

In the chapter some fundamental logical rule formats are considered. They are a basis for rule languages. Rules can be practically written and processed in the logic programming paradigm, e.g. in Prolog (Bratko, 2000). Even though the language uses a subset of first order predicate logic (restricted to Horn clauses), it is easy to write meta-interpreters working another languages.

Decision Rules

Decision rules are one of the most important and successful knowledge representation methods. Systems based on rules, the so called rule-based expert systems, or just rule-based systems (RBS) find numerous applications in many fields, from decision support in areas ranging from business to medicine, to intelligent control. This is due to the fact that rules have an intuitive, straightforward semantics, close to the natural language, making them accessible to non-experts. Simultaneously, they also have a clear formal description, which allows for both formalized design and analysis of mission-critical rule-based systems.

A general rule expression corresponds to a *conditional* statement in the natural language. Often this statement is simply presented as:

IF some condition is met THEN some conclusion may be driven