Chapter 3
Automatic Knowledge Acquisition in the Form of Fuzzy Rules From Cases for Solving Classification Problem

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ABSTRACT

The authors consider an approach to automatic knowledge acquisition through machine learning on the basis of integrating the two basic reasoning methods – case-based reasoning and rule-based reasoning. Case-based reasoning allows using high-performance database technology for storing and accumulating cases, while rule-based reasoning is the most developed technology for creating declarative knowledge base on the basis of strong logical approach. This allows realizing the transformation of the spiral of knowledge, leading to continuous improvement of the knowledge quality in the management system. In the chapter, they propose one method of obtaining rules from cases based on fuzzy logic. Here the method is considered for solving classification problem, but it also can be applied for solving regression problem. The research shows acceptable accuracy of cases classification even for small training samples. At the same time, smoother (quadratic) membership functions show on average classification accuracy.

INTRODUCTION

The emergence of the so called knowledge based systems (KBS) in the 1970s were definitely associated with "success stories" in the artificial intelligence (AI) development when the AI methods began to be successfully used in the real economy. In the 1980s, the creation of KBS is becoming very popular in different areas of practical use. By 1992 it was implemented about 2,000 expert systems based on knowledge (DTI, 1992). Despite the commercial success of expert systems, from the outset it was clear that the bottleneck in creating KBS was knowledge elicitation, when a transfer of knowledge of an expert in the specific application domain into the knowledge engineer occurs.

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The process of knowledge elicitation is a long and laborious procedure in which a knowledge engineer (or, an analyst) experienced in cognitive science, system analysis, mathematical logic, etc, has to build the model of application domain, which is used to make decisions by experts (Diaper, 1989; Brooke & Jackson, 1991). Inexperienced expert system developers often tried to impose this procedure on the experts themselves. However, this does not lead to successful results, because, first, most of the expert knowledge is of multilayer nature consisting of many levels of experience. Often, knowing that A entails B (A⇒B), the expert does not realize that his chain of reasoning is much longer, for example, A⇒C⇒D⇒E⇒B. Second, thinking is dialogical by nature, so the dialogue of the knowledge engineer with an expert is the most natural way of highlighting shaded places of expert's memory. It is in the process of explaining things to the knowledge engineer the expert puts verbal structures on his fuzzy associative images, i.e. verbalizes the knowledge. Third, it is difficult for the expert to create the formalized application domain model because of the depth of knowledge he owns, and, at the same time, because of his insufficient skills in system analysis methodology.

The term "knowledge elicitation" is used interchangeably with the term *knowledge acquisition* in the literature (Addis, 1987). However, most researchers draw a clear distinction between these two notions emphasizing their relation to knowledge engineering.

Knowledge engineering is the over-arching process of building KBS including problem identification, elicitation, representation, implementation, as shown in Fig.1. Knowledge acquisition is a subset of knowledge engineering which consists of gathering all forms of the domain knowledge using any methods. Finally, knowledge elicitation is a subset of knowledge acquisition and intended to extraction of knowledge from human experts.

By computer aided knowledge acquisition we mean automatic tools of communication with an expert. These tools really acquire ready-made pieces of knowledge in accordance with the structure implemented by the system developers. These tools are not universal, they are focused on specific expert domain with strictly given application domain and specified model of knowledge representation. For example, the system TEIRESIAS (Davis, 1982), the first system for knowledge acquisition, was intended to supplementing the knowledge base for medical diagnosis of the application domain (MYSIN) based on the production model of knowledge representation. Thus, following clear logic of the knowledge base model built in the knowledge acquisition systems while helping to formulate expert knowledge, but hardly helps to reveal hidden (deep, nontrivial, hierarchical) pieces in expert's memory.

Figure 1. Basic strategies of knowledge acquisition in knowledge engineering process