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RELIABILITY AS THE CRITERION OF KNOWLEDGE BASE VALIDATION

Validation of knowledge base is an important aspect of the knowledge-based systems (KBS) development procedure, which aims to assure the system's ability to reach correct results. Certain common accepted criteria were formulated according to a knowledge base (KB), namely completeness and consistency. The paper addresses the issues of reliability in KBS, the less popular but necessary feature of the knowledge base. Beyond a doubt, knowledge reliability should be regarded as a very important and useful criterion of knowledge verification or evaluation, however a lack of formal basis as well as measuring problems, results neglecting it. Two main approaches seem to be proper for applying such a criterion: total and partial evaluation of the knowledge base. In such a context, concepts and scopes of reliability have been described in the paper. The final part is devoted to concerning reliability as the potential measure of KB quality.

1. INTRODUCTION

Validation of knowledge is still observed as some additional task, which can improve the quality of knowledge-based systems. The idea of knowledge validation (KV) though intuitively intelligible – has more than one interpretation. For the first sight, the proposal of concerning the term of "validation" as the general word to refer to the field (Laurent 1992, p.829–833) is very convincing. However without precisely expressed limits of the whole validation process, it is impossible to understand and resolve all theoretical and practical issues, (Owoc et al. 1996, pp. 453–458).

In my opinion two main objections should be considered. The first one deals to vary and distinguish crucial activities of the process (very promising is splitting validation into verification and evaluation done by J.P. Laurent). The second refers to the definition criteria of knowledge validation. From the very beginning, completeness and consistency have been noticed as comparatively easy to formulate (for example Suh et al. 1995; Nguyen 1987). As a result, software tools check consistency and completeness of knowledge, expressed as a set of rules (Suwa et al. 1982), were elaborated. Some of the authors went deeper, touching difficult areas like consistency of structured knowledge (Hors et al. 1995).

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But these criteria seem to be insufficient. According to the proposal discussed later, the criterion list should be extended, at least to include knowledge adequacy and reliability discussed later, the criterion list should be extended, at least to include knowledge adequacy and reliability.

2. KNOWLEDGE VALIDATION CRITERIA OVERVIEW

One of the first criterion list of knowledge validation was prepared by B. Gaines (1990, pp. 76–79). He called criteria "knowledge dimensions" including:

- objective, correspondence to actual events and efficacy in applications,
- pragmatic, correspondence to actual events and to expert knowledge,
- referential, interpreting as adequacy of foundations and comprehensibility of explanations and
- foundational, joining before mentioned: adequacy of foundations and correspondence to actual events.

Other authors put different knowledge characteristics: ambiguity (Loveland et al. 1983), completeness (Marek 1986), consistency (Suwa et al. 1982), accuracy (O'Leary 1989), non-redundancy (Ginsberg 1988). Knowledge attributes listed above prove the importance of knowledge validation criteria. For evaluating knowledge, we need clear defined measures of quality and sometimes "dimensions" more particularly expressed. On the other hand, the knowledge features should create mildly explicit and separate properties. That is why the revised knowledge validation criteria should be introduced, see also: (Owoc 1994).

The mentioned before completeness and consistency are commonly recognised. Let us try to systematise all introduced knowledge properties. It can be done using chosen concepts from the KV environment. Initially, the environment is constituted by domain knowledge and knowledge sources. Additionally, we should take into account "interior" of knowledge, thus: knowledge contents and knowledge structure itself. It again may be expressed as knowledge validation dimensions, which create a clearer picture. The modified approach to knowledge validation dimensions is expressed in Figure 1.

Knowledge adequacy refers basically to domain knowledge. According to the Gaines's interpretation cited before, we should check adequacy of foundation – enriching by correspondence to expert knowledge. The important thing is to evaluate knowledge accuracy. Sometimes this aspect of knowledge is perceived exactly as knowledge adequacy. In other words, regarding defined goal of the knowledge-based system, we try to evaluate concordance knowledge base and domain knowledge in the context of the assumed goal of a system.

Knowledge completeness, very often applied in different knowledge validation methods, deals with knowledge contents. Mostly knowledge base (representing frequently just a small part of domain knowledge) is the subject of validation (Marek 1986; Suwa et al. 1982). A lot of techniques, especially for rule-based systems, were used for checking unreferenced or illegal attributes or unreachable conclusions and dead-end conditions. It seems to be more proper to take into consideration what part of domain knowledge is represented as the knowledge base. In short speaking, we evaluate sense largo a degree of covering domain knowledge by knowledge base.

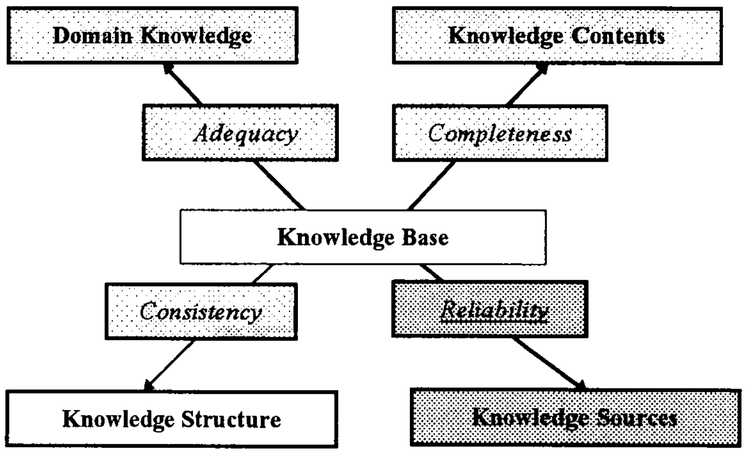

Fig. 1. Knowledge validation criteria and references

Knowledge consistency, has also an important role in knowledge validation procedures, and it refers to knowledge structure. Again there are very sophisticated toolsets for checking consistency of the implemented knowledge base. The methods contain searching for redundant rules (so we may include here as a subcriterion – knowledge non-redundancy), conflicting, subsumed or circular rules. Comparing to the previous one, consistency relates to a couple of rules (not to knowledge base as the whole).

Knowledge reliability – the last but not least criterion – affects in a more general sense, knowledge sources. This is a very big simplification, because reliability denotes reached level of quality of knowledge base and even may be observed as a certain measure of knowledge effectiveness. On the other hand, knowledge reliability should depict the user's satisfaction of computer supporting decision-making moments. Knowledge reliability is practically a new direction of validation, despite some trials in the past (for instance Kerlinguer 1973). Some of the authors derive reliability concepts directly from the knowledge base correctness idea (for example Culbert et al. 1987, pp. 27–37).

3. KNOWLEDGE RELIABILITY CONCEPTS AND SCOPES

Knowledge reliability, as was mentioned earlier, can be recognised as a general knowledge base evaluator. Let us regard some potential requirements we can address to reliability. It allows for the evaluation of utility criterion.

First of all, knowledge reliability depends on expertise generated by knowledge-based systems. If results of reasoning are correct then we may come to the conclusion about satisfying reliability of knowledge. In this case we treat the whole system with knowledge base of its own, as a black-box. All expert system tests work in this manner. Taking knowledge base as the whole, we evaluate knowledge in a general sense, so let us call this – global reliability.

Second, parts of knowledge embodied into a system can be expressed with some certainty factors. As a result, the level of knowledge reliability is reduced. Additionally, different parts of knowledge base have a varying importance for the system. Taking into consideration in this case only a small piece of knowledge, we evaluate KB partially, thus let us call this sort – local reliability.

The crucial problem, practically unresolved up to now, is the measuring of knowledge base reliability. This economical aspect of knowledge validation seems to be a very urgent task. Existing solutions were developed not exactly for KV context.

There are two different approaches for expressing level of knowledge validation reliability: empirical and analytical (Zlatareva et al.1994). Each of them represents different ways of evaluation and could be applied independently in the same or close conditions.

The first of them, empirical, relies on testing KBS in different circumstances. This means using similar test generators, which can check chosen knowledge properties (mostly: consistency and completeness). Finally, on the basis of fragmentary marks knowledge could be arbitrary evaluated as reliable or not. These approaches were described by P. E. Lehner (1989, pp. 658–662) and L. A. Miller (1990, pp. 249–269).

Applying an analytical approach we have to determine a way of measuring by combining some formulas adequate for the evaluating of knowledge base reliability. On the surface, the idea of pragmatical knowledge derived from pragmatical information seemed to be effective (Hintikka 1968, pp. 311–332), and modified (Szaniawski 1974, pp. 5–10). Substituting suitable variables, we may formulate very general function-like dependencies but it does not work in every case. Utility functions applied to knowledge, as a whole as well as to knowledge items, comprise too many indeterminated values. It effects a very inexact mark at least in the case of global validation of knowledge reliability.

4. CONCLUSIONS

Generally speaking we may divide all efforts aiming to knowledge validation regarding reliability, into:

a) testing approach,
b) analytical approach.

The methods have different procedures and are performed in various phases of KBS developing.

The first one is commonly used for general validation of knowledge when a knowledge-based system is ready for testing. In other words, it is post-factum evaluation and can be used for local purposes as well (and here the approach is more successful).

The analytical approach may be used during earlier phases. Namely, global or local reliability can be validated in the time of representing domain knowledge. It allows for the modification of a knowledge base exactly when a level of reliability becomes too low.

The crucial point of validation of knowledge reliability consists in the expression of adequate formal basis for the problem. Local and global validation, introduced in the paper, can clarify the circumstances, where validation of knowledge reliability is performed. This is still an actual research problem and direction for future works.

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