Knowledge Acquisition in MedFrame/Cadiag: A Generalized Fuzzy Approach

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ABSTRACT

We propose a stepwise knowledge acquisition approach based on fuzzy set theory to support the development and refinement of medical knowledge bases. The definition of fuzzy relationships between medical entities allows to represent knowledge at different levels of precision. The definition of relationships is supported by the use of linguistic variables and a semi-automatic knowledge acquisition program.

INTRODUCTION

Knowledge acquisition (KA) has often been pictured as the bottleneck in the development of medical expert systems. In MedFrame/Cadiag, a medical expert system based on the preceeding Cadiag systems [1,2], we propose an intuitive stepwise KA process that refines fuzzy relationships between medical entities such as symptoms, diagnoses, and therapies. Fuzzy relationships are specified according to type and strength: Types of relationships between symptoms S and diagnoses D, for example, include D→S (occurrence of S with D), S→D (confirmation of D by S), ¬D→S (occurrence of S with not D), and S→¬D (exclusion of D by S). Strengths of relationships μ are expressed as binary fuzzy relationships taking values in [0,1].

METHODS

The KA process is separated into the following steps:

First, we distinguish relationships that are representing either positive, negative, or neutral correlations. They are the most vague kind of relationships and are formalized by 'most general' fuzzy sets (Figure 1a).

In a second step, correlations are refined as a set of nine MedFrame/Cadiag relations. For example, the relation O(D)NC describes a symptom S, that is 'obligatory but not confirming' a diagnosis D. Here, the 'most general' fuzzy sets can partly be replaced by crisp values (Figure 1b).

In a third step, types of relationships are expressed as linguistic variables: For example, the strength of confirmation of D by S may be defined as 'strong'. Therefore, the 'most general' fuzzy set is replaced by a more specific fuzzy set that expresses the linguistic term 'strong' (Figure 1c).

Finally, fuzzy sets can be replaced by crisp values. For example, S confirms D by a strength of confirmation of 0.75 (Figure 1d).

A semi-automatic KA program is proposed that should support in the definition of the crisp values. Here, the types of relationships are formally interpreted by explicitly calculated ratios of fuzzy sets. For example, the strengths of confirmation of D by S are computed by sigma counts Σcount (D/S), where the partial presences of S and D in a patient database are considered.

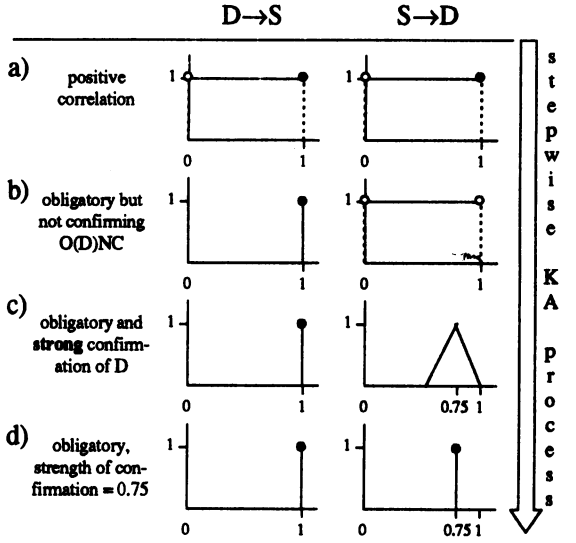

Figure1- Example stepwise KA process

DISCUSSION

We argue that the KA approach, as proposed for MedFrame/Cadiag, reflects the need for incremental definition and refinement of medical knowledge. Thus, the critical part of expert system development can be passed more easily.

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References

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