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MILORD: A DIAGNOSIS ORIENTED SHELL THAT MANAGES LINGUISTICALLY EXPRESSED UNCERTAINTY*

R. López de Mántaras, P. Meseguer, F. Sanz*, C. Sierra, A. Verdaguer*
Centre d'Estudis Avançats de Blanes, CSIC
Camí de Santa Bárbara, 17300 BLANES, Girona, Spain

*Institut Municipal d'Investigació Mèdica
Passeig Marítim 25, 08003 BARCELONA, Spain

EXTENDED ABSTRACT

MILORD is an expert systems building tool for diagnosis applications which has the capability of managing uncertainty expressed by means of a verbal scale.Recent psicological studies (1) have shown the feasibility of verbal scales: "....a verbal scale of probability expression is a compromise between people's resistence to the use of numbers and the necessity to have a common numerical scale" (1).

MILORD contains two cooperative inference engines, a rule-oriented editor wich provides tools for verification, a knowledge base compiler and an explanation module. Another feature of this system is that allows to perform three different calculi of uncertainty on the experts-consensued scale of linguistic certainty values. The internal representation (semantics) of each linguistic value is a weighted interval on [0,1]. It's representation is given by the four parameters (a_i, b_i, c_i, d_i) corresponding to the following trapezoidal function:

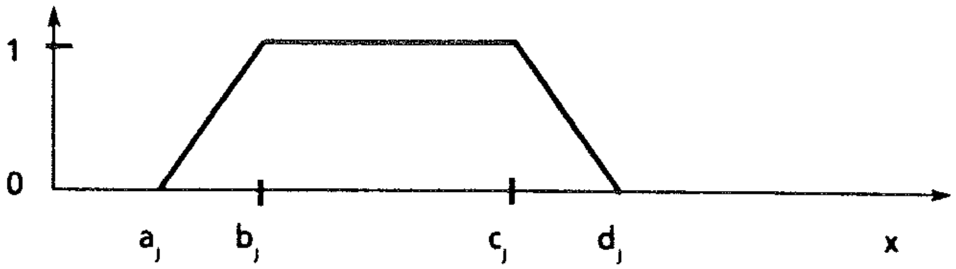

Fig 1

Qualitative expressions of uncertainty have different meanings to different people, which can lead to missunderstanding among physicians and between physitians and patients. A study conducted asking several hundred medical professionals about the applicability of a list of (spanish) linguistic terms to subintervals of [0,1], gave the following result for the nine linguistic certainty values whose english equivalent are:

IMPOSSIBLE	= (0,0,0,0)
ALMOST IMPOSSIBLE	= (0,0,0.05,0.08)
SLIGHTLY POSSIBLE	= (0.05,0.07,0.14,0.17)
MODERATELY POSSIBLE	= (0.10,0.15,0.35,0.45)
POSSIBLE	= (0.25,0.35,0.55,0.65)
QUITE POSSIBLE	= (0.45,0.55,0.75,0.85)
VERY POSSIBLE	= (0.65,0.75,1,1)
ALMOST SURE	= (0.95,0.98,1,1)
SURE	= (1,1,1,1)

A similar study was performed in the Massachusetts General Hospital and reported in (2).

The operations of propagation and combination of uncertainty performed by the inference engines on this verbal scale are not closed in general, therefore a linguistic approximation process has to be performed in order to find the linguistic value, in the given scale, whose meaning is the closest to the meaning of the result of the propagation or combination operation.

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The problem consists in computing the distance between two trapezoidal functions. MILORD, following the work of Bonissone (3), we have adopted a simple solution consisting in the computation of a weighted euclidian distance of the first moment and the area under the function.

The three pairs of conjunction and disjunction operators available in MILORD are

CONJUNCTION	DISJUNCTION
MAX (0,X + Y-1)	MIN (1,X + Y)
X.Y	X + Y-X.Y
MIN(X,Y)	MAX(X,Y)

We have chosen the previous three calculi of uncertainty following the experimental results obtained by Bonissone (5) which consisted in applying nine different calculi to three different verbal scales. Bonissone analyzed the sensitivity of each operator with respect to the number of elements in the scale and concluded that only the the three given above generated sufficienly different results for verbal scales containing no more than nine elements. Furthermore, the results of Miller (6) concerning the span of absolute judgement show that it is unlikely that an expert or user would consistently qualify uncertainty using more than nine terms.

Another advantage of our approach is that the system computes and stores the matrices corresponding to the three diffrent calculi of uncertainty on all the pairs of linguistic values of the verbal scale. Therefore, when Milord is run, the propagation and combination of uncertainty is performed by simply accessing these precomputed matrices. In our approach we also manage non-monotonic reasoning using the uncertain reasoning framework Furthermore, a semantic network representation allows to deal with incomplete information through inheritance mechanisms.Problems such as overlaping findings are also dealt with the semantic network.

The Knowledge Base is structured in modules that cluster the rules. The control is performed by means of two types of meta-rules: module-oriented and rule-oriented The module-oriented meta-rules are used to represent the problem-solving strategies which consist in activating and deactivating an agenda of hypotheses.

The editing and verification module extends the work of Nguyen et al (7) in order to deal with uncertain rules.

The application to the diagnosis of pneumoniae presently contains 700 rules, around 100 meta-rules and over 250 facts, and covers more than 90% of the comunity-acquired pneumoniae. The treatment modules is in progress and in the future we are planning to include also post-treatment complications.

The application to pneumoniae was particularly well suited for our system due to the fact that there is a great deal of uncertainty in their diagnosis. As a matter of fact, in around the 40% of the community acquiered pneumoniae the causal agent is not identified (8) Furthermore, in most cases, microbiological data is not readily available to the physicians who, nevertheless, needs to take a decision for the treatment. The results obtained so far with around 20 difficult cases (some of them reported in international medical journals) are very promising. The system is now under external validation in five spanish hospitals.

REFERENCES

(1) BEYTH-MAROM, R.(1982).How Probable is Probable ?, A Numerical Taxonomy Translation of Verbal Probability Expressions, **Journal of Forecasting**. Vol. 1, pp.257-269.

(2) AUGUSTINE KONG,A.M., et al. (1986). How Medical Professionals evaluate expressions of Probability. **The New England Journal of Medicine**. Sept. 18, pp 740-744.

(3) BONISSONE, P (1979). The Problem of Linguistic Approximation in System Analysis. **Ph.D. Dissertation, EECS Dept. U.C. Berkeley**. Available in University Microfilms International 80-14618

(4) VALVERDE, L & TRILLAS, E (1985). On Modus Ponens in Fuzzy Logic, **15th Int. Symp. on Multiple-Valued Logic**, Kingston, Canada

(5) BONISSONE, P.& DECKER,K.S. (1986). Selecting Uncertainty Calculi and Granularity: An Experiment in Trading-off Precision and Complexity, in **Uncertainty in Artificial Intelligence**, L.N. Kanal and J.F. Lemmer (editors), Elsevier, pp 217-247.

(6)MILLER G.A. (1967) The Magical Number Seven PLus or Minus Two: Some Limits on our Capacity for Processing Information, in **The Psychology of Communication**, Penguin Books Inc.

(7)NGUYEN, T.A. et al (1987) Knowledge Base Verification. **AI Magazine**, Summer 1987.

(8)MacFARLANE,J.T. et al. (1982). Hospital Study of Adult Community Acquired Pneumoniae, **Lancet 2**, pp. 255-258.