Cadiag-2 and Fuzzy Probability Logics

Pavel RUSNOK [1], Thomas VETTERLEIN, Klaus-Peter ADLASSNIG
Section on Medical Expert and Knowledge-Based Systems
Medical University of Vienna, Austria

Abstract. We briefly describe the medical expert system Cadiag-2, developed to support the differential diagnostic process in internal medicine. We propose a propositional logic called fuzzy probability logic as a possible formalization of Cadiag-2 and indicate the way of transferring Cadiag-2's methodology into this framework.

Keywords. medical expert system Cadiag-2, fuzzy probability logics, differential diagnosis

From the mathematical point of view, Cadiag-2 [1] – a medical expert system to assist in the differential diagnosis in internal medicine – shows some challenging features, e.g., it combines notions of linguistic vagueness and frequentistic uncertainty. Our research aims at formalizing Cadiag-2's logical elements within the framework of a probabilistic logic [2], where we propose to use fuzzy probability logics [3]. We expect new results to improve Cadiag-2's inference engine and a solid mathematical basis for checking the consistency of its medical knowledge base. Cadiag-2 works with two sets of entities: symptoms and diagnoses. Their truth values are from [0,1]. The system's input is a (partial) evaluation that assigns truth values to a subset of the symptoms. The system then applies IF-THEN rules, contained in its knowledge base. Every rule may change the evaluation. A typical IF-THEN rule is (c_d), "confirmation to a certain degree d". The rule (c_d) says that the antecedent of the rule is implying the consequent to the degree min (d,t), where t is the truth value of the antecedent and d its estimated probability that the consequent applies if the premise is fully true. The consequent's actual value is compared to min (d,t) and is updated if it is smaller than the new value. The semantic structure in fuzzy probability logics is a triple (W,e,μ), where W is a set of possible worlds, e is a valuation: $W \times V \to \{0,1\}$ and μ is a measure on W. There are *Boolean* and *modal formulas*. The latter result from atoms of the form Pφ, φ being a Boolean formula, by means of connectives of a chosen fuzzy logic. Pφ stands for the sentence "φ is probable". We translate one part of the inference into the deduction in Boolean logic and the remaining to the deduction in fuzzy modal logic. Thus we describe the inference engine as a deduction in this (two-layered) language. At this stage our work is mainly theoretical, but we intend to obtain a number of formal results to improve Cadiag-2.

[1]   Adlassnig, K.-P. (1980) A fuzzy logical model of computer-assisted medical diagnosis. *Methods of Information in Medicine* 19(3):141–148.
[2]   Ciabattoni, A., Vetterlein, T. On the (fuzzy) logical content of Cadiag-2, submitted.
[3]   Flaminio, T., Godo, L. (2007) A logic for reasoning about the probability of fuzzy events. *Fuzzy Sets and Systems* 158(6):625–638.

[1] Corresponding Author: Pavel Rusnok, Section on Medical Expert and Knowledge-Based Systems, Medical University of Vienna, Spitalgasse 23, A-1090 Vienna; E-mail: pavel.rusnok@meduniwien.ac.at.