

ACUTNESS OF VISION TEST BY FUZZY LOGIC, APPLICATION IN OPHTHALMOLOGIC IN TELE MEDICINE

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ABSTRACT : The principle consists in connecting a patient to an eye specialist situated in a hospital through a telecommunication network. The patient may be at home or any other place agreed for that teleconsultation. The goal is to check eye sight or to detect definite diseases. Test methods other than scales of visual acuteness are not widespread and even less knowledge to implement them, even in alive circles as occupational medicine. So, there is an interest for Public Health to bring these tests in proximity to persons, in some places as schools, firms and so on, tests being implemented from a distance by competent personnel thanks to modern telecommunication means. We will notice in this connection the significance of a visioconference link which make possible the feedback of the tested patient. We have been interested thus in the study of a complete telediagnostic system. Within the scope of this communication, we have realized a method first to automatically determine from a distance the visual acuteness of a subject with the help of fuzzy set theory . The patient Read on a screen (and type out) letters sent by the specialist. Answers are perused little by little with fuzzy logic. After about ten tests (or letters) visual acuteness is displayed .

Keywords : *Fuzzy logic, telemedicine, ophthalmologic.*

INTRODUCTION

All around the world, knowledge and informations are not perfect. Because uncertainty and inaccuracy exist. Human mind is of a great efficiency and flexibility in reasoning, using those informations. One of the stakes of Computer Science and Artificial Intelligence is to try to reproduce human reasoning classical mathematics like bilean algebra and probability theory are not sufficient to give intermediate value between true of false and take in account the imprecision of information. In our application that is visual acuteness, we are concerned by these problems where to decide is not easy. That is why we have preferred a logic that takes in account imprecision, ignorance and approximation in decision systems : the fuzzy logic theory. We expound, in a first part, the justification of the choice of the method in the content of our application. Then, after a brief reminder on fuzzy logic, we define our workspace and the solution we have developed. We finish on the results we have obtained and their validity in relation to classical processes.

APPLICATION TO THE DETECTION OF VISUAL ACUTNESS

Here, we interest us in a method of automatic determining visual acuteness in a distance. The subject, situated at 5 meters from the screen, read on that screen (and made type on his keyboard) characters sent in by the specialist. Answers are perused little by little from the point of vue of fuzzy logic. At the end of ten tests, at the maximum, value of acuteness is displayed.

Visual acuteness is determined by the delimitation of one dimensional domain of perception. The bounds are given by :

-A lower limit which is defined by the size of the smallest perceptible object.

-An upper limit which is defined by the size of an object seen from an angle of 2 degrees (image can go over the edge of macula). In the approach of classical sets, one have the following coarse set (or sharp set) which define aeras where sight is good or not good . We well notice an area (between 0.05 and 1.6) where the response cannot be so categorical and we must ask us on the relevance of coarse sets. That bears out

the use of fuzzy sets. One define then the following belonging function from the following decision thresholds.

$$\mu_{A_a}(x) = 0 \quad \text{si } 0 \leq \mu_A(x) \leq 0.1$$

$$\mu_{A_a}(x) = 0.5 \quad \text{si } 0.1 \leq \mu_A(x) \leq 0.9$$

$$\mu_{A_a}(x) = 1 \quad \text{si } 0.9 \leq \mu_A(x) \leq 1$$

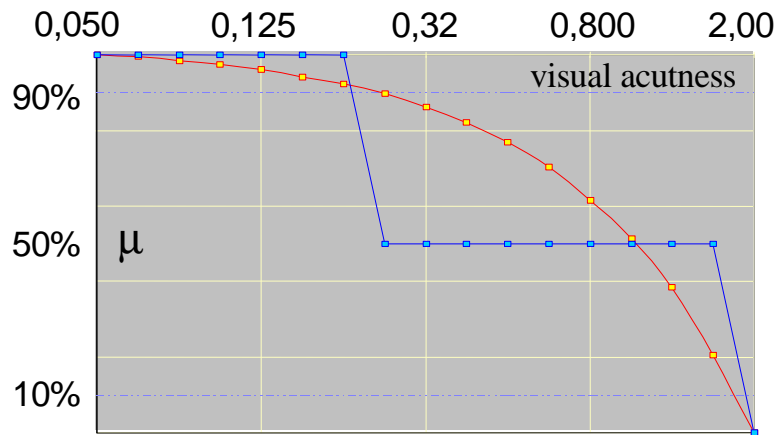


Figure : Initial belonged fonction

AGREGATION OF ANSWERS

The goal is to make A set the less fuzzy as possible to determine acuteness. So we must reduce the value of fuzzy index with a serie of tests. The tests will succeed each other untill fuzzy index goes under his limit value. In that conditions, the answers to the tests must make the belonging functions evolve.

BELIEF FUNCTIONS

It is attractive to test not all the points of the domain with the aim of minimize the number of tests. For that, variation of a point must have an effect on his neighbours.

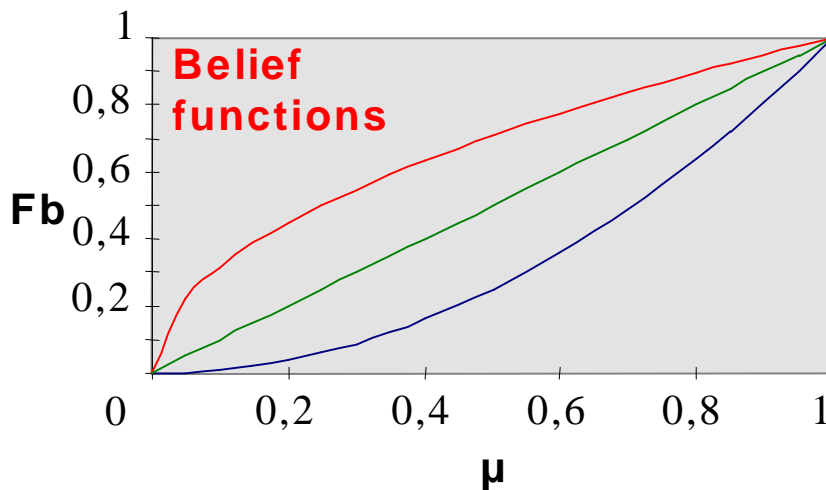


Figure : Belief fonctions

One introduce belief functions which allow to correct the belonging function when the tests are in progress. As answers may be positive or negative,one propose two belief functions $F_b(\mu_A)$ and $F_m(\mu_A)$.

RESULTS

We give an example of application of our method. We Show the evolution of the different curves which lead us to take a decision about the acuteness of the subject. Our method is use in Regional Université Hospital Center of Lille in France.

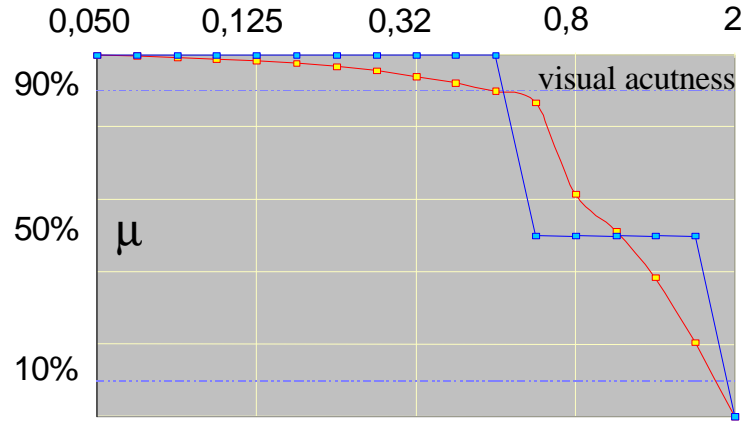


Figure : belonged function after a first test

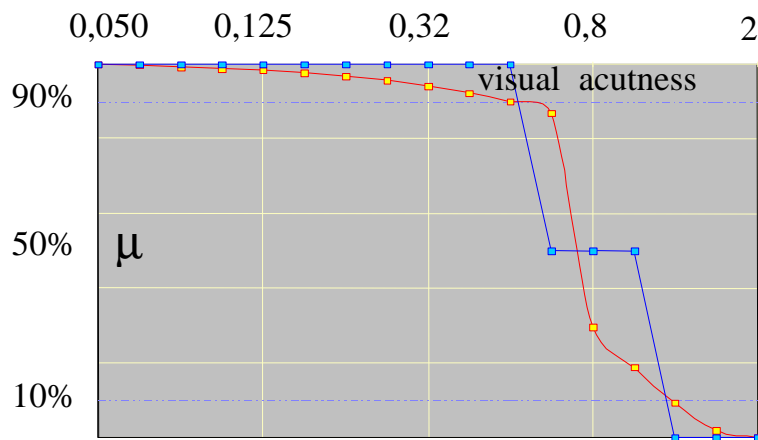


Figure : belonged function after a second test

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