Fuzzy Inf. Eng. (2017) 9: 405–422

Available online at www.sciencedirect.com
ScienceDirect
Fuzzy Information and Engineering
http://www.elsevier.com/locate/fiae

ORIGINAL ARTICLE

Fuzzy Logic Based on Belief and Disbelief Membership Functions

Poli Venkata Subba Reddy

Received: 11 February 2015/ Revised: 3 May 2017/
Accepted: 19 March 2017/

Abstract Many theories are developed based on probability to deal with incomplete information. The fuzzy logic deals with belief rather than likelihood (probability). Zadeh first defined fuzzy set as a single membership function. The two fold fuzzy sets with two membership functions will give more evidence than a single membership one. Therefore there is need of fuzzy logic with two membership functions. In this paper, The fuzzy set is defined with two membership functions "Belief" and "Disbelief ". The fuzzy inference and fuzzy reasoning are studied for "a two fold fuzzy set". The fuzzy certainty factor (FCF) is defined as a single membership function by taking difference between "Belief" and "Disbelief ". The quantification of fuzzy truth variables are studied for "a two fold fuzzy set". The medical expert system shell EMYCIN is given as an application of "a two fold fuzzy set".

Keywords Fuzzy sets · Fuzzy logic and fuzzy reasoning with two fold fuzzy set · Fuzzy certainty factor· Fuzzy truth variables· Medical expert system· EMYCIN

1. Introduction

There are many theories proposed to deal with incomplete information like fuzzy logic, fuzzy probability, probability theory, Dempster-Shafer theory, certainty fac-

Poli Venkata Subba Reddy (✉)
Department of Computer Science and Engineering, Sri Venkateswara University, Tirupati-517502, Andhra Pradesh, India
email: vsrpoli@hotmail.com
Peer review under responsibility of Fuzzy Information and Engineering Branch of the Operations Research Society of China.

https://doi.org/10.1016/j.fiae.2017.12.001

tor, many-valued Logic, possibility theory, plausibility logic, non-monotonic logic, etc. The fuzzy logic[20] deals with belief rather than likelihood (probability). Zadeh defined fuzzy set with a single membership function. The fuzzy set with a two membership functions will give more evidence than a single membership function. For instance "Rama has Headache". In this fuzzy proposition, belief and disbelief are to be considered for better judgement. The fuzzy set "Headache" is necessary to study with a two membership functions $\mu^{Belief}_{Headache}(x)$ and $\mu^{Disbelief}_{Headache}(x)$. The fuzzy set with two membership functions is defined with "True"and "False"[6] and extend to Zadeh fuzzy logic [20]. In MYCIN [1], the incomplete information is defined with two functions MB[h,e] and MD[h,e], where "h" hypothesis and "e" is evidence. MB[h,e] and MD[h,e] are probabilities. The certainty factor is defined as difference between functions MD[h,e] and MD[h,e]. It is possible to define MB[h,e] and MD[h,e] as fuzzy sets and fuzzy certainty factor as difference between these fuzzy sets.

In the following, fuzzy logic and fuzzy reasoning is given briefly for a single fuzzy membership function. The fuzzy logic and reasoning are studied for "two fold fuzzy set"with membership functions $\mu^{Belief}_{Headache}(x)$ and $\mu^{Disbelief}_{Headache}(x)$. The fuzzy certainty factor is studied as difference between two fold fuzzy sets "belief"and "disbelief". The quantification of fuzzy truth variables are studied for "two fold fuzzy set" and finally medical expert system shell EMYCIN is discussed as an example for "two fold fuzzy sets".

2. The Fuzzy Logic

The fuzzy logic [20] is defined as a model to deal with imprecise, incomplete, vague and inexact information transition. The fuzzy set is a class of objects with a continuum of grades of membership.

Definition 2.1 *Fuzzy set A in a universe of discourse X is defined as its membership function* $\mu_A(x) :\rightarrow [0,1], x \in X.\ A = \mu_A(x_1)/x_1 + \mu_A(x_2)/x_2 + \mu_A(x_n)/x_n$, where "+" is union.

For example, the fuzzy proposition "x is young" is given as with membership function.

$$\begin{aligned}\mu_{young}(x) &= (1 + (n/30)^2)^{-1} \\ &= \{0.9/10 + 0.8/15 + 0.69/20 + 0.59/25 + 0.5/30 + 0.42/35 + 0.36/40 \\ &\quad + 0.31/45 + 0.26/50\}.\end{aligned}$$

The fuzzy proposition "x is not young" is also given as .

$$\begin{aligned}1 - \mu_{notyoung}(x) &= (1 + (n/30)^2)^{-1} \\ &= \{0.1/10 + 0.2/15 + 0.31/20 + 0.41/25 + 0.5/30 + 0.58/35 \\ &\quad + 0.64/40 + 0.69/45 + 0.74/50\},\end{aligned}$$

For instance, the fuzziness of "Rama who is 40 years old is YOUNG is 0.64".

The Graphical representation of "young" and "not young" is shown in Fig.1.