Combination Method of Evidence Grouping

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Abstract. The theory of Evidence reasoning is an important method for processing uncertain information, in order to improve the accuracy of evidence fusion and to reduce the amount of operation, and ensure that combining results are still reasonable and effective when it happens to information conflicting, so this paper presents combination method of evidence grouping. The method can be used to judge whether it is available to combine with Dempster combination rule in evidence, if it works, the two evidences are classified as known groups, otherwise they are classified as unknown groups. For the known evidence, it makes use of combination rule to combine directly(combination within the group); the data obtained by the combination within the group and the data of an unknown group can combine in groups using computer simulation techniques, this paper analyzes the method that it is provided with characteristics of small operation, good stability, high accuracy.

Dempster Fundamentals Rules

Demspter-Shafer theory has been put forward by Demspter in 1976,and been improved and expanded by shafer, Demspter-Shafer theory is also been known D-S Theory(DST). DS evidence theory is an important method in uncertainty reasoning,and for uncertainty and unknow evidence ,the D-S evidence theory is more suitable than traditional probabilistic.Furthermore, various of evidence can be combinated by combination rule of D-S Theory.The relevant rules of D-S Theory as follows:

Θ is defined as a frame of discremment in evidence theory, if the set function can meet the following two conditions:

$$\begin{cases} m(\phi) = 0 \\ \sum_{A \subseteq \Theta} m(A) = 1 \end{cases} \quad (1)$$

Then, m is called basic probability assignment,and $Bel(A) = \sum_{B \subseteq A} m(B)$ is called belief function.

Listed below is the most valuable part of the evidence theory. N basic probability assignment function($m_1, m_2, ..., m_n$)to identify the framework on which the orthogonal and defined as

$m = m_1 \oplus m_2 \oplus ... \oplus m_n$

$$\begin{cases} m(\phi) = 0 \\ m(A) = K^{-1} \prod_{\cap A_i = A} \prod_{1 \le i \le n} m_i A_i \end{cases}$$

(2) $K = \prod_{\cap A_i = \phi} \prod_{1 \le i \le n} m_i A_i$, K is the conflict factor, combining results m(A) reacts the $m_1, m_2, ..., m_n$ united supporting degree of Proposition A.

Measurement of conflict level

The conflict factor K in D-S combining rules reflects the conflict relation in evidences. If $K \neq 0$, the combining result will be the trust which experts focus on proposition A; if K = 0, m_1 is conflicted with m_2, there is no orthogonal and can not use D-S theory to achieve inference. k = 1-K represents the level of conflict in evidences, it reacts collision state in evidences, the larger k value is, the greater conflict in evidences. It is commonly used the value of k to reflect the conflict in evidences[1].

However, there is still no uniform standard for the measurement of conflict in evidences[2] , lets $m \oplus (\phi)$ as a measure of conflict in belief functions has obvious shortcomings. Therefore, Liu [3] introduced the distance between the two evidence Pignistic BPA probability value (referred to as difBetP), and made the $cf(m_1, m_2) =< m \oplus (\phi), difBetp >$ binary measure as a measure of conflict basis, it discusses the application scope of Dempster combination rule:

1) $m \oplus (\phi) > \varepsilon$ and difBetP>ε, it is unable to use;2) $difBetp \geq \varepsilon_2$, is not recommended to use;

3) $difBetp \in (\varepsilon_1, \varepsilon_2)$, it is be cautious to use;4) $difBetp \leq \varepsilon_1$, it is able to use.

Liu[11] can be obtained by experimen $\varepsilon \in [0.85,1], \varepsilon_1 \in [0,0.3], \varepsilon_2 \in [0.8,1]$.

According to the criteria of the measurement of conflict, if there is a conflict in evidences, amount to K = 0, it can not achieve inference by using the D-S theory. Thus the following conclusions can be obtained, because of the advantages of evidence theory in its uncertainty, measurement and composition, it has to get more and more attention in the field of uncertain inference, but it can be found in practical application, on the one hand since D-S combining rule abandoned independent focal element conflict, the practices of the information structure belief functions based on without any contradiction makes that the combining results are often counterintuitive humans [4], for the reason, the scholars in worldwide have research on evidence theory combining formula to improve, but when it resolves the failure problem caused by the evidence of combination conflict, to modify model is more effective than to modify formula.

Idea of Group Combination Method

In this paper, evidences are grouped by the conflict level in evidences, when grouping the static weights will be adopted for different evidences[5]. The static weights as prior information reflect the different reliability and authority which belong to the different sources of evidence identify the identification of true subset in frames. It reflects the self-reliability of evidence in trust discount. The determination methods of static weight exist subjective and objective weighting method, if there is no special instructions, evidence source is generally considered with the same static weight, when there are n sources, so when in discount calculation, for each source of evidence static weights $x_i = 1/n, \in n$, .Assuming a discrimination problem identification framework, there are L evidence $e_i, i = 1,...,n$, that static weights is $\omega_i, \omega_i \in [0,1]$ and each of the evidence in the initial reliability under various propositions, for the static weight of the evidence-based discount after referred to as Under Proposition H_j probability dispatch for $m_{ij}^{\omega_i} = \omega_i B_{ij}$.

In this article, it is regard as after discount for the static weight of the evidence, and it can greatly reduce the conflict level in evidences, thus it can validate the rationality and practicality of combination method of grouping. The core idea of grouping combination method is according to the application scope of the measure referenced conflict of D-S combination rule, and then the thought can be summarized in two points[6]:

(1) Given two evidence, if, (as in this article use k value as a measure of conflict, it is worth obtaining Unlike difBetP, too large to difBetP, so it is different from the citations in the range of $difBetp \leq \varepsilon_1$), then Description DS combination rule can be used, as the same set of evidence, the direct use of this rule synthesis, synthesis of evidence that is within the group;

(2)If the distance k between the two evidences is not satisfied, then it might get contrary conclusion with facts if it adopts D-S combination rule, then it will be regarded as different groups of evidence. After all the evidence being grouped, amending them by optimizing model, and making the distance K in the evidences minimized, then to combine with Dempster combination rule, that is evidence combination in groups.

Specific groups as follows:

(1) Create the first group of uncombined evidence , new evidence mi classified in the group;

(2) When the new evidence arrived, searching in each group of uncombinedevidence, if the condition is found then go to continue (3), otherwise go to (4);

(3) If the group j and the new evidence found among the evidence, then using Dempster combination rules to combine eividence m_i,m_j, the corresponding value of evidence in group j is g_j, then go to (5);

(4) Recreate the n+1 group of evidence, and the new evidence mi is classified in this group, go to (5);

(5) Decide whether there is new evidence, if it presents then proceeds to (2), or else go to the evidence combination in groups.

The total process of Specific groups as the follow figure:

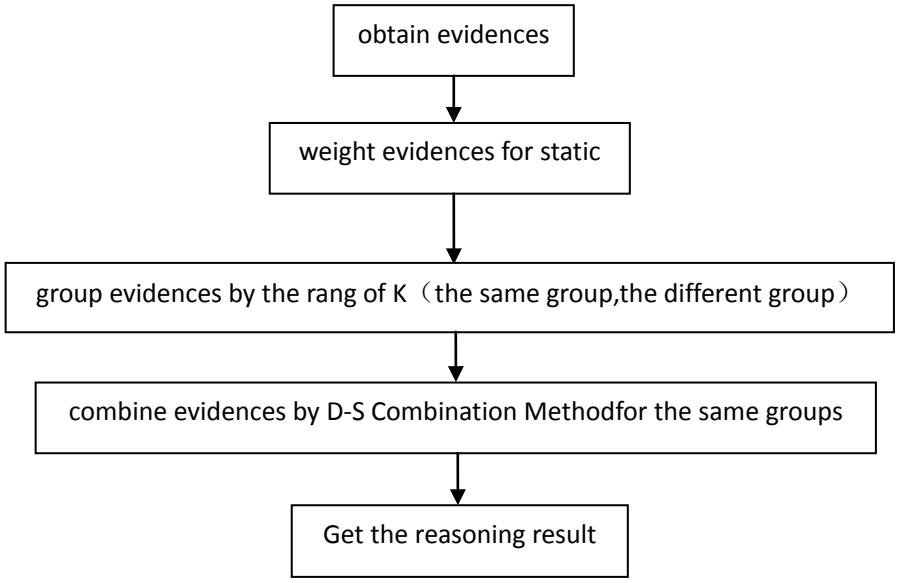

Fig.1: the process of combination method of evidence grouping

Evidence combination in groups

Optimized synthetic rules of evidence reasonably avoid conflicts traditional algorithms synthesis results counterintuitive problem. In this paper, the use of computer simulation technology to improve the synthesis algorithm [7], because the synthesis within the group obtained by the value of the probability function $m_j(j=1,...,n))$ are independent, small data, but the sum of these tiny data is decisive for the synthesis of the results effect. So among the evidence cited in this article are set in [7] is an improved combination rule, using Matlab simulation software for the synthesis of the evidence in the group data for statistical analysis, to determine the distribution of the data (normal distribution) based on statistical analysis, and further identified simulation Model($y=\mu+\sigma\sqrt{2}\sum_{k=1}^{6}(\xi_k-3)$) to obtain the model parameters (μ and σ) using Matlab program generates a large sample simulation data. Then, the simulation data to test whether there is a significant difference between the inner judge simulation data and set evidence synthetic data, if there are significant differences in the use within the mean instead of group simulation data synthesized evidence of data as a whole, trust propositions degree metric participate reasoning. By knowledge of probability and statistics shows that although the simulation data is based on the

synthesis of evidence within the data set available, but the distribution of the data distribution within the simulation evidence than synthetic data set uniform, reasonable and in the mean closer to the true value, more objective, and therefore the improved algorithm using synthetic conducted D-S theoretical reasoning, more accurate results than the use of conventional synthetic inference algorithm.

Conclusion

In this paper, it takes use of the average method of static weight to optimize the initial evidence, reducing the conflict level in evidences and achieving the greatest combination within the groups. Then it adopts the method of grouping to combine, the evidences are combined within the group for the value of conflict factors which meets the range, it achieved reasonable grouping and combining of evidence, obtained intermediate results of inference; finally it improves combination algorithm by simulation technology, and improves algorithm of evidence combination in groups, it solves the problem that traditional combination algorithm can not be combined in order to obtain the final inference result. It ensures that the information conflicts combining results are still reasonable and effective, and it improves the accuracy of the convergence of evidence and reduces the computation of fusion, it has strong practicality and usefulness.

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