A Survey on Multi-Objective Decision Making on Vague Sets

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Abstract— This paper provides report of a survey on the vague sets and also multi-objective decision making. As a further fuzzy set theory generalization, the vague set theory can overcome the fuzzy set shortcomings through defining the membership from two different sides of both FALSE and TRUE, rather than only through a value of a single membership. MCDM approach has evolved to accommodate numerous application types. Methods dozens have been developed, with even small variations in the existing approach causing the creation of research of new branches. The MCDM analysis approach performed in this paper provides a clear guide for how MCDM methods should be used in specific situations.

Key words: Data Mining, Vague Sets, Fuzzy Sets, Multi-Objective Decision Making

I. Introduction

A. Data Mining

Data mining refers to extracting or "mining" knowledge from huge volume of data [1]. By performing information mining, interesting knowledge, reliabilities, or high-level data can be extracted from database and viewed or browsed from various method. Data mining is regarded as one of the essential frontiers in database framework and one of the encouraging integrative evolution in the information industry.

Unexpected improvements in record collections and storage collections have enabled the association to combine much amount of volume of records. It has been already measured that the quantity of records in the world are going to double in each twenty months and it doubles the size and numbers also of the catalogues are increasing much faster. Though, collecting the useful data is considered as a easy task [2]. The area of data mining is vast and contain several sub-fields. The foremost emerging fields is the mining of association rule field that has been discussed further.

Rule mining is a characteristic of data mining as well as a process of Knowledge Discovery in Databases (KDD), where various available data sources are explored, [3].An expert system integrates knowledge, facts and reasoning methods in making a decision. Expert system [4] consist of a knowledge base as a major module. Knowledge base maintain domain specific information in the form of heuristic rules. Rules or heuristic rules describes method of reasoning used to solve a definite issues. From this feature the concept of "Association Rule Mining" evolved. Association rule mining determines correlation relationship or interesting association among a big items data set.

B. Fuzzy Sets and Vague Sets

Fuzzy association rule mining primary started in the discovery of knowledge in the systems of Fuzzy expert. A system of fuzzy expert [7] uses a fuzzy membership functions set and rules, Boolean logic instead, to reason about data [8]. The rules [9] in a system of fuzzy expert are generally of a form similar to the following: "If it is raining then put up your umbrella" Here if antecedent part and then part is the part of consequent. This rules type as a set helps in pointing towards any solution with in the solution set. But in Boolean logic case all knowledge attribute is measured only in terms of yes or no, in other words negative or positive. So it never permit us to contain the diverse solutions field. There are numerous other different fuzzy logic methods which are in use in fuzzy association rule mining [10].

There are numerous statuses of a hesitation information piece (called hesitation status (HS)). Let us consider a motivating such as an online shopping scenario that conclude numerous statuses: (s_1) HS of the items that the user browsed only once and left; (s_2) HS of the items that are detail browsed (e.g., the figures and each conditions) but not put into their internet shopping carts; (s_3) HS of the items that user put into carts and were checked out finally. Each of the above-mentioned HSs are the hesitation knowledge of those items. Few of the HSs are comparable based on the some criterion, which means we can describe an order on these HSs. Such as, provide a criterion as the possibility that the user an item buys, we have $s1 \leq s2 \leq s3$.

The hesitation data can then be used to implement and design selling approaches that can potentially turn those "interesting" items into "under consideration" items and "under consideration" items into "sold" items.

Our modelling HSs methods of an item rests on a vague set theory solid foundation [11]. The main advantage of this method is that the theory addresses the single membership value disadvantage in fuzzy set theory through applying interval-based membership that captures evidence three types with respect to an object in a universe of discourse: hesitation, support and against. Thus, we naturally model the hesitation item data in the mining context as the hesitation evidence with respect to an item. The knowledge of the "sold" items and the "not sold" items (without any hesitation data) in the AR mining classical setting correspond to the evidence of support and against with respect to the item. Such as, if a user bought an item 5 times, hesitated to buy (when different HSs are not distinguished) it 2 times, and did not browse it 3 times (in 10 visits), then we can obtain a vague membership value,[0.5, 0.7] (where 0.7 = 1-3/10), for the item. When we distinguish various HSs,say the user hesitated to buy the item 2 times in HSs s1 once and s2 once, where$s1 \leq s2 \leq s3$. Then the vague membership value for s1 is [0.5, 0.6] and that for s2 is[0.6, 0.7]. As for s3, since there is no hesitation evidence for it, and $s2 \leq s3$, its value of vagueme mbership is a single point, [0.7, 0.7].

To study the relationship between the hesitation evidence and support evidence with the item respect, we propose hesitation and attractiveness of an item, which derived from the vague membership in the sets of vague.

Applying the items of hesitation and attractiveness, we model a database with the hesitation knowledge as an AH-pair database that AH-pair transactions consists, where Astands for attractiveness and also H stands for hesitation. Based on the database of AH-pair, we then propose the VARs notion, which capture four relationships types between two items sets: the implication of the hesitation/attractiveness of one items set on the hesitation/attractiveness of the other different items set. Such as, if we find anAH-rule like “People always purches quilts and pillows(A) but quit the buying beds process at the level of choosing delivery method(H)”. To evaluatethe quality of the various kind of VARs, four kind of confidence and support are defined.

1) Vague Sets

Let I be a classical set of objects, called the universe of discourse, where an element of
I is denoted by x.

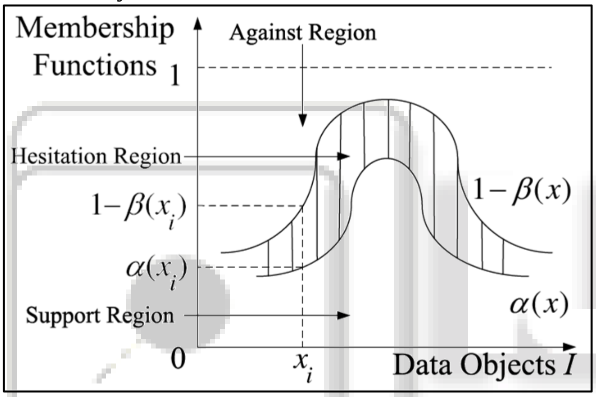

Fig. 1: The true (α) and False (β) Membership Functions of a Vague set

(Vague Set) Gau’s and Buehrer [12] describe the vague sets. A vague set V notion in a discourse universe I is categorized through a function of true membership, β_V , and a function of false membership, α_V , as follows:

α_V : I ->[0,1] , β_V : I ->[0,1], where

$\alpha_V(x)+ \beta_V(x)\leq 1$,

$\alpha_V(x)$ is a lower bound on the membership grade of x derived from evidence for x, and $\beta_V(x)$ is a lower bound on membership grade of the negation of x derived from the evidence against x. Suppose I = {x_1, x_2, …, x_n }.

The membership grade of x is bounded to the [$\alpha_V(x)$; 1- $\beta_V(x)$], which is a sub interval of [0,1] as depicted in the Fig. 1. For brevity, we omit the subscript V from $\alpha_V$and β_V.We say that to [$\alpha_V(x)$; 1- $\beta_V(x)$]/x is a vague element and the interval to [$\alpha_V(x)$; 1- $\beta_V(x)$] is the object xvague value.

C. Vague Association Rule Mining

In this section, the Hesitation Statuses (HSs) idea of an item is present and discussed how to the model HSs. Then the VARs notion and four kinds of confidence and support used in order to completely evaluate their quality. Few VARs properties that are valueable to increase the mining VARs efficiency are presented.

1) Hesitation Information Modeling:

A HS is a particular state between two different conditions of “not buying” and “buying” in the purchase transaction process.

Here we use a extra detail such as placing an order with “Amazon.com” to illustrate the HS idea. There are following nine level, which queue forms, toplace an order: (s1) Find queue items; (s2) Add the shopping cart items ;(s3) Proceed to checkout; (s4) Sign in; (s5) Enter an address of shipping; (s6) Choose a shipping technique; (s7) Provide an knowledge of password and payment; (s8) Review and order submit ; (s9) Check your status of order. A customer may quit the ordering procedure at any level for few reason, such as,forgetting the name of sign or password. Therefore, the HSs with respect to various quitting level are various, since the more level a user goes, the higher possibility the user buys the item. However, some HSs are incomparable.

2) Attractiveness and Overall Attractiveness:

The x attractiveness with respect to the an HSs_i, describe as $att(x, s_i)$ is dscribe as the median membership of x with respect to the S_i that is $\frac{1}{2}\left(\alpha_i(x) + \left(1 - \beta_i(x)\right)\right)$.

The complete x attractiveness is a function $ATT(x){:}\, I \rightarrow [0,1]$ such that $ATT(x) = \frac{1}{2}\left(\alpha(x) + \left(1 - \beta(x)\right)\right)$.

Provide the Intent [αV(x); 1- βV(x)] of an object x for an HS si, we've a one-one correspondingpair of the beauty and hesitation of x, called the AH-pair, denotedas [att(x; si); h(x)]. Good looks and hesitation are two predominant standards, sincepeople can have certain curiosity to find ARs with gadgets of excessive beauty (soldwell) or high hesitation (almost sold).

We now define an AH-pair transaction and an AH-pair database.

3) Vague Association Rules and their Support and Confidence

We now present the VARs notion and describe the VAR confidence and support. Definition 6. (Vague Association Rule) A VAR, r = (X ->Y), is an association rule obtained from database of AH-pair.

Based on the item hesitation and attractiveness with respect to an HS, we can describe various kind of confidence and support of a VAR. For this purpose, we define AH support and AH confidence of a VAR to evaluate the VAR. Similarly, we can obtain the association between an itemset with excessive hesitation and an additional itemset with high attractiveness, between two itemsets with excessive attractiveness, and between two itemsets with excessive hesitation for one of a kind purposes. Accordingly, we define some kind of support and also confidence to evaluate the VARs as follows:-

D. Multi-Objective Decision Making

A General Overview Multi-Attribute Decision Making is the most well known branch of decision making. It is a branch of a general class of Operations Research (or OR) models which deal with decision problems under the presence of a number of decision criteria. This super class of models is very often called multi-criteria decision making (or MCDM). According to many authors (see, for instance, [13]) MODM studies decision problems in which the decision space is continuous. A typical example is mathematical programming problems with multiple objective functions. The first reference to this problem, also known as the "vector-maximum" problem, is attributed to [14]. On the other hand, MADM concentrates on problems with discrete decision spaces.

Although MADM methods may be widely diverse, many of them have certain aspects in common [15]. These are the notions of alternatives, and attributes (or criteria, goals) as described next.

1) Alternatives

Alternatives represent the Different picks of action to be had to the choice maker. Mostly, the set of possible choices is believed to be finite, ranging from a few to hundreds. They're supposed to be screened, prioritized and eventually ranked.

2) Multiple attributes:

All problems of MADM is associated with the multiple attributes. Attributes are also mentioned to as "aim" or "criteria of decision". Attributes represent the various dimensions from which alternatives can be viewed.

3) Conflict among attributes:

Since various attributes represent various alternatives dimensions, they may conflict with all other.

4) Incommensurable units:

Various attributes may associated with various measure units. For example, in the buying a car case, the attributes " mileage" and " cost " may measured in dollars and thousands terms, respectively. It is this nature of containing to consider various units which creates MADM to be intrinsically hard to solve.

5) Decision weights:

Methods of MADM need that the attributes be assigned weights of significance. Commonly, these weights are normalized to add up to one.

E. Main Features of MCDM

In the common, there exist two different MCDM problems types because of the varioussettings of problems: one kindcontaining an alternative solutions number and also other different and solutions of various number. Generally in the problems associated with the assessment and selection. If this is the case, the issue is referred to As more than one goal optimisation issues rather of a couple of attribute selection problems. Think there are m choices to be assessed founded on n attributes, a choice matrix is a m × n matrix with each and every aspect Yij being the j-th attribute value of the i-th substitute. Despite the fact that MCDM issues might be very exclusive in context, they share the following fashioned aspects.

1) Multiple attributes/criteria often form a hierarchy

Almost any alternatives, such as an employer, an action plan, or a made from any form, can be evaluated on the basis of attributes. An attribute is a property, excellent or characteristic of choices in query. Some attributes may just wreck down additional into minimize levels of attributes, known as sub-attributes. To evaluate an substitute, a criterion is installed for each and every attribute. MCDM itself will also be referred to as Multiple Attribute Decision Analysis (MADA) if there are a finite number of alternatives.

2) Conflict among criteria

Multiple criteria generally conflict with one another. Such as, in the car designing, the Criteria of higher gas economic system could mean a decreased alleviation rating as a result of the smaller passenger house.

3) Hybrid nature

1) Incommensurable units - An attribute may be a measurement of various unit. In the car selection issue, economy of fuel is measured through miles per gallon, and price is define through pound sterling etc. In numerous decision issue, attributes may even be non-quantitative.
2) Mixture of quantitative and qualitative attributes. It is possible that few attributes can be measured numerically and other different attributes can only be define subjectively.
3) Mixture of probabilistic and deterministic attributes. Such as, in the car selection issue, car price is deterministic and fuel economy could be random.

4) Uncertainty

1) Uncertainty in the judgments of subjective It is general that a person may not be 100% sure when creation subjective judgments.
2) Uncertainty because of lack of data or incomplete knowledge Sometimes knowledge of few attributes may not be completely presentable or even not presentable at all.

F. MCDM methods

The literature review examined scholarly literature referring to selection evaluation. With a purpose to establish those articles that offered probably the most priceless understanding, a search was performed for long-established MCDM methods in title, summary, and keyword phrases, making use of the following databases: Elsevier, Springer, ScienceDirect, and IEEExplore. These integrated journal articles and conference proceedings concentrating most of the time on the areas of operations study and administration science. These were narrowed right down to articles that serious about application of widespread MCDM systems. Each paper was once grouped by means of its MCDM technique and reviewed entirely. The following eleven MCDM methods were recognized throughout the overview: 1) Multi-Attribute Utility idea, 2) Analytic Hierarchy process, three) Fuzzy Set conception, 4) Case-headquartered Reasoning, 5) knowledge Envelopment analysis, 6) easy Multi-Attribute score manner, 7) goal Programming, eight) ELECTRE, 9) PROMETHEE, 10) easy Additive Weighting, and eleven) procedure for Order of alternative via Similarity to best resolution. The next sections deal with each designated process first with a abstract and dialogue of the reviewed reviews, and then comply with with a brief dialogue of the general technique and an examination of the advantages and drawbacks of every method.

G. Some mcdm application areas

Some of the industrial engineering MCDM applications conclude the decision analysis use in the integrated manufacturing [16], in the evaluation of methodology decisions of investment, in the systems of flexible manufacturing [17], design of layout [18], and also in other different problem of engineering. As an illustrative application considers the case in which one wishes to computer system upgrade of a CIM facility. There is a various configurations presentable to choose from. The various systems are the alternatives.

A resolution must additionally keep in mind problems similar to: rate, performance traits (i.E., CPU pace, memory potential, RAM dimension, and so forth.), availability of program, upkeep, expendability, and many others. These could also be one of the crucial decision standards for this quandary. Within the above quandary we are excited about selecting the fine replacement (i.E., pc approach). In any other situations, nevertheless, one could also be keen on deciding upon the relative importance of all the possible choices into consideration. MCDM plays a principal function in lots of actual existence issues.

II. Related Work

An Lu, Yiping Ke, James Cheng, and Wilfred Ng [19] applied theory of vague set in the AR mining context as to conclude the hesitation data into ARs. Defines the hesitation and attractiveness idea of an item, which characterize the complete customer's data intent on an item. Depending on these two different idea, proposed the VARs notion and designed an efficient algorithm to mine the VARs. Experiments demonstrate that the algorithm was efficient and the VARs capture more exact and better knowledge in turn to conventional ARs.

An Lu et al. [20-21] aids in recognition of what is improved within the Sets of Fuzzy, Intuitionistic Fuzzy Sets and also Sets of Vague also giving VARs notion through applying two different more measures:data item of hesitation and attractiveness permits interval-based membership to confine more evidence to universe object. The theory of vague set has been applied to education field for mining association rules.

An Lu and Wilfred Ng [22] devised an algorithm for the issue, provide a relation of vague r over a method of R and a FDs set F over R, what is the "best" approximation of r with respect to F when taking intomedian membership (m) account and the imprecision membership (i) thresholds. Employing these two thresholds of a vague set, defined the notion of mi-overlap among vague sets and a merge operation on r. Satisfaction of an FD in r is defined in terms of values being mi-overlapping. The main outcomes is that the output of the process is the most object-precise approximation of r with respect to F. The complexity of VChase(r, F) is polynomial time in the sizes of r and F.

Anjana Pandey and K.R.Pardasani [23] presented a vague association rule to make available hesitation information and expand an algorithm to mine the hesitation information. The algorithm was devised to mine the courses and the hesitation of students to attend the courses. Experiments on real datasets confirmed that the algorithm to mine the Vague Association Rule is effective. In contrast to the conventional Association Rule mined from transactional databases, the Vague Association Rule mined from the AH-pair databases are more detailed and capable to capture better information.

Starr and Zeleny[24] give a brief outline of the origins of MODM in the field of management science. This work began in the early 1950's. After initial contributions, the next major contribution was that of goal programming. In goal programming, a multiplicity of objectives are reduced to a single objective by minimizing deviations of each objective from certain pre-specified target levels or goals. The following decade saw traditional utility extended to multiattribute utility theory, and with Johnsen's (1968) study on the multigoal nature of the firm, Starr and Zeleny (p.12) suggest that "multiple criteria decision making was firmly on its path."

In the naive approach used by Wallenius, the OM chooses a desired solution and is told only whether or not it is feasible; no attempt is made to find an efficient solution. And Martinson [26] has used a minmax formulation where the objectives were normalized using the fractional achievement norm. In his solution method the OM was required to provide a set of weights which reflected the relative importance of each objective. These were then used to find the achieved solution. Some practical experience with this approach has indicated that the OM often has difficulty in relating the achieved solution to the particular set of weights chosen.

Considerable research effort has been directed to finding solution methods which ensure that only efficient solutions are generated; in fact in many MODM solution methods, the actual optimization involves nothing more than distinguishing between efficient and inefficient solutions. As will be seen from the literature review to follow, almost all MODM solution methods only consider efficient solutions; consequently the characterization of efficient solutions is of high priority. Kuhn and Tucker, in presenting necessary and sufficient conditions for solving the single objective optimization problem, also extended their work to the mul tiple objective case. Let 1T i' i = 1, 2, . . . m be the Lagrange multipliers for each constraint of X and assume that the objective functions are concave and the feasible set X is convex.

A subjective approach is one whereby objectives are either included or excluded on the basis of preference information which is provided by the OM. Any successful approach for reducing the number of objectives will be a balance between both analytic and subjective approaches. This balance is well illustrated in Keeney and Raiffa [26] where they cite examination of the literature, analytical study and casual empiricism as being relevant considerations in determining the objectives for a MOOM.

III. Conclusion

This paper proposes a brief idea of vague set based approach for extracting patterns based on attractiveness and hesitation. Due to the use of this concept, an elaboration of the whole mining and the sub-fields of mining have been explained. The multi objective decision making has also been explained in detail. Based on this survey, literature review has been mentioned so as to explain all the work done till date. This concept helps in exposing necessary knowledge that may also be considered for profitable decision making process.

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