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Mathematics of Multisets

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ABSTRACT

Numerous fields of modern mathematics have developed in violation of the fundamental principles of a particular theory because the structures that are useful can be described in this manner. For example, modern non-Euclidean geometry is being developed due to the belief that it is the case it is impossible to establish it is true that the Parallel Axiom does not hold. Similar to multisets they are defined by the assumption that for a certain set a, elements x are repeated with a finite frequency. The term bags may also call multisets" but some view the term "bag" to be vulgar "heap", "bunch", "sample", "occurrence set", "weighted set", and "fireset" finitely repeated sets of elements. One argument against the idea of "bag" is vulgar enough is the fact that this word is a common English word that refers to something used to place objects in to transport the items around. In addition, in English mathematic literature, it is normal to employ simple terms like group set and ring, in contrast to other disciplines, where researchers develop lengthy new terms by joining Greek and Latin words together. Also, it is worth noting that the term "multiset" was coined by N.G. de Bruijn. In his well-known research, the first person who used multisets is Richard Dedekind. From a practical perspective, multisets are extremely beneficial structures used in many fields of mathematics and computer science. Primary factorization involves changing an integer with n > 0. This is an N-multiset, whose constituents are all primes. Every single multinomial f(x) with complex numbers linked is naturally in a multiset with "roots". Multisets also represent the zeros and poles of meromorphic functions. They also contain an invariant of matrices found in canonical form, and the invariant for infinite Abelian groups, for instance. The strings that end context grammars are the multiset that's created when the grammar isn't ambiguous. The processes that operate on the system can be considered multisets. The mathematical method of concurrency is to make the application of multisets. In social sciences, multisets are used to depict social structures.

Keywords- finite frequency, Primary factorization, complex numbers, infinite Abelian groups.

I. INTRODUCTION

Ordinary sets consist of various element pairs, i.e. each element is the same. If we permit this to be permissible, i.e., if we can allow multiple but limited elements, it is an extension of the notion of a set, which is known as a multiset. There are two types of sets that offer the possibility of having a finite number of repeating elements: sets with specific repetitions e.g. people sharing a common characteristic or sets that are not distinguishable repetition elements e.g. the word "soup" is a reference to the term "soup" comprised of elementary-level particles. Monro refers to the primary type of multisets and the second kind of multinumbers. To keep things clear, let us use the term "multiset" to describe Monro's multinumbers and "real" multisets to define Monro's multisets. Multisets and real multisets may be linked with the ordinary set as well as equivalence relations or functions. Because multisets can be defined as sets comprising many limited instances of every element, it's possible to construct multisets with lists. To avoid confusion, we'll employ brackets that are in the form of braces for multisets as well as squares in making sets. Next, we'll use the most effective definition method to every situation we encounter. A major and crucial concepts within the study of set theory concerns the notion of subsets. Additionally to normal sets, there are certain actions you can apply to sets, for example, union, set intersection, and so on. The next step is to define the meaning of the concept of the subsets of a multiset as well as the interactions between multisets.

Method	Description
iterator()	Returns an ***iterator*** over the elements in this collection.
remove(Object element)	Removes a ***single occurrence*** of the specified element from this multiset, if present.
remove(Object element, int occurrences)	Removes a ***number of occurrences*** of the specified element from this multiset.
removeAll(Collection<?> c)	Removes all of this collection's elements that are also contained in the specified collection (optional operation).
retainAll(Collection<?> c)	Retains only the elements in this collection that are contained in the specified collection (optional operation).
setCount(E element, int count)	Adds or removes the necessary occurrences of an element such that the element attains the desired count.
setCount(E element, int oldCount, int newCount)	Conditionally sets the count of an element to a new value, as described in setCount(Object, int), provided that the element has the expected current count.
toString()	Returns a string representation of the object.

SOURCES:
https://encryptedtbn0.gstatic.com/images?q=tbn:ANd9GcR5OdmO9kRmJDRh6NWjD5YWEWWGEFgmYYD6rA&usqp=CAU

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II. HYBRID SETS

The new sets and hybrid sets or sets are explained as the generalization of sets and multisets. In a hybrid setting, there are elements that may be zero in negative numbers or a positive value. A new set is classified as a hybrid that is also an instance of multiset i.e. a specific circumstance. It is known as a hybrid because of Loeb. The universe is U can be defined as every function in form f: U - Z, where Z is the whole number of numbers. It is known as a 'hybrid set. What value of f (u) is thought to be the multiplicity of the element called u? If the value of f (u) has zero value, it is possible to say that u is a component of "F". In this situation we write u as in form f. In the opposite case, the opposite is to write u in place of 'U'. A number of elements, #f is the sum that can be described as U f (u). F is also known as a "#f" (element) combination set. Hybrid sets are identified by using the list method, and by using a bar to differentiate elements with negative multiplicity, and with a positive multiplicity. The elements with positive multiplicity are displayed on the left of the bar. Elements with negative multiplicity are on the right-hand part of the bar. Example 2. If f = a B, b E, that is the case, the value of f (a) is one. F (b) is 2 and the value of f (d) equals -1 and the f (e) is 2. As per the name, a non-compliant hybrid or empty is the unique hybrid set in which each element has the same amount of elements. There is a way to identify a non-filled hybrid set as a subset. Subset-hood is a term that can be used to define the context for hybrid sets in addition to Loeb

Consider the two sets be considered as hybrid sets. It is possible to declare this subset forms part of the set g. The g set includes the subset f. We can write f g in the case that you select one of the following: f (u) g(u) for the entire U from g(u) plus f(u) g(u) within all u, which is an arrangement that is part of the integers using the formula following: I j in the event that > j and the J is greater than 0 or I is less than. We will now go over the definitions of the various methods employed by the hybrid sets.

Take into consideration that f and g are two sets of hybrids with the same universe U. Their interplay, f creates the set is known as the hybrid, in this sense: h(u) can be described as max(f(u), g(u)) and their union F g is the hybrid set in which the h (u) corresponds to the min (f(u), g(u)) and their sum is the sum of f and g. This is the hybrids in with h. In this case, the h (u) can be described as the sum of f (u) and the t (u). It is easy to confirm the validity of these definitions by using Subset Hood's description.

There are three different ways to define an item, and we'll have to remember them in the future since they will be used throughout the rest of the book.

1. A set is defined by naming the members of that set (the list method). This method is suitable only for sets that have finite members. Set A, with the members A1, A2, and n is often described with this formula: A.
2. An established set may be described as the property that is satisfying by the members (the most common method). The most popular way to express the concept is "A = P (x) is used to refer to the expression "such which" while the word (x) is an assertion of an amorphous form "x is the property that belongs to P."
3. Sets are identified using an operation typically called "the typical function. It specifies which elements of a general set X belong to set A, and which elements don't. The definition of the set is determined by its basic function, khA. This is: (x) = 1 If the khA (x) equals 1. Ax is zero.

In the following section, we'll discuss the definitions of multisets and the basic operations that multisets perform. Additionally, we will briefly describe the hybrid multisets i.e. multisets that contain multisets with negative numbers and they also have nonnegative integers. Then, we will take an approach that categorizes multisets by defining various types of multisets. Then, we will discuss fuzzy multisets and their functions. The final part of the presentation is the pomsets and their fundamental operations.

In the field of set theory, an element can be classified as belonging to or belonging to a set. If we allow several instances of an object to form part of a "set" Then new structures are created. These structures are described within the field of literature by their name: multisets. The most common way to define a multiset is that it is defined as an equation A: D-N The domain D is the realm from which parts from A can be drawn. Therefore A(d)=n It means an element that is a part of the multiset in n instances This means that the element d is part of the multiset A. The different operations that multisets can perform (e.g. their union and intersection) can be considered natural extensions to the actions among sets. Lotfi Askar Zadeh created fuzzy sets to create a mathematical instrument to explain the ambiguity. It is considered vague when it is difficult to identify which category of objects it is. Let's suppose we meet a person whose height is 1.70m is this person tall? Whatever the gender of the individual we can categorize the person as long or tall. An A-fuzzy set is distinguished by a specific function A: D-[0,1] Where [0,1] The unit is called the interval and A(d)= I This means that d is part of A, with an amount equal to i. Just as fuzzy sets are extensions from (classical) sets that are able to define vagueness, fuzzy sets extend multisets that are able to deal with the presence of uncertainty. Because fuzzy multisets are too general, the writer created multi-fuzzy sets. Particularly A multi-fuzzy set is distinguished by the function A: D-Nx [0,1]. So A (d)=(m,r) This means an element that has to m times as a member degree multisets are used to create a variety of types of computational models. Some of the most well-known examples include the GAMMA model, the chemical abstract machine, and the P systems. In addition, there are models of computation whose fundamental components include fuzzy multisets (but look up chapter 5 of. The fundamental set-theoretic functions among fuzzy sets are denoted with the help of functions min, max, and min. This is not an unintentional choice but was a necessity triggered because the interval of the unit is the lattice. After the advent of fuzzy sets, additional functions were suggested to determine the primary functions of sets in fuzzy. These functions that have properties that are similar to min are called t-norms and those that have properties that are similar to the max are called t-conorms. The fuzzy sets that result are extremely useful as they are able to better describe diverse scenarios and the literature is filled with usage examples. But, the storm has not directly affected multisets as well as fuzzy multisets. Here we intend to rectify the situation. Particularly, the aim of this study is to present an extension rather than a generalization of both fuzzy multisets. The union and intersection between these two structures could be defined by using other functions that min or max. Broadly speaking Multi-criteria decision making (MCDM) is an approach to decision making in which a lot of individuals are involved and multiple aspects are considered to arrive at an informed decision. Multisets, specifically as well as fuzzy multisets in general, deal with "decisions that involve multiple factors" and "decisions with multiplicities", and it is normal to incorporate them into MCDM. In fact, some authors have utilized multisets in MCDM however, we'll show what the use of t-norms as well as T-conorms may impact MCDM.

1. *The structure of the paper*

In the following, you will find an explanation of the theory behind discrete t -norms and t -conorms. Triangular multisets, as well as triangular fuzzy multisets, will be introduced. Then, there is an explanation of the application of these new types of structures in MCDM.

2. *Discrete Triangular Norms and Conorms*

Typically, t'norms and t'conorms are functions whose domains and codomain is the set of functions. [0,1] x [0,1] and [0,1] The same applies to (e.g. See for the overview). Particularly: Definition 1. A t-norm binary operation *: [0,1]x[0,1]-[0,1] with the following properties that are applicable to all of them. a,b,c[0,1] :

1. Boundary condition a*1=a and a*0=0.
2. Monotonicity b<=complies a*b<=a*c.
3. Commutativity a*b=b*a.
4 Associativity a*(b*c) = (a*b)*c.

Here is the standard ordering operator. The opposite of a t-norm is a t-conorm. Definition 2. A t-conorm binary operation: [0,1]x[0,1]-[0,1] with the following properties that are applicable to all of them. a,b,c[0,1] :

1. Boundary condition a0=aanda1=1.
2. Monotonicity b<=complies ab<=ac.
3. Commutativity ab=ba.
4. Associativity a (bc) = (ab) c.

In general, if we substitute the unit interval with a full lattice structure and the definitions previously used are valid. But, if we opt not to employ the unit interval, but instead a fully ordered set (L, <= a, b) In which case, A and B Are the minimum, and most elements of L are the minimum and maximum elements of L, as such. ab If we define discrete t-norms and T-conorms to provide an overview as well as an explanation of the value of these functions when defining a fuzzy version. Numbers).Assume that N+= Such as x<+ and x + (+) = (+) + x=+ All for all xN. Assume, too, that Nm= for some nonnegative integer m, for some nonnegative integer. Then, it's simple to prove that: Proposition 1. (N+,<,0,+) and (Nm,<,0,m) Are completely ordered sets that are completely ordered. Example 1. Function gcd (m,n) (i.e. the largest common divisor of m and N) is an angular norm (i.e., the greatest common divisor of m and n) (N+,|) In which case, d|n If there is a natural number q, such as n=dq. Gcd clearly is a molecule with the following characteristics:

1. gcd (m,n)=gcd (n,m);
2. gcd (m,n),k)=gcd(m,gcd(n,k));
3. If'>m|m'and'>n|n', then,n')'>gcd(m,n)|gcd(m',n'); and
4. gcd(m,+)=m.

Example 2. Function lcmext(m,n) (i.e. (i.e., that is, the least frequent multiple extended of both m and (i.e., the extended least common multiplication of m and) is defined as follows: lcmext(m,n)=lcm(m,n),n,+,ifm>0andn>0ifm=0andn>0ifm=+ Since lcm(m,n)=lcm(n,m) There is no need to define certain instances in the previous definition. It is now easy to recognize that lcmext(m,n) can be described as a triangular coneorm (N+,<) .

3. Triangular Multisets and Triangular Fuzzy Multisets

In this article, we discuss T-multisets as well as t-fuzzy multisets, which are multisets as well as fuzzy multisets which are based on an ordered set. The concept of triangular multiset can be described as an alternative to the standard definition of multisets.

Consider D become a collection referred to as the universe. A triangular multiset or a t-multiset over D is recognized by the function A: D-N+ This is known as its membership function. Similar to a k-triangular multiple set or simply k-t multiset B over D is recognized by an equation B: D-Nk. Obviously, A(d)=m In which case, dD and mN+ It means that d is a constant when it is a part of the triangular multiset. Similarly, B(d)=n is that d is a number of times in the triangular multiset k. In order to simplify the discussion, the next section will focus on t-multisets.

Assume A, B: D-N+ are two triangular sets. Their union and their intersection form triangular multisets. E, F: D-N+ This is true for everyone. A.D. E(a)F(a)=A(a)B(a),=A(a)*B(a) in which a discrete triangular conorm, and * is a triangular discrete norm. The total of the two triangular sets is described in the following way.

Imagine that A,B: D-N+ There are two sets of triangular. Then, their sum can be referred to as AB The triangular multiset C: D-N+ This is true for everyone. A : C(d)={+,A(d)+B(d),if A(d)=+orB(d)=+,otherwise. The proof is simple and can be left out. Proposition 2. The triangular multisets' sum is characterized by the following characteristics:

1. Commutative: AB=BB;
2. Associative: (AB)C=A(BC);
3. There exists a multiset. It is the null multiset, in as A=A.

Fuzzy multisets were created. He began with a universe D and later declared fuzzy multisets to be functions that have domain D, and codomain, the collection of the multisets that are over the set [0,1]. Therefore, a fuzzy multiset A is an algorithm A: D-([0,1]-N). In other words, this function is similar to function A: Dx[0,1]-N. In another way, fuzzy multisets is a multiset spanning the "universe" Dx[0,1]. This means, however, that the element xD There are different degrees of membership. Furthermore that each membership degree is associated with a specific multiplicity degree. The author has stated that this is way too broad and in certain cases, unrealistic. Instead, we employ multi-fuzzy sets in the manner they were described in the intro. Let's now talk about the triangular set of multi-fuzzy sets.

Let's say the set D can be viewed as a set referred to as the universe. A triangular multi-fuzzy A over D can be identified using an equation A: D-N+x[0,1]. For any dD, A(d)=(n, i) This means that the element d is to A n times and the degree of membership will be equal to i. Given the fuzzy multiset A and a fuzzy multiset B, we can identify two functions which are: the multiplicity function Am: D-N+ and the function of membership Am: D-[0,1]. Of course, the question is, A(d)=(n,i) If not, then Am(d)=n and Am(d)=i .The fundamental set operations that are common to triangular fuzzy multisets are described by the definition below.

Let A,B:D-N+x[0,1] Two triangular fuzzy multisets, and suppose we choose to use the pair (*D,D) as a discrete t - norm or the t-conorm as distinct, and as a pair. (*,) as the normal t'norm and t'conorm and t-conorm, respectively. We denote their union and intersection in the following manner: (AB)(d)(AB)(d)(AB)(d)=(Am(d)+Bm(d),Am(d) Bm(d))=(Am(d)DBm(d),Am(d)Bm(d))=(Am(d)*DBm(d),Am(d)*Bm(d))

4. Utilizing Triangular Multi-Fuzzy Sets within MCDM

An MCDM problem can be presented in a matrix.

Assume A=1<=i<=n is a (finite) set of options and G=1<=j<=m is a (finite) collection of objectives that determine the sacrificialness of action is assessed. Choose the most effective option A* that has the highest degree of appeal to all goals relevant to it. The prior method for MCDM is solely qualitative and totally ignores quantifiable aspects of a similar issue. To illustrate this "flaw" think of an entity that wishes to improve its military gear. In all instances, it's the kind of weapons you purchase (e.g. warplanes and warplanes as well as battleships,) and also the amount is important. For instance, if the nation can buy 100 F-15EX warplanes as well as the equivalent of 20 F-35 warplanes, it is likely that it would prefer to buy F-15EX warplanes despite being aware it is true that the F-35 warplane has more advantages than one of the F-15EX warplane. In general in the event that we own Ai In which case, i=1,...,n alternative decision-making options, and the diverse factors Cj Where j=1,...,m The various factors that are used in the decision-making process and what the weights they carry. WJ, aij It should be a positive number that encodes the quantitative part of this test. Naturally, this method could be modeled easily using multi-fuzzy sets. However, to expand the concept and be flexible it is recommended to use t-multi-fuzzy sets since we might require some sort of operations across various sets of data, and we need to select the right tools to provide the most optimal outcome. In the article, the authors discuss an example of a shop owner who would like to purchase some items for his store. In this case, the authors fail to explicitly explain what the quantification aspect of their dilemma influences their final choice. Therefore, the seller can choose to purchase diverse goods with different characteristics and in various quantities. She has to take this into account before making her decision. It isn't immediately apparent that a product offered at a bargain price and in huge quantities is not of good quality. For instance, there are businesses that attempt to market their products and offer them at very low prices.

III. CONCLUSION

The concept of triangular multisets as well as triangular multi-fuzzy sets is an obvious expansion of multi-fuzzy sets and multisets. They are much more flexible in their mathematical structure than their traditional counterparts due to the fact that one can choose which of the fundamental functions between sets. This implies that data can be processed in a manner that is more in line with their original purpose. In the end, this is why the related extensions of fuzzy sets are extremely useful. To demonstrate the value of these structures we've discussed briefly their properties and potential application in MCDM. There are also computational models that deal with various fuzzy multisets and, therefore, these new structures may be used to replace them. If the new systems are able to produce fascinating properties is yet to be discovered.

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