Fourth Dimension Data Representation and Its Analysis Using Turiyam Context

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Abstract

In this era handling uncertainty its significance is considered as one of the crucial tasks for the dark data analysis. In this process problem arises that the data and its uncertainty exists beyond fourth dimensions. To deal with it "Turiyam set" is introduced at Int'l Conference on Operations Research and Applications (ORA 2021) which held at Guilin, China. In this talk the precise representation of fourth dimension data in turiyam context and its application for data analysis will be discussed. This logic is motivated from Yin-Yang theory of Chinese Taoism as well as Sanskrit Yamma-Yammi. One of the most suitable examples is medical diagnoses data set. Let us suppose COVID 19 data which contain fourth dimensions uncertainty for the analysis. The people who got recovered can be considered as true regions (t), people who died due to COVID 19 can be considered as false regions (f), people who are still active can be considered as indeterminacy (i), people who got vaccinated can be considered as Turiya or Liberated state (l). The refusal degree means people who still did not come under these regions can be represented as $1-(t+i+f+l)$. This speech will discuss the analysis of fourth dimension data using the Turiyam context.

Keywords

Fourth Dimensions: Plithogenic Set, Three-Way Decision Space, Turiyam Set, Granulation: Knowledge Representation

1. Introduction

The current decade most of the researchers focused on handling uncertainty, indeterminacy and hesitant part in the given data sets. Due to which three-way fuzzy space [1] [2] and its graphical representation is considered as one of the

prominent mathematical tool. This set provides a way to characterize the human cognition based on its truth, falsity, and indeterminacy membership-values independently [3] [4] [5] [6]. The issue arises when the human cognition exists beyond the truth, falsity and indeterminacy stage as None of the Above (NOTA). Some of the people called it as Turiya state [7] [8]. This dimension is indeed as the truth, false and indeterminacy membership-values of any event changes based on given phase of time. Some researchers claimed that the three-dimensional data representation is stereographic projection of fourth dimension as shown in **Figure 1** [9].

The fourth dimension data used to found in dark data [10]. There are many data which represents something else beyond its truth, false and indeterminacy values called as Turiya cognition [11] [12].

1) One of the most suitable examples is cricket series which is beyond the Win, Draw and Loss of match. Same time people opinion in democratic country like India used to have fourth dimension as supporting the leader (t), rejecting the leader (f), neutral about leader (I), or None of the Above *i.e.* NOTA(l).

2) The medical diagnoses data set there are four conditions arises the medicine is effective, medicine is ineffective, medicine is destructive or medicine has allergies with the given patients.

Recently it is observed while dealing with Covid 19 data where four possibilities arise. How to deal with recover patient, active patient, death, vaccinated or not affected by Covid 19. It is indeed requirement while dealing the lockdown or unlock down condition. Same time the performance of any state in the given pandemic while dealing with this disease.

To deal with above data set recently a new set called as Turiyam set is introduced by Singh [12] motivated from [13]-[18]. This paper focused on handling the dark data using Turiyam Context with an illustrative example. To achieve this goal, Covid 19 data is considered for better understanding.

Remaining part of the paper is organized as follows: Section 2 provides brief
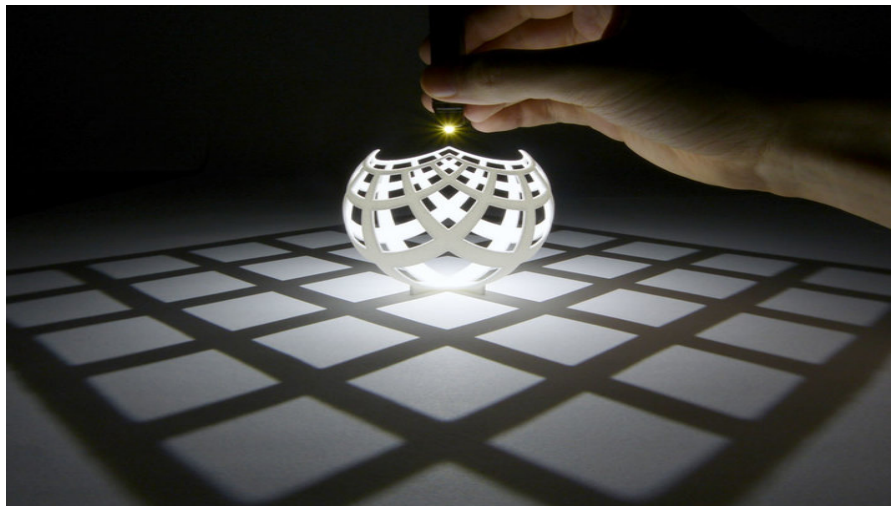

Figure 1. Stereographical projection of three Dimension.

background about turiyam set. Section 3 provides the proposed method to represent the data set in Turiyam context. Section 4 provides an illustrative example for handling the Covid 19 data set followed by conclusions and references.

2. Turiyam Set

In this section basic mathematics of three-way decision space, neutrosophic set and its extension to fourth dimension is given:

Definition 1: Neutrosophic Set [3] [19]: This set was introduced to handle the uncertainty based on three independent functions called as truth, indeterminacy and false, (T, I, F) as mutually exclusive under the conditions $0^- \leq T + I + F \leq 3^+$ in form of a set:

$N = \left\{ \langle k; T_N(k), I_N(k), F_N(k) \rangle : k \in \xi; T_N(k), I_N(k), F_N(k) \in \xi \right] ^- 0, 1^+ [\right\}$ as shown in **Figure 2**.

Problem (Three-dimension): Let us suppose someone wants to represent covid 19 data more precisely. In this case four possibilities exist. Some patients got recover from covid 19 can be called as truth (t), some patient still active as covid 19 can be considered as indeterminant (i), some patients may be died due to covid 19 can be considered as false (f). The last one the patient who got vaccinated and watching all these three-regions cannot be represented using the neutrosophic set. The reason it contains a fourth dimensions (l). Same time people who has not affected till now by Covid 19 cannot be computed precisely using the neutrosophic set. It require another dimension to measure it via complement as $1 - (t + i + f + l)$. This set called as Turiyam set introduced recently by Singh in [12].

Definition 2 (Turiyam or Fourth Dimensional Set): The Turiyam set solves the above problem as follows:

1) The patients got recover from covid 19 can be considered as truth membership-values (t),

2) The patient still active as covid 19 can be considered as indeterminant (i),

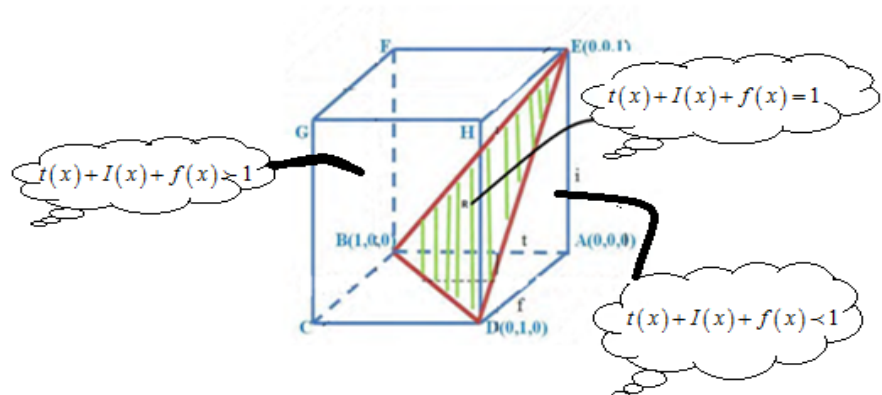3) The patients may be died due to covid 19 can be considered as false (f),

Figure 2. The three-way space representation using Neutrosophic set.

4) The patient who got vaccinated and watching all these three-regions can be called as Turiyam dimensions (l).

In this way, the Turiyam set provides a way to find those patients who has not affected till now by Covid 19 can be found as $1-(t+i+f+l)$. This is one of the major advantages of the Turiyam set while dealing with medical data set.

In this way, the Turiyam Set can contain 4-tuple: truth (t), Indeterminacy (l), falsity (f), and liberalization (l). Each of the dimensions is independent to each other as: $0 \leq t+i+f+l \leq 4$. The turiyam value 0 represents the universal neutral values, -4 represents universal false cases and $+4$ represent the universal truth cases *i.e.* $T=\{\langle x:t,i,f,l\rangle : x \in \xi\}$. It means this set contains a true, a false, an indeterminacy membership values and a liberalization values which can be characterized independently as. $T=\{\langle k;t_t(k),I_t(k),F_t(k),l_t(k)\rangle : k \in \xi\}$ where $0^- \leq t(k)+I_t(k)+f_t(k)+l_t(k) \leq 4^+$.

Definition 3 (Intersection of Turiyam): The intersection of turiyam set T_1 and T_2 can be computed as follows:

(i) $T_1 \wedge T_2 = ((t_1 \wedge t_2),(i_1 \vee i_2),(f_1 \vee f_2),(l_1 \wedge l_2))$.

(ii) $T_1 \wedge T_2 = (t_1.t_2,i_1+i_2-i_1.i_2,f_1+f_2-f_1.f_2,l_1.l_2)$.

It will helpful in finding the maximum common opinion in two intellectuals and their conversations.

Definition 4 (Union of Turiyam): The union of turiyam set T_1 and T_2 can be computed as follows:

(i) $T_1 \vee T_2 = ((t_1 \vee t_2),(i_1 \wedge i_2),(f_1 \wedge f_2),(l_1 \vee l_2))$.

(ii) $T_1 \vee T_2 = (t_1+t_2-t_1.t_2,i_1.i_2,f_1.f_2,l_1+l_2-l_1.l_2)$.

It will helpful in finding that two intellectual of different era or space are once agree on a given thought.

Definition 5 (Complement of Turiyam): The complement of turiyam set can be computed as follows:

(i) $t'=f,i'=1-i,f=t,l'=1-(t+i+f)$

It will helpful in finding the refusal degree of two intellectual based on given thought.

It means the complements of Turiyam is independent and provide maximum values of non-refusal.

Definition 6 (n-refinement of Turiyam): In case the refusal measurement become uncertain then the turiyam set can be written as $0 \leq t+i_1+f+i_2 \leq 4$ that is refinement of n-valued Neutrosophic set. In this way, the turiyam can be
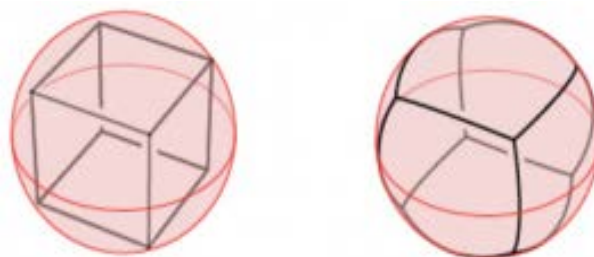

Figure 3. The Turiyam visualization of three-dimensions.

written in form of refinement as follows: $0 \leq \sum t + \sum i + \sum f + \sum l \leq n$ to handle the n-finite truth, uncertain, false, and liberalization to measure the n-number of elements.

In this way, turiyam set allow to measure the universal false, universal true, universal neutral cases other than that are uncertain cases which can be analyzed based on time. The turiyam set have Up-Down or length (x), Left-Right or width (y), Back-Forth or height (z) and Trench or Turiyam (w). These can be written using the vertices of square (1, 1, 1, 1), (1, 1, −1, 1), (1, 1, −1, −1), and (1, 1, 1, −1) as shown in **Figure 3**. The next section proposed a method to represent the dark data set in Turiyam context for knowledge discovery and representation tasks.

3. Proposed Method

In this section a method is proposed to deal with data with Turiyam attributes as follows:

Step 1: Let us suppose the medical diagnoses or COVID 19 data set of India having 29 states.

Step 2: Consider the each state as object set and represent them as row.

Step 3: The weekly or monthly data of COVID 19 data set can be considered as attributes and represent them as columns.

Step 3: The COVID 19 data and its values can be represented using Turiyam set as follows:

1) The patients got recover from covid 19 can be considered as truth membership-values (t),

2) The patient still active as covid 19 can be considered as indeterminant (i),

3) The patients may be died due to covid 19 can be considered as false (f),

4) The patient who got vaccinated and watching all these three-regions can be called as Turiyam dimensions (l).

Step 4: In this way the COVID 19 data set can be precisely represented using the Turiyam context as shown in **Table 1**.

Step 4: Now we can investigate the minimum and maximal level affected state by COVID, recovered from the COVID, active cases of COVID as well as vaccinated from COVID using t-norm and t-conorm as follows:

1) $T_1 \wedge T_2 = ((t_1 \wedge t_2), (i_1 \vee i_2), (f_1 \vee f_2), (l_1 \wedge l_2))$.

Table 1. A Turiyam context representation of COVID 19 data set.

	Jan COVID Data	*Feb COVID data*	...	*December COVID data*
State$_1$	(*Recovered$_{11}$, Active$_{11}$, Death$_{11}$, Vaccinated$_{11}$*)	(*Recovered$_{12}$, Active$_{12}$, Death$_{12}$, Vaccinated$_{12}$*)	...	(*Recovered$_{17}$, Active$_{17}$, Death$_{17}$, Vaccinated$_{17}$*)
State$_2$	(*Recovered$_{21}$, Active$_{21}$, Death$_{21}$, Vaccinated$_{21}$*)	(*Recovered$_{22}$, Active$_{22}$, Death$_{22}$, Vaccinated$_{22}$*)	...	(*Recovered$_{27}$, Active$_{27}$, Death$_{27}$, Vaccinated$_{27}$*)
...				
State$_{29}$	(*Recovered$_{291}$, Active$_{291}$, Death$_{291}$, Vaccinated$_{291}$*)	(*Recovered$_{292}$, Active$_{292}$, Death$_{292}$, Vaccinated$_{292}$*)	...	(*Recovered$_{297}$, Active$_{297}$, Death$_{297}$, Vaccinated$_{297}$*)

2) $T_1 \vee T_2 = ((t_1 \vee t_2),(i_1 \wedge i_2),(f_1 \wedge f_2),(l_1 \vee l_2))$.

Step 5: Same time people who has not affected from COVID can be found using the complement operator as follows: $1-(t+i+f+l)$.

Step 6: It will also provide which are twin or complement of each other in dealing with COVID as: $t' = f, i' = 1-i, f = t, l' = 1-(t+i+f)$.

Step 7: In case government want to decide for lockdown or unlock down based on recovered or vaccinated cases. In this case, a threshold values can be defined for the same.

Step 8: In this way the Turiyam context provides an alternative way to deal with medical diagnoses data set more precisely when compared to any method.

Time Complexity: Let us suppose, the COVID data contains n-number of states and m-number of Turiyam attributes. In this case total time to represent them in the given context may take more than O($4m.n$) time complexity for representation. Same time defining threshold based on the turiyam attribute for lock down or unlock down may take O($16m^2.n^2$). In the next section proposed method is illustrated with an example.

4. Illustration

In this section the proposed method is illustrated for handing the COVID data set. Let us suppose three Indian states and their COVID data sets as shown in **Table 2**.

The entry (0.4, 0.2, 0.6, 0.1) represents that the 40 percent cases are active in State 1 in month of April among all confirm cases. There are 30 percent death happen in the given case, 60 percent people recovered and till now 10 percent people got vaccine. Same time people who has not affected can be found using the confirm cases. In case the expert wants to know the upper and lower boundary of cases then can be found as: State 1: min (0.4, 0.4, 0.4), max (0.2, 0.2, 0.1), max (0.6, 0.7, 0.8), min (0.1, 0.2, 0.3)= (0.4, 0.2, 0.8, 0.1). It means state 1 has still 40 percent active cases and slow vaccination process. In similar way other state can be computed which shows that State 3 active cases reduces and vaccination is fast. In this case, the state 3 can be unlocking at certain cases when compared to state 1. In similar way other knowledge can be discovered. The locking and unlocking of states can be defined using the threshold on active cases, or vaccination. In this way, the proposed method is helpful in handling the data with turiyam attributes more precisely when compared to three-way fuzzy space [1] [2] [3] [19] [20]. In near future the author will focus on introducing other metric of turiyam set and its visualization process.

Table 2. A Turiyam context representation of COVID 19 data set.

	April COVID Data	*May COVID data*	*June COVID data*
State 1	(0.4, 0.2, 0.6, 0.1)	(0.4, 0.2, 0.7, 0.2)	(0.4, 0.1, 0.8, 0.3)
State 2	(0.5, 0.2, 0.6, 0.1)	(0.4, 0.3, 0.6, 0.25)	(0.4, 0.1, 0.6, 0.4)
State 3	(0.3, 0.2, 0.7, 0.1)	(0.3, 0.2, 0.6, 0.25)	(0.2, 0.1, 0.8, 0.45)

5. Conclusion

This paper introduces a method for handling the data with Turiyam attributes with an illustrative example. The proposed turiyam set and its context representation is illustrated using the COVID data. It is hoped that, the proposed study will be helpful for handling the medical diagnoses data set more adequately than any available set. In future, the author will focus on introducing other metric of fourth dimension to deal with Turiyam context and its graphs.

Ethics Approval

This article does not contain any studies with human or animals participants.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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