



Four-Way Turiyam based Characterization of Non-Euclidean Geometry

Prem Kumar Singh

Department of Computer Science and Engineering,
Gandhi Institute of Technology and Management-Visakhapatnam,
Andhra Pradesh 530045, India
Email: premsingh.csjm@gmail.com; premsingh.csjm@yahoo.com
ORCID: 0000-0003-1465-6572

Abstract

Recently, a problem is addressed while dealing the data with Non-Euclidean Geometry and its characterization. The mathematician found negation of fifth postulates of Euclidean geometry easily and called as Non-Euclidean geometry. However Riemannian provided negation of second postulates also which still considered as Non-Euclidean. In this case the problem arises what will happen in case negation of other Euclid Postulates exists. Same time total total or partial negation of Euclid postulates fails as hybrid Geometry. It become more crucial in case the data is unknown, incomplete or exists beyond the three-way space as heteroclinic pattern. To understand this problem, the current paper tried to distinguish Euclidean, Non-Euclidean, Anti-Geometry, Neutrogeometry and Turiyam or Unknown geometry using the complement operator with an example.

Keywords: Consciousness; Euclidean geometry; knowledge representation; NeutroGeometry; Non-Euclidean; Turiyam Geometry; Unknown Graph.

1. Introduction

The geometry is one of the oldest branches of mathematics which discuss measurement of land or space [1]. It becomes somewhat easier after the Euclidean geometry which is based on five postulates: (i) A straight line can be drawn from any given two points, (ii) A finite length straight line can be drawn continuously in a straight line, (iii) A circle can be drawn from a given point using any radius, (iv) Each of right angles in the given plane is equal to each others, (v) The last one is parallel postulates which says that, one and only one parallel line can be drawn from a point not lie on the straight line [2].

There are several applications of Euclidean geometry. However problem arises when any of the Euclid postulates fails. In this case the precise representation of data and its analysis is one of the crucial tasks. The Sachheri Quadrilateral shown in Figure 1 given a way to think beyond Parallel Postulates [3-4].

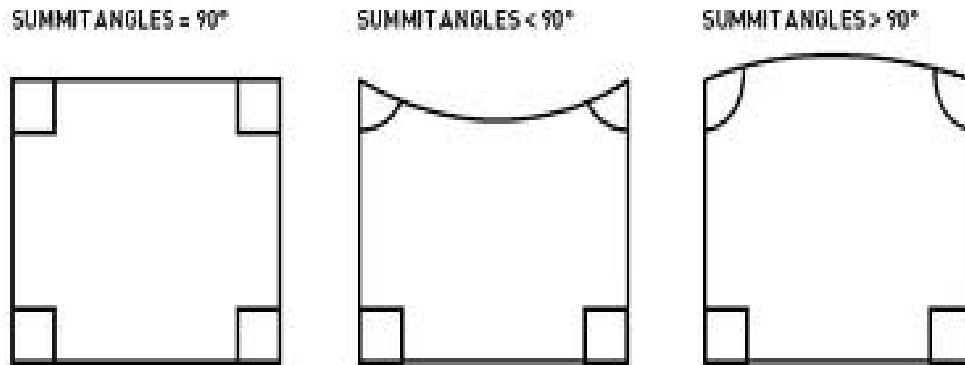


Figure 1: The Saccheri Quadrilateral

The Lobachevsky provided an example for the negation of fifth postulate called as non-Euclidean [5]. It give a platform to find the negation of other postulates to find the new geometry. The Riemann gave an example for negation of second postulates also which is still called as Non-Euclidean [6]. This motivates to find negation of each postulates and other partial geometry where both Euclidean and Non-Euclidean data exists [7-9]. It is called as Neutrogeometry which is recently studied [10-13]. The problem arises in case no complement exists for the given data sets or no geometry exists as per unknown data, undefined data or none [13]. It can be understood via following ways:

- (i) The data can be represented via Euclidean Geometry i.e (EG),
- (ii) The data can be represented via Non-Euclidean Geometry i.e (NE),
- (iii) The data can be represented via partial i.e. Euclidean+Non-Euclidean called as NeutroGeometry(NG),
- (iv) The data cannot be represented by any other ways. It is nothing, unknown, undefined which required human awareness to explore it (TG). In this case exploration is more crucial rather than space time tradeoff.

It means the motion of any elements depend on the human or expert cognition and its Turiyam state which cannot be decided without space and time [15-17] which is recently studied extensively [18-21]. These types of non-commutative geometry (where multiplication is not commutative) requires a four-dimensional space [22-23] and its characterization [24-25]. Some of the example for these types of data sets are discussed recently [16-30] and its analysis via Non-Euclidean [31-32]. Hence this gave a way to deal with complement of Euclidean, Non-Euclidean, Hybrid and Unknown or Turiyam Geometry based on human conscious [32-33] or unconsciousness [34-35]. It has many applications in case of self driving car or robotics as discussed in [36]. This paper focus on introducing some new concepts of Non-Euclidean geometry and its real life examples for further study.

Other parts are structured as follows: Section 2 provides some data with Non-Euclidean geometry and its visualization. Section 3 proposed a method for characterization of Non-Euclidean data sets and its complement for validation of four way characterization. Section 4 provides some of examples for Knowledge processing tasks. Section 5 provides conclusions followed acknowledgement and references.

2. Non-Euclidean Geometry

In this section, some distinct geometry and its visualization is shown for understanding the Non-Euclidean data:

Definition 1. (Types of Geometry) [1-4]: The Geometry is to measure the any shape. The first measurement is established by Euclid based on five postulates. The problem arises when the Euclid postulates divorced for some of the data sets. In this case, the first issue arises with any researchers about difference among Euclidean and Non-Euclidean geometry. To achieve this goal, the Hyperbolic, Euclidean and Elliptic geometry and their difference is shown in Figure 2.

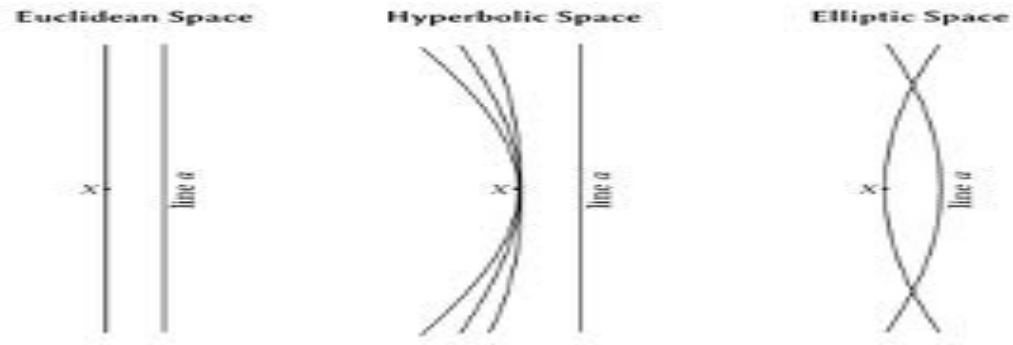


Figure 2: The difference among Euclidean and Non-Euclidean geometry (Hyperbolic and Elliptic)

Definition 2. (Hyperbolic Geometry) [5, 25]: It represents those data sets which contain negation of parallel postulates that many lines can be drawn from a point outside the given line as discussed by Lobachevsky. Figure 3 represents the visualization of Hyperbolic Geometry.

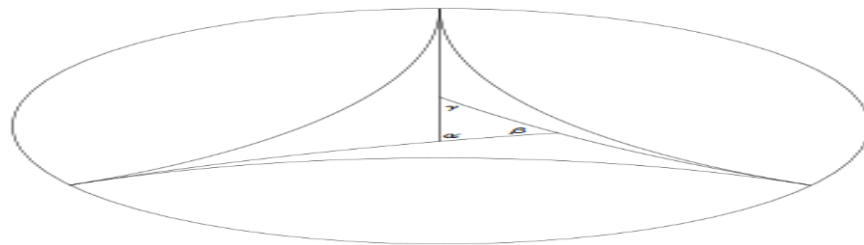


Figure 3: An example of Non-Euclidean geometry arises by negation of fifth postulates

Definition 3. (Elliptic Geometry) [6] : This geometry provides negation of Second and Fifth postulates as shown in Figure 4. It is introduced by Riemann. This Geometry provide a way to find the partial negation of other hybridization of Geometry.

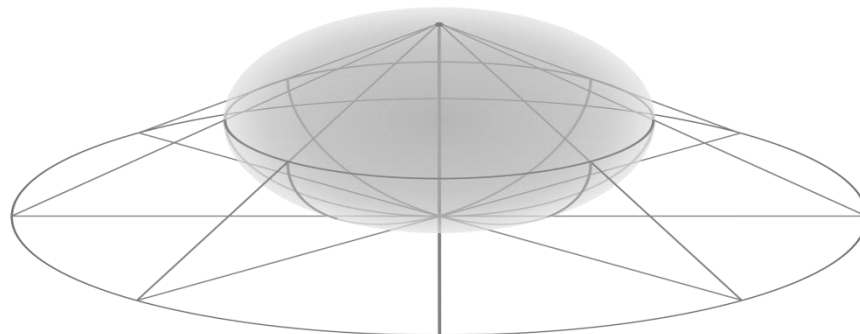


Figure 4: An example of Non-Euclidean arises by negation of second and fifth postulates both

Definition 4. (NeutroGeometry) [7-13] : NeutroGeometry means at least one of the Euclid postulates is partially true, partially indeterminate, and partially false (and no axiom is totally denied) as shown in Figure 5. It shows several lines parallel to CE passing through point N (i.e. Hyperbolic) but not with the point D (i.e. Elliptical), whereas from point M only one line is parallel to CE. This is hybrid case which contain Euclid+Non-Euclid geometry.

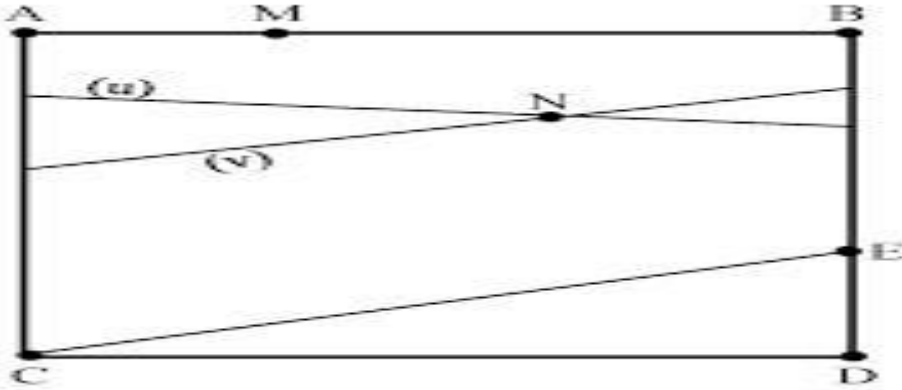


Figure 5: An example for Euclidean+Non-Euclidean i.e. NeutroGeometry

The problem arises when the data set is unknown, undefined or incomplete in this case precise characterization of data set based on human consciousness or unconsciousness way is considered as one of the crucial tasks [32-26]. How to deal these types of physical phenomenon and characterize them in Euclidean, Non-Euclidean, NeutroGeometry or Unknown Geometry recently Turiyam Graph[33] and Turiyam matrix [34] is introduced. It characterize the data sets based on human consciousness beyond true, false and uncertain regions. In the next section a method is proposed to deal with these types of Non-Euclidean data sets using a new operator as well as complement operator.

3. A PROPOSED METHOD

In this section two methods are proposed for dealing the Non-Euclidean data sets. The first method proposed to characterize the Non-Euclidean data sets using a defined operator. The second method proposed to validate the obtained characterization using the complement operator.

3.1 A Proposed method for characterization of Non-Euclidean data sets

In this section, a method is proposed to for characterization of Non-Euclidean data in Euclidean, Non-Euclidean, Hybrid or NeutroGeometry and last Unknown Geometry i.e. Turiyam Geometry(TG).

Step 1. Let us consider the data set contains non-Euclidean geometry i.e. NE. It means divorced one of the Euclidean postulates (EG).

Step 2. Let X be any non-empty set of a given data sets in Non-Euclidean Geometry (NG).

Step 3. Now propose a new operator as $\circ: X \times X \rightarrow P^n(X)$ which provides the data representation as $(T, I, F, U) \notin \{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0)\}$ where T represents true regions means Non-Euclidean, I represents NeutroGeometry, F represents not Non-Euclidean, and U represents unknown geometry. The last one can be explored based on human cognition and its expertise for characterization.

Step 4. This type of case can be explored as follows:

- (i) The first case arises when $x \circ y \subseteq X$ for each $x, y \in X$ then it can be characterized as true Non-Euclidean (NE).
- (ii) The second case arises when $x \circ y \not\subseteq X$ for each $x, y \in X$ then it can be characterized as false Non-Euclidean. It means negation of Non-Euclidean (EG).
- (iii) The third case arises when $x \circ y$ provides a new element in saddle space which position is indeterminant or uncertain. It may contain both Euclidean+Non-Euclidean. This type of element can be considered in NeutroGeometry (NG).
- (iv) The fourth case arises when the $x \circ y$ provides nothing, unknown, undefined, ungeometry or impossible data. These types of data and its exploration require human cognition to explore rather than space and time complexity.

Step 5. In this way the proposed method provides a way to characterize the Non-Euclidean data sets in four way based on human cognition.

Time Complexity: It can be observed that the proposed method takes four way characterization of Non-Euclidean data sets having n -elements. In this way it can take maximum $O(n^4)$ time complexity. However the problem arises in case of dealing the Not Non-Euclidean and last Unknown Geometry. To understand this in better way the complement operator is used in the next section as validation.

3.2 A Proposed method for characterization of Non-Euclidean data sets using Complement Operator

In this section a method is proposed to understand the Euclidean, Non-Euclidean, NeutroGeometry and Turiyam or Unknown Geometry using the complement operator as follows:

Step 1. Let us suppose, the data can be represented via five postulates of Euclidean Geometry (EG). The complement i.e. $C(EG)$ will provide a new geometry where one of the postulates fails. Let us suppose that complement geometry is Non-Euclidean (NE). It means the $C(EG)=NE$. The second complement of Euclidean geometry will provide again the Euclidean Geometry as per bitwise complement. It means the $CC(EG)=EG$ or $C(NE)=EG$.

Step 2. Let us suppose, the data can be represented via failure of any one postulates as Non-Euclidean geometry (NG). The complement of Non-Euclidean should provide Euclidean geometry. It means $C(NG)=EG$. The double complement of Non-Euclidean will provide again Non-Euclidean $CC(NG)=NG$. The problem arises when the Non-Euclidean contains failure of two or more postulates as Riemann Geometry. In this case the complement of Non-Euclidean may provide Hybrid Geometry where some of Euclid postulates is true and some of them are partially false. The double complement will provide again NeutroGeometry. It means the case where two or more postulates fails cannot be considered as Non-Euclidean. It can be considered as Neutrogeometry.

Step 3. Let us suppose, the data can be represented via partial fulfillment of Euclidean and Non-Euclidean geometry. It is the case when some postulates of Euclid is true and some are false. It means the data set is both Euclidean+non-Euclidean. This type of data can be considered as NeutroGeometry(NG). The complement of NeutroGeometry is NeutroGeometry. The double complement of NeutroGeometry is again NeutroGeometry.

Step 4. Let us suppose, the data sets cannot be represented by Euclidean, Non-Euclidean or its Hybridization. These types of data sets are unknown, undefined or impossible objects. These type of data sets can be explored based on human cognition and its awareness. It can be called as Turiyam geometry. The complement of these types of data sets provides again Unknown data. The double complement will also provide the unknown data.

Step 5. In this way the complement operator provides a precise way to understand the Euclidean, Non-Euclidean, Neutrogeometry and Turiyam Geometry.

Time Complexity: It can be observed that the proposed method takes double complement for understanding any type of data sets having n -elements. In this way, it can take maximum $O(n^2)$ time complexity to decide it is Euclidean, Non-Euclidean, NeutroGeometry or Unknown. In this way it solves the issues of Not Non-Euclidean case of the proposed methods shown in Section 3.1.

The next section contains some of the examples of Non-Euclidean data sets and its four way characterization.

4. Applications

The application of Euclidean geometry is already known like Pythagoras and all which is based on five postulates. The problem arises when the Euclid postulates fails. The Lobachevsky and Bolyai provided geometry where fifth postulates fail. Riemann Geometry introduced via failure of second (and fifth) postulates both which is also considered as Non-Euclidean. There are several example of NeutroGeometry as discussed in [10-13]. The problem arises while dealing the unknown or undefined or impossible object. In this section some of the example of impossible, unknown, undefined and unknown objects is discussed:

Example 1. (Impossible Objects): There are many example of impossible objects as Borromon ring as shown in Figure 6. It represents three closed curves in three-dimensional space. These rings are topologically connected such that one cannot be separate them. Similar to that three linked triangle also represented as shown in Figure 7. Chimera is another impossible or unknown object as shown in Figure 7. These types of impossible data can be characterized based on human cognition in four dimensions as follows:

- (i) The ring can be separated: The expert is aware that the rings can be separated (1, 0, 0, 1),
- (ii) The rings cannot be separated: The expert aware that the rings cannot be separated (0, 0, 1, 1),
- (iii) Neutro Separated: The expert is uncertain that the rings can be separated or not. It can be partially separated (0, 1, 0, 0),
- (iv) The Unknown or impossible: The expert knows that it is impossible objects and need to be explored based on awareness as (t, i, f, u).

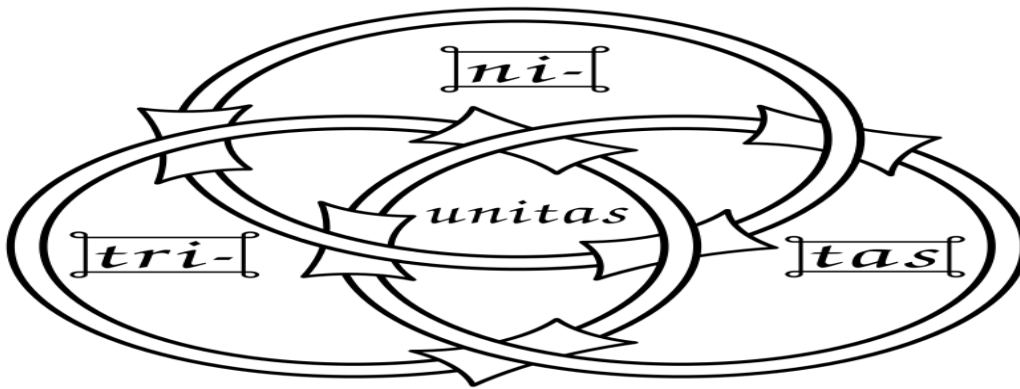


Figure 6: A Borromon Ring as symbol of TriUnity

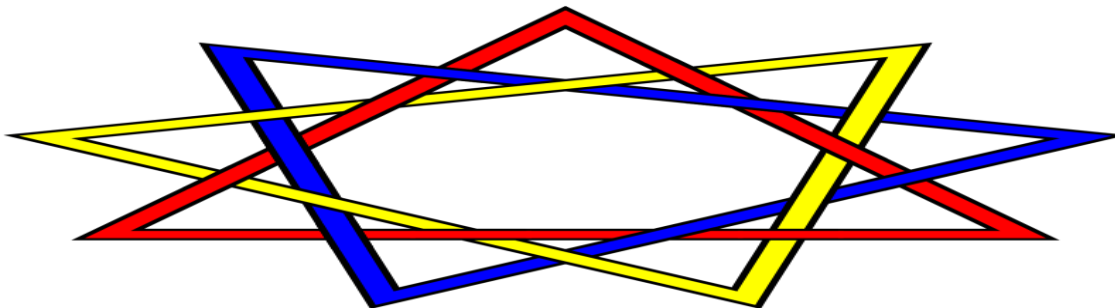


Figure 7: A three Linked Triangle in Chennai as Enneagram



Figure 8: An impossible or unknown object like Chimera

Example 2. (Soil Pollution): The Soil pollution and its measurement is another issue which can be characterized based on four ways as follows:

- (i) Pollution: The expert is aware that soil is polluted (1, 0, 0, 1),
- (ii) Anti-Pollution: The expert is aware that soil is not Polluted (0, 0, 1, 1),
- (iii) Neutro-Pollution: The expert is unaware that soil is polluted or not polluted (0, 1, 0, 0),
- (iv) Unknown or nothing: The last is nothing, it is desert, it is snow area no soil nothing unknown like other planet. The last one is based on expert awareness or consciousness to explore the soil pollution as (t, i, f, u) .

Example 3: (Student Image verification) [13]: One of the crucial tasks for the faculty to match the student image in exam time. It becomes more crucial when many students start misusing the online system and fraud. This problem arises when the student blur the images or may happened due to failure of uploading the image. These types of data can be characterized via proposed method as follows:

- (i) Student image : In this case the faculty able to match the student image with his photo. In this case the same student is writing the exam which can be verified by any faculty or examiner. It can be represented as (1, 0, 0, 0).
- (ii) Anti-student image: In this case the faculty unable to match the student image with his photo. The different student is writing the exam at place of the given student. This can be verified with any faculty which can be represented as (0, 0, 1, 0).
- (iii) Neutro-Image: In this case the expert is uncertain about student image due to blur in image. The image may be mix with two photos or may be some pixel issues. In this case the student photo is partially matched with its image. This type of image can be represented as Neutro-Image (0, 1, 0, 0)
- (iv) Unknown or nothing: In this case the student image is not available, nothing exists at that place, and image is removed. This case arises due to the technical error or student unknown about the uploading the image. These types of cases can be explored using the awareness of faculty who taught the particular student. The faculty who taught the student will verify the student and allow for exam otherwise decides that he/she is unknown student. He is not the student of particular subject. This type of case can be explored using the fourth dimension awareness as (t, i, f, u) . These type of image found while Characterization of Indian algae also [26].

Example 4: (Love) [17]: The marriage success rate in any country can be decided based on following parameters:

- (i) Love: The family knows that the couple love each other fully and live together (1, 0, 0, 1). It happens in country like USA and UK where people go for love marriage.
- (ii) Anti-Love: The family knows that couple hates each other but still living together (0, 0, 1, 1). It happen in country like India and Pakistan where people still live together without love,
- (iii) Neutro-Love: The couple partially loves each other as they are in live- in-relationship (0, 1, 0, 1). It is called as partially married. It is now observed at several places in high society.
- (iv) The last is nothing: The family knows that the couple do not know each other, nothing exists, and they are unknown to each other. They are Divorced. In this case, the relationship explored based on awareness at given social sites or other ways. These type of cases explored based on human cognition as (t, i, f, l) . It happen in country like India where people go for arranges marriage.

Example 5: (Marriage): The marriage and its type can be characterized based on four way as follows:

- (i) Marriage: In this case a Male and Female or vice versa marry each other without awareness or unawareness. In case they are aware then can be represented as (1, 0, 0, 1) otherwise (1, 0, 0, 0).
- (ii) Anti-Marriage: In this case the Male marry with Male or Female marry with Female. This happened when the Male or Female aware about their interest. It can be represented as (0, 0, 1, 1).
- (iii) Neutro-Marriage: In this case the Male or Female marry with transgender as uncertainty and vice versa. The marriage among Transgender to transgender, Transgender to male and female can be characterized as Neutro-Marriage (0, 0, 1, 0).
- (iv) Unknown or Nothing: This is the case when the human known life is nothing. He/she or Transgender self aware that marriage is nothing. Hence they decided to live alone like saints. They may live separate way or divorced. This type of data can be explored based on human awareness rather than true, false or uncertain condition which can be represented as (t, i, f, u) .

Example 6: (Religious Characterization): The religious characterization and its graphical analysis is another issue for the country like India. It needs four way characterization as follows:

- (i) True-Religious: It is the case when someone follows a particular religion like Abraham truly with its awareness (1, 0, 0, 1) or unawareness by birth (1, 0, 0, 0).
- (ii) Anti-Religion: It is the case when someone does not follow the Abraham Religion. They follow some other religion like Sikh, Hindu, Buddhism or Jain with awareness (0, 0, 1, 1) and unawareness by birth (0, 0, 1, 0).
- (iii) Neutro-Religion: In this case the person follow Hindu+Islam, Hindu+Christians, Sikh+Hindi or Abrahamic+Non-Abrahamic religion. Some time the person keeps Abrahamic name but follow non-Abrahamic and vice versa. It can be called as liberal, transgender religion, crypto religion or neutro religion. It is uncertain religion which can be characterized via Neutro-Religion (0, 0, 1, 0).
- (iv) Unknown or Nothing: This is the case when the author does want to declare any religion. The author want to declare as Atheist. There is no interest in any religion. The person is unknown about language, religion or anything. He or she wants to change the religion or think that nothing is good. The animal has no religion then why me. This type of self awareness when someone has nothing to follow. He/she wants to live peacefully. This type of thought arrives after self awareness and super consciousness. It needs exploration which is beyond the space time tradeoff. These types of data can be characterized as (t, i, f, u) .

Example 7. (Democracy): The characterization of democracy and its visualization in a given country based on people opinion is one of the crucial tasks. It is totally based on hierarchical ordering of citizens and its positional power in the given country rather than Euclidean space. It can be defined as follows:

- (i) Democracy (1, 0, 0, 0): In case there is absolute democracy exists in the given country. Everything decided based on public opinion or elected leaders.
- (ii) Anti-Democracy (0, 0, 1, 0): In this case there is no democracy in the given country. Everything decided by some powerful person rather than elected leaders.
- (iii) Partial Democracy (0, 1, 0, 0). In this case the partial democracy exists where elected leaders and some powerful family or business class decide the country (0, 1, 0, 0).
- (iv) Nothing or Unknown: It is the case where nothing exists, no law, no government, terrorist occupied, forest area, human existence is less, sea where no law exists, Animal dominated area, different planet which need exploration based on expert awareness. The expert knows that there is no absolute democracy exists. It is nothing just to rule the people rather than service. These types of data can be explored based on expert consciousness or awareness as (t, i, f, u) .

Example 8. (Citation) [17, 27-28]: The characterization of citation and its visualization is another crucial task. It become more crucial in case of intellectual measurement as the citations contains large number of data. It can be done as follows:

- (i) True Citation (1, 0, 0, 0): A paper is cited due to its related keyword, title, methodology, or similar topic can be considered as true citation (1, 0, 0, 0). In this case two or more authors working in same area cite each other paper.
- (ii) Anti-Citation (0, 0, 1, 0): A paper is cited in irrelevant way without matching keyword, title, similar topic or any relevancy. The retracted paper is citation, the paper is not cited due to conflict of interest, same departmental citations beyond the relevant of topic, host conference citation without relevancy, forced citation, random citation can be considered as Anti-Citation(0, 0, 1, 0).
- (iii) NeutroCitation: A paper is cited with interdisciplinary, collaboration, self-citations, influenced citations, honours citations, editorial citation, same journal citations, the diverse indexed citation, the author is uncertain about founding paper, time based citation, plagiarism citation, etc. can be considered as Neutro-citation (0, 1, 0, 0, 0).
- (iv) Unknown or Nothing: The paper does not cited founding paper in the reference. The author does not aware about the given topic. The author cited current research just to increase the impact factor of the given journal rather than linguistic diversity. There are many papers written in other language rather than English. The author unaware about those works and consider the work from some defined indexing. It may happen that some good idea also exists outside the Scopus. The author unknown about those potential work and did not cited. These types of citation can be characterized based on awareness of expert which comes after hard work. It can be characterized based on fourth dimension as (t, i, f, u) .

Example 9. (Brain Drain Analysis) [29]: The brain drain analysis is one of the most crucial data which is not Euclidean. In this case the precise measurement and visualization of data is major issues for data science researchers. It can be characterized in four way as follows:

- (i) Brain Drain (1, 0, 0, 0): The Professor of given expert area left the organization due to salary, promotion or other issues can be characterized as Brain Drain (1, 0, 0, 0). It can be easily verified by the paper published by the author in the given research domain, its citation and influenced. It used to observed in undeveloped country where many researchers left the organization to developed country.
- (ii) Anti-Brain Drain (0, 0, 1, 0): The Professor having no papers, Posthumous authors papers, No citation or no knowledge about given research area left the organization. The Professor who does not contribute anything to the organization and left the organization. It can be considered as Anti-brain drain (0, 0, 1, 0). It used to observe when a Professor from developed country live the organization and join some other undeveloped country.
- (iii) Neutro Brain Drain (0, 1, 0, 1): This problem arises when author publishes different papers in various areas as collaboration, multiple co-authors exists in the given paper, author is having less corresponding author paper, or author work is retracted, plagiarism work is totally uncertain. It can be characterized as Neutro Brain Drain where uncertainty arises about author wor as (0, 1, 0, 0). It can be observed at many places where people write paper as collaboration. In this case totally uncertain that who is more expert of the given area.
- (iv) Nothing or Unknown: It exists when the expert write papers in different language than English, non-indexed papers, the expert have less resources but still do his/her best. Same time the Professor may resign due to family pressure, unethical work of organization, do not want to work, want retirement, died, killed by some agency, forced to leave the organization, the author understood that his is business leave it and start something new. This type of data needs exploration for better understanding. The reason is this type of awareness is based on human cognition rather than simple mathematics. It can be characterized as (t, i, f, u) .

Example 10. (AQI Measurement) [30]: The AQI measurement in particular area may and its impact can be characterized as follows :

- (i) AQI Polluted: The expert knows that the AQI in the given area is polluted and harmful for the human can be characterized as $(1, 0, 0, 1)$.
- (ii) Anti-Pollution: The expert knows that the AQI in the given area is not polluted $(1, 0, 0, 1)$.
- (iii) Neutro-Pollution: The expert is uncertain about level of pollution or indeterminant about its parameter at given time. The reason is pollution in particular area fluctuate based on environment and its condition. These type of AQI can be measured using Neutro-Pollution area $(0, 1, 0, 0)$.
- (iv) Nothing or Unknown: These type of area where expert is unknown about condition of air, existence of Air, existence of forest or human. This type of case require exploration based on consciousness of expert which can be represented as (t, i, f, u) .

Example 11. (Conflict Analysis) [11-12, 32]: The precise analysis of conflict or cold war among USA and Russia (or USA-China, Israel-Philistine, India-Pakistan) is totally beyond the win, draw or loss of the given issue. It is totally based on the conduit metaphor or digital diplomacy of USA and Russia (or USA-China, Israel-Philistine, India-Pakistan) can be characterized in following ways:

- (i) True graph (V_r, E_r) : A set of countries that support Russia (S_r) can be characterized as true regions. These countries (V) and their relationships (E) are known to everyone. These countries and their graph can be explored in precise way for better understanding.
- (ii) False or Misleading graph (V_u, E_u) : A set of countries supporting the USA can be characterized as false regions (S_u). These countries always and their relationship with the USA can be easily drawn. However they just mislead Russia to show the affection.
- (iii) Neutro-graph (V_i, E_i) : A set of countries supports Russia or USA based on their metaphor. These types of countries and their vote is uncertain can be characterized as $(2^k - S_r)$. These countries and their relationship with Russia or USA can be defined based on membership values rather than known or misleading graph. They can change their support any time based on their conduit metaphor.
- (iv) Unknown graph (t, i, f, u) : The fourth case is some countries like India or China choose nothing as per their interest to fulfill their hidden agenda. It is not uncertain vote. It is totally based on digital diplomacy. It is unknown that where these countries support to USA or Russia. Everyone knows that due to choosing nothing or Absent India, China or UAE supported Russia. However no one can define the conduit metaphor behind it. This type of unknown data can be explored based on human awareness or expert consciousness as (t, i, f, u) .

In this way the proposed method provides a way to deal with unknown data sets and its characterization. In near future the author will focus on exploring data with Turiyam set [30-33] with its comparison with other set theory [34-35] for various applications [36] .

5. CONCLUSIONS

This paper explores the non-Euclidean data sets and its characterization. A method is proposed to characterize the given Non-Euclidean data sets in true, false, uncertain or unknown regions with an illustrative example. To validate the results complement operator is used. In near future, the author will focus on exploring some other applications of Non-Euclidean geometrical data sets and its applications.

Acknowledgements: Author thanks the editorial team for the valuable time.

Funding: Author declares that, there is no funding for this paper.

Conflicts of Interest: Author declares that, there is no conflict of interest for the given paper.

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

References:

- [1] Birkhoff G.D., "A Set of Postulates for Plane Geometry (Based on Scale and Protractors)". *Annals of Mathematics*, Vol. 33, 1932.
- [2] Russell B., "Introduction: An essay on the foundations of geometry". Cambridge University Press, 1897.
- [3] Coxeter H.S.M., "Non-Euclidean Geometry. University of Toronto Press, 1942. reissued 1998 by Mathematical Association of America.
- [4] Singh PK, "Data with Non-Euclidean Geometry and its Characterization". *Journal of Artificial Intelligence and Technology*, Jan 2022, Volume 2, Issue 1, pp. 3-8, doi : [10.37965/jait.2021.12001](https://doi.org/10.37965/jait.2021.12001)
- [5] Lobachevsky N., "Pangeometry, Translator and Editor: A. Papadopoulos. Heritage of European Mathematics Series". European Mathematical Society, Vol. 4, 2010.
- [6] Jürgen J., "Riemannian Geometry and Geometric Analysis". Berlin: Springer-Verlag (2002)
- [7] Bhattacharya S., "A model to a Smarandache Geometry". 2004, <http://fs.unm.edu/ModelToSmarandacheGeometry.pdf>
- [8] Popov, M. R., "The Smarandache Non-Geometry. Abstracts of Papers Presented to the American Mathematical Society Meetings, Vol. 17, Issue 3, pp. 595, 1996.
- [9] Kuciuk L., and Antholy M., "An introduction to the Smarandache geometries. JP Journal of Geometry & Topology", Vol. 5, Issue 1, 77-81, 2005, <http://fs.unm.edu/IntrodSmGeom.pdf>
- [10] Smarandache F., "NeutroGeometry & AntiGeometry are alternatives and generalizations of the Non-Euclidean Geometries". *Neutrosophic Sets and Systems*, Vol. 46, pp. 456-476, 2021. <http://fs.unm.edu/NSS/NeutroGeometryAntiGeometry31.pdf>
- [11] Singh P. K., "AntiGeometry and NeutroGeometry Characterization of Non-Euclidean Data Sets". *Journal of Neutrosophic and Fuzzy Systems*, Vo 1, Issue 1, pp. 24-33, 2021, doi: <https://doi.org/10.54216/JNFS.010102>
- [12] Singh P. K., "NeutroAlgebra and NeutroGeometry for Dealing Heteroclinic Patterns." In: *Theory and Applications of NeutroAlgebras as Generalizations of Classical Algebras*, IGI Global Publishers, 2021, Chapter 6, doi: 10.4018/978-1-6684-3495-6
- [13] Granados C., "A note on AntiGeometry and NeutroGeometry and their application to real life." *Neutrosophic Sets and Systems*, Vol. 49, pp. 579-593, 2022. doi: [10.5281/zenodo.6466520](https://doi.org/10.5281/zenodo.6466520)
- [14] Deng X., and Papadimitriou C. H. (1990) Exploring an unknown graph," *Journal of graph Theory*, 32 (3):265-297,
- [15] Singh P.K., "Turiyam set a fourth dimension data representation. *Journal of Applied Mathematics and Physics*, Vol. 9, Issue 7, pp. 1821-1828, 2021, DOI: [10.4236/jamp.2021.97116](https://doi.org/10.4236/jamp.2021.97116)
- [16] Singh P.K., "Fourth dimension data representation and its analysis using Turiyam Context". *Journal of Computer and Communications*, Vol. 9, Issue 6, pp. 222-229, 2021 doi: [10.4236/jcc.2021.96014](https://doi.org/10.4236/jcc.2021.96014)
- [17] Singh P. K., "Data with Turiyam Set for Fourth Dimension Quantum Information Processing". *Journal of Neutrosophic and Fuzzy Systems*, Vol 1, Issue 1, pp. 9-23, 2021. doi: <https://doi.org/10.54216/JNFS.010101>
- [18] Singh PK, Ahmad KD, Bal M, and Aswad M., "On The Symbolic Turiyam Rings." *Journal of Neutrosophic and Fuzzy Systems*, Vol. 1 , No. 2 , pp. 80-88, 2021, Doi : <https://doi.org/10.54216/JNFS.010204>
- [19] Bal M., Singh P. K., and Ahmad K. D., "A Short Introduction To The Symbolic Turiyam Vector Spaces and Complex Numbers." *Journal of Neutrosophic and Fuzzy Systems*, Vol. 2, Issue 1, pp. 76-87, 2022. doi : <https://doi.org/10.54216/JNFS.020107>
- [20] Bal M., Singh P. K., and Ahmad K. D., "A Short Introduction To The Concept Of Symbolic Turiyam Matrix. *Journal of Neutrosophic and Fuzzy Systems*, Vol. 2, Issue 1, pp. 88-99, 2022 doi : <https://doi.org/10.54216/JNFS.020108>
- [21] Bal M., Singh P. K., and Ahmad K. D, "An Introduction To The Symbolic Turiyam R-Modules and Turiyam Modulo Integers." *Journal of Neutrosophic and Fuzzy Systems*, Vol. 2, Issue 2, pp. 8-19, doi: <https://doi.org/10.54216/JNFS.020201>
- [22] Belnap J. N. , "A useful four-valued logic". In J. Michael Dunn and George Epstein, editors, *Proceedings of the Fifth International Symposium on Multiple-Valued Logic, Modern Uses of Multiple-Valued Logic*. Indiana University, D. Reidel Publishing Company, pp 8-37, 1975.
- [23] Font J. M., "Belnap's Four-Valued Logic and De Morgan Lattices." In: *Logic Journal of the IGPL*, Vol. 5, no. 3, pp. 1-29, 1997, doi: 10.1093/jigpal/5.3.1-e.

- [24] Irmak E., and Kurtuldu, Ö., “Concept of 4th Dimension for Databases.” In: Proceedings of 2015 IEEE 14th International Conference on Machine Learning and Applications (ICMLA), pp. 1159-1162, doi: 10.1109/ICMLA.2015.186.
- [25] James A. W., “Hyperbolic Geometry”. Second edition 2005, Springer.
- [26] Pandey L. K., Ojha K. K., Singh P.K., Singh C. S., Dwivedi S., Bergey E.A, “Diatoms image database of India (DIDI): a research tool”. *Environmental Technology & Innovation*, Vol. 5, pp. 148-160, 2016. <https://doi.org/10.1016/j.eti.2017.02.005>
- [27] Tixeira da Silva J.A., Vuong Q.H., “The right to refuse unwanted citations: rethinking the culture of science around the citation”. *Scientometrics*, Vol. 126, pp. 5355–5360, 2021.
- [28] Singh P. K., “*t*-index: Entropy based random document and citation analysis using average *h*-index.” *Scientometrics*, Vol 127, pp. 637-660, 2022, doi: 10.1007/s11192-021-04222-4
- [29] Singh, P. K., “Quaternion set for dealing fluctuation in quantum turiyam cognition”. *Journal of Neutrosophic and Fuzzy Systems*, Vol. 4, Issue 02, pp. 57–64, 2022. <https://doi.org/10.54216/JNFS.010101>
- [30] Singh P. K., “Air Quality Index Analysis Using Single-Valued Neutrosophic Plithogenic Graph for Multi-Decision Process.” *International Journal of Neutrosophic Sciences*, Vol 16, Issue 1, pp. 28-141, 2021, doi: <https://doi.org/10.54216/IJNS.160103>
- [31] Singh PK, “Non-Euclidean, Anti-Geometry and NeuroGeometry Characterization”. *International Journal of Neutrosophic Sciences*, Vol 18, Issue 3, pp. 8-19, 2022, doi : <https://doi.org/10.54216/IJNS.180301>
- [32] Singh, P. K. (2022) “Four-Way Turiyam set-based human quantum cognition analysis”. *Journal of Artificial Intelligence and Technology*, Vol. 2, Issue 4, pp. 144-151
- [33] Ani A., Mashadi M., Sri G. "Invers Moore-Penrose pada Matriks Turiyam Simbolik Real." *Jambura Journal of Mathematics* 5, no. 1, pp. 95-114, 2023.
- [34] Smarandache, F., “Introduction to the symbolic plithogenic algebraic structures (revisited)”. *Neutrosophic Set and System*, 53, 653–665, 2023.
- [35] Singh Pritpal, “Ambiguous Set Theory: A New Approach to Deal with Unconsciousness and Ambiguousness of Human Perception”. *Journal of Neutrosophic and Fuzzy Systems*, Vol. 5 , No. 1 , pp. 52-58, 2023
- [36] Silva, Manuel. "The Latest Advances on AI and Robotics Applications." *Journal of Artificial Intelligence and Technology* 2, no. 4, pp. 131-131, 2022.