Galoitica: Journal of Mathematical Structures and Applications

♦ ISSN: 2834-5568 Vol: 13, No. 2, 2026 ♦ PP. 01–05
Article DOI: https://doi.org/10.54216/GJMSA.130201

FULL LENGTH ARTICLE

Turiyam Set Comparison with Aristotle and Belnap Four-Valued Logic

Prem Kumar Singh[1,*]

[1] Department of Computer Science and Engineering, Gandhi Institute of Technology and Management, Visakhapatnam, Andhra Pradesh 530045, India

Email: premsingh.csjm@gmail.com

Received: November 02, 2025 Revised: December 28, 2025 Accepted: January 27, 2026 ⋆ Corresponding author

ABSTRACT

In recent times, investigating data with Turiyam attributes and its analysis has been considered one of the crucial tasks. It provides a way to characterize fuzziness in attributes in four independent ways: the true region (t), false region (f), indeterminate region (i), and liberal region (l). Numerous algorithms have been suggested for applications of the Turiyam set as a graph, a Turiyam matrix and algebraic properties of a Turiyam matrix. It tries to use words to calculate whenever there's a human consciousness. One suitable example is the voting system in a democratic country like India where people vote according to their conduit metaphor or they select NOTA. There are, however, several older four valued methods, such as those of Nagarjuna (Catuskoti) and Aristotle's logic and Belnap's logic. The author gives an example to compare the Turiyam logic with each of these approaches in this paper.

Keywords: Aristotle logic ▪ Anekantavada ▪ Consciousness ▪ Four-valued logic ▪ Unknown ▪ Turiyam set

1. INTRODUCTION

Dealing with dark datasets is a crucial task for researchers [1]. Dark datasets can contain interesting patterns and hidden agendas related to accomplishing particular tasks [2]. Human quantum Turiyam cognition [1], or its wisdom, is required to explore these patterns [3]. Several methods have been introduced to compute with these kinds of *philia* words through Aristotle's logic [4, 5], Belnap's logic [6], Nagarjuna's Catuskoti logic [7, 8], and Syadvada [9, 10, 11]. Turiyam sets have also been used to explore cognitive maps for humans and other animals [12]. This means that precision and recall should be high for Turiyam cognition, whereas false-negative cases cannot be identified in Aristotle's logic or a neutrosophic set. This paper focuses on the Turiyam set and compares it with the available approaches through an example.

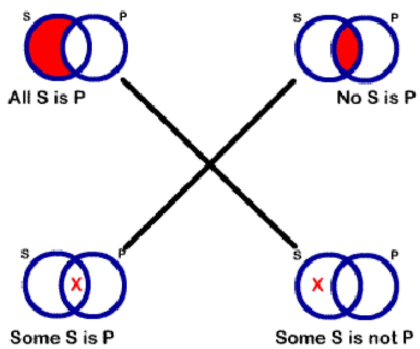

Figure 1. Aristotle's square of opposition.

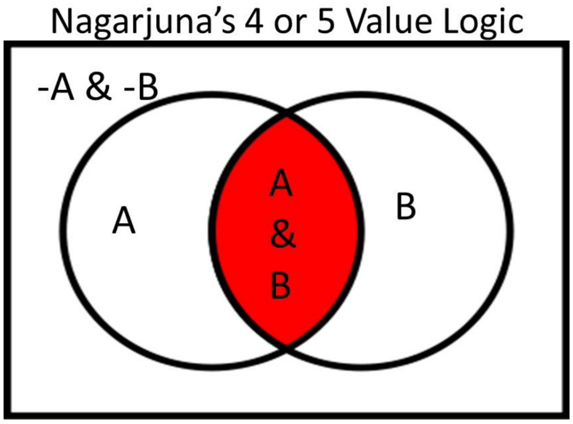

Figure 2. Nagarjuna's Catuskoti logic.

Figure 1 represents Aristotle's square of opposition, whereas Figure 2 represents Nagarjuna's logic. A comparative study of the differences between them can be found in [11]. The two approaches are distinct. Syadvada [9, 10], however, focuses on seven-valued propositions: (i) maybe it is; (ii) maybe it is not; (iii) maybe it is and it is not; (iv) maybe it is indescribable; (v) maybe it is and yet is indescribable; (vi) maybe it is not and it is also indescribable; and (vii) maybe it is, it is not, and it is also indescribable. Syadvada is therefore more generalized than Aristotle's and Nagarjuna's logics. It contains the complement of four-valued logic and represents most possibilities through seven propositions.

The Turiyam set focuses on four-valued wisdom, which increases after repetition [7, 8]. One suitable example is a voting system in a democratic country: some voters support a party, some reject it, some vote for anyone based on their choice, and others choose NOTA. Medical science also contains four-valued situations, such as a patient having symptoms of a disease, having no symptoms, being uncertain, or being liberal. In a diverse country such as India, where many opinions exist, it is difficult to conduct a definite analysis. People's ideas and even languages may be unknown to others, and expert quantum Turiyam cognition is needed to analyze their opinions.

For example, some people speak the national language of India (suppose Hindi), some prefer non-Hindi languages such as Tamil, Kannada, or Marathi, some speak hybrid languages such as Manipravalam, Telugu, Gadal, Jopara, or Dao, and others may not be aware of the classification of their language, which must be explored through their conduit metaphor. Speaking and learning a language is thus based on human quantum cognition and the desire to fulfil a conduit metaphor rather than solely on region. Patriotism is another Turiyam attribute that can be measured through a person's actions. Understanding a cartoon and its conduit metaphor depends on expert consciousness rather than uncertainty and cannot simply be classified through Aristotle's logic as partial or complete ignorance.

Aristotle used affectionate friendship to explain four-valued logical concepts. The Greek word *philia* describes affectionate friendship and its characterization in four independent ways. The type of friendship depends on human consciousness rather than partial ignorance. Similarly, affection for a language and the decision to learn it depend on a person's conduit metaphor rather than partial acceptance or ignorance. Turiyam awareness concerning unknown friends or languages increases over time, whereas indeterminacy remains unchanged during a given period. To address such concepts, the Turiyam set was introduced by Singh [1, 2], with examples and Python code in [1]. This paper compares several available four-valued logics through an example to clarify their applications in artificial intelligence, robotics, geometry, and other mathematical structures.

The remainder of the paper introduces the basic mathematics of the Turiyam set, presents an illustration and discussion, and concludes with references.

2. DATA WITH TURIYAM ATTRIBUTES

This section provides the basic definition of a Turiyam set for data representation.

Definition 1 (Turiyam set) [3, 4]. A Turiyam set contains the four-tuple truth (t), indeterminacy (i), falsity (f), and liberalization (l). Each dimension is independent of the others, with

$$-4 \leq t, i, f, l \leq +4. \tag{1}$$

A Turiyam set over a universe ξ may be represented as

$$T_X = \{\langle x; t_X(x), i_X(x), f_X(x), l_X(x)\rangle \mid x \in \xi\}. \tag{2}$$

Consider voting data for exploring a Turiyam set. Membership value 0 represents universal neutral cases, including absent voters, ineligible voters, voters below 18 years of age, and voters affected by brain drain. The value -4 represents universal false cases, such as true supporters of the ruling party choosing NOTA, whereas $+4$ represents universal true cases, such as anti-party, NOTA, or new voters choosing the ruling party.

Definition 2 (Intersection of Turiyam sets) [3, 4]. The intersection of Turiyam sets T_1 and T_2 can be computed as follows:

$$T_1 \wedge T_2 = \big((t_1 \wedge t_2), (i_1 \vee i_2), (f_1 \vee f_2), (l_1 \wedge l_2)\big), \tag{3}$$

$$T_1 \wedge T_2 = \big(t_1 t_2, i_1 + i_2 - i_1 i_2, f_1 + f_2 - f_1 f_2, l_1 l_2\big). \tag{4}$$

This operation helps to identify the maximum common wisdom between two voters.

Definition 3 (Union of Turiyam sets) [3, 4]. The union of Turiyam sets T_1 and T_2 can be computed as follows:

$$T_1 \vee T_2 = \big((t_1 \vee t_2), (i_1 \wedge i_2), (f_1 \wedge f_2), (l_1 \vee l_2)\big), \tag{5}$$

$$T_1 \vee T_2 = \big(t_1 + t_2 - t_1 t_2, i_1 i_2, f_1 f_2, l_1 + l_2 - l_1 l_2\big). \tag{6}$$

This operation helps determine whether ruling-party and anti-ruling-party voters agree on a given agenda.

Definition 4 (Complement of a Turiyam set) [3, 4]. The complement of a Turiyam set can be expressed as

$$t' = f, \qquad i' = 1 - i, \quad f' = t,$$

$$l' = \begin{cases} 1 - l, & \text{dependent case,} \\ 4 - l, & \text{independent case.} \end{cases} \tag{7}$$

or, for real events, unconscious uncertainty, or other unknown cases,

$$t' = f, \qquad i' = -i, \qquad f' = t, \qquad l' = -l. \tag{8}$$

The Turiyam set provides a precise mathematical way to examine voting systems and their hidden agendas, more precisely than Aristotle's or Belnap's logic. In Belnap's logic, an unknown remains unknown, whereas in a Turiyam set unknown voters can be characterized through their conduit metaphor at a given phase of time.

3. ILLUSTRATIONS

This section explains Aristotle's logic, Belnap's logic, Nagarjuna's Catuskoti, Syadvada, and Turiyam logic through the voting system of a democratic country such as India. Suppose nine political parties, numbered 1 through 9, contest an election. Voters cast ballots based on the parties' agendas. The parties and their flags can be represented on a ballot by numbers 1 through 9, as shown in Figure 3. The last option is NOTA, meaning "none of the above." Voters who do not wish to select any listed political leader may choose NOTA.

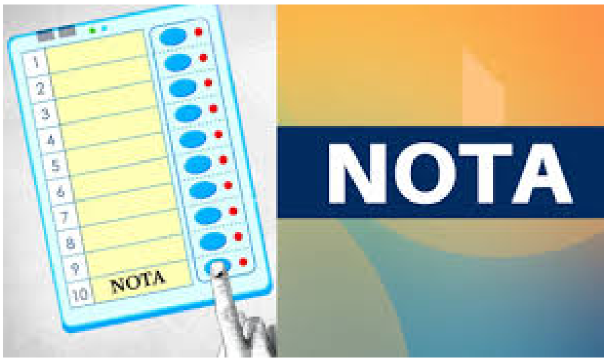

Figure 3. NOTA as a Turiyam or liberal vote in a democratic country such as India.

Each person can cast one vote for one political party. The combined votes determine whether a party wins, draws, or loses. Suppose number 1 in Figure 3 represents the ruling party's ballot and the remaining entries represent opposition parties standing on their political agendas.

3.1 Turiyam Logic Characterization of the Vote

The public vote can be characterized by a Turiyam set as follows.

True or supporter votes (t): These are true voters or supporters of the ruling party during a given period.

Anti-voters (f): These are anti-voters of the ruling party during the given period.

Indeterminate voters (i): These voters select anyone based on their profit. They may sell their vote according to a given condition rather than support any party, and are therefore uncertain voters.

Liberal or Turiyam votes (l): These voters are aware that none of the political leaders on the ballot is eligible to receive their vote. They select NOTA and confirm that they do not trust the listed leaders. The decision to choose NOTA is based on quantum cognition. These votes are assertible when compared with absent voters, ineligible voters, voters outside the constituency, or voters who boycott the election.

The complement of a Turiyam set can provide eight-valued logic to represent several possibilities of voter consciousness:

Turiyam or true voters ($t \vee l$): These voters may select either the ruling party or NOTA. They are true voters of the ruling party but may choose NOTA because of an incorrect agenda. They do not want to vote for the opposition and may select NOTA if the ruling party passes a bill against them.

Turiyam or anti-voters ($f \vee l$): These voters may select either an anti-ruling party or NOTA. They are true voters of an anti-ruling party but may choose NOTA because of that party's incorrect agenda. They will not vote for the ruling party and may select NOTA to demonstrate unhappiness with the opposition.

Turiyam or indeterminate voters ($i \vee l$): These voters may choose any party based on their conduit metaphor; examples include business people, young voters, and first-time voters who focus on a particular agenda.

Nothing or absent (0): These are people who are absent, boycott the voting system, or are unable to vote for other reasons.

3.2 Aristotle and Belnap Logic Characterization of the Vote

Aristotle's logic describes four values: true, false, partially true, and partially false. The voting example can be analyzed as follows.

(i) **Universal affirmation:** All voters support the ruling party. In reality, this condition is generally infeasible in a democratic country.

(ii) **Universal negation:** No voters support the ruling party. This appears contradictory because a ruling party cannot win without voters, although such a condition may arise if the party acts against the wishes of the people.

(iii) **Particular affirmation:** Some S are P; that is, some voters support the ruling party.

(iv) **Particular negation:** Some S are not P; that is, some voters do not support the ruling party.

Aristotle's logic thus provides a four-way data representation distinct from the Turiyam set. Belnap's logic represents the unknown as a fourth value, whereas in a Turiyam set unknown voters can still have a conduit metaphor and vote according to a choice that fulfils an agenda.

3.3 Nagarjuna and Syadvada Characterizations

Nagarjuna's characterization of the vote follows the logic illustrated in Figure 2. Syadvada provides seven-valued logic, which can be described through the voting example:

(i) Maybe it is: voters may support the ruling party.

(ii) Maybe it is not: voters may not support the ruling party.

(iii) Maybe it is and it is not: voters may support the ruling party or an opposition party.

(iv) Maybe it is indescribable: voters may choose NOTA.

(v) Maybe it is and yet is indescribable: voters may choose the ruling party or NOTA.

(vi) Maybe it is not and is also indescribable: voters may choose an opposition party or NOTA.

(vii) Maybe it is, it is not, and it is also indescribable: voters have not yet decided whom to vote for.

The Turiyam set and its complement cover all logical possibilities of voters compared with the other logics. They can also represent the hidden agenda behind a voter's decision to vote for someone or not to vote, based on a conduit metaphor. This may help a political party analyze voters' mindsets and trends at a given phase of time and provides a mathematical approach for applications in knowledge-processing tasks.

4. DISCUSSION

There has been limited debate concerning four-valued logic, although many logics discuss four-valued data representation [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]. Examples include Nagarjuna's Catuskoti, which inspired the Turiyam set [1, 2]; Aristotle's logic [4, 5]; Belnap's logic [6]; four-way consciousness [7, 8]; and Syadvada [9, 10]. Table 1 compares these logics in terms of several applications. Each logic has its own advantages and means of addressing uncertainty and linguistic computation. In the era of artificial intelligence and robotics, however, the Turiyam set may be especially useful because it deals with consciousness and hidden agendas in dark attributes. It provides a way to examine dark datasets in which human consciousness is involved in fulfilling a conduit metaphor.

Table 1. Comparison among available four-valued logics.

Criterion	Aristotle logic	Belnap logic	Nagarjuna logic	Turiyam logic
Domain	$[0,R]$	$[-\mathbb{Z},\mathbb{Z}^+]$	$[-\mathbb{Z},\mathbb{Z}^+]$	$[-\mathbb{R},\mathbb{R}^+]$
Co-domain	$[0,4]$	$[0,4]$	$[-4,4]$	$[-4,+4]$
Four dimensions	Yes	Yes	Yes	Yes
Dependent case	$[0,2]$	$[0,1]$	$[0,1]$	$[0,2]$
Independent case	$[0,2]$	$[0,4]$	$[-4,4]$	$[-4,+4]$
Dynamic attributes	No	No	Yes	Yes
Consciousness	No	No	No	Yes
Lattice	No	Yes	No	Yes
Graph	Yes	Yes	Yes	Yes
Square of opposition	Yes	Yes	Yes	Yes
Artificial intelligence	Yes	No	No	Yes
Robotics	No	No	No	Yes
Time-based analysis	No	No	No	Yes
Altmetrics	Not counted	Not counted	Not counted	Counted
Deductive and inductive	Yes	No	No	Yes

Table 1 shows that the Turiyam set is distinct from other four-valued logics in many ways. The study of this set theory is still at an initial stage and requires further work to explore its logic and mathematics. Cricket provides another example of data with Turiyam attributes, where an expert can classify weak, strong, average, or liberal teams. Turiyam awareness may be used to rank teams with equal points by selecting another parameter based on expert consciousness. A Turiyam-aware team may attempt to keep its run rate higher than others to remain at the top of the ranking. Turiyam sets have several applications in artificial intelligence, health care, agriculture, robotics, and cognitive-map exploration [12]. Future work will focus on other metrics for exploring data with Turiyam attributes and its applications in knowledge-processing tasks.

5. CONCLUSION

This paper focused on the consensus among four-valued logics and their examples. Aristotle's logic, Belnap's logic, Nagarjuna's Catuskoti, and the recently introduced Turiyam logic were compared using real-life examples and the criteria shown in Table 1. Each logic has applications associated with particular events. Turiyam logic may be useful for dark data in which human consciousness introduces fuzziness. Such dark datasets contain hidden agendas intended to fulfil the conduit metaphors of experts. Further research is needed to identify these hidden patterns at a given phase of time for knowledge-processing tasks.

ACKNOWLEDGEMENTS

The author thanks the editor for providing an opportunity to resubmit the revised manuscript.

REFERENCES

[1] P. K. Singh, "Data with Turiyam set for fourth-dimension quantum information processing," *Journal of Neutrosophic and Fuzzy Systems*, vol. 1, no. 1, pp. 9–23, 2021.

[2] P. K. Singh, N. Surathu, and G. S. Prakash, "Turiyam-based four-way unknown profile characterization on social networks," *Journal of Galoitica: Journal of Mathematical Structures and Applications*, vol. 10, no. 2, pp. 27–43, 2024.

[3] S., "Four-dimensional space," *Nature*, vol. 31, p. 481, 1885.

[4] T. Parsons and G. Ciola, "The traditional square of opposition," 1997.

[5] S. Boffa and P. Murinova, "Aristotle's square for mining fuzzy concepts," *Fuzzy Sets and Systems*, vol. 508, p. 109323, 2025.

[6] N. D. Belnap, "A useful four-valued logic," in *Modern Uses of Multiple-Valued Logic: Proceedings of the Fifth International Symposium on Multiple-Valued Logic*, J. M. Dunn and G. Epstein, Eds. D. Reidel Publishing Company, 1975, pp. 8–37.

[7] G. I. Gurdjieff, *In Search of Being: The Fourth Way to Consciousness*. Shambhala Publications, 2021.

[8] P. D. Ouspensky, *A New Model of the Universe*. New York: Vintage Books, 1971, p. 378.

[9] P. C. Mahalanobis, "The Indian-Jaina dialectic of Syadvad in relation to probability (i)," *Dialectica*, vol. 8, pp. 95–111, 1954.

[10] G. B. Burch, "Seven-valued logic in Jain philosophy," *International Philosophical Quarterly*, vol. 4, no. 1, pp. 68–93, 1964.

[11] A. Schumann, "Nagarjunian-Yogacarian modal logic versus Aristotelian modal logic," *Journal of Indian Philosophy*, vol. 49, pp. 467–498, 2021.

[12] N. Martin, R. Priya, P. K. Singh, and R. Gandhi, "Turiyam cognitive maps in optimal industrial decision making," *Big Data and Computing Visions*, vol. 5, no. 4, pp. 276–286, 2025.