Turiyam Based Four Way Unknown Profile Characterization on Social Networks

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Abstract

Recently Turiyam set and its algebra is introduced for dealing with the data containing human quantum cognition. This paper tries to extend the applications of Turiyam set while profile characterization at Social Network. To achieve this goal, a method is proposed for characterization of social network profiles in true regions (*t*), false region (*f*), Neutro region (*i*) and Liberal or Turiyam region (*l*), independently. The proposed method also provides implementation to understand the concept of Turiyam logic. In addition, many real life examples for data with Turiyam attributes is given with its four way characterization.

Keywords: Knowledge representation; multi-valued logic, Quaternion; Turiyam sets, Unknown.

1. Introduction

The precise analysis and characterization of uncertain [1] and unknown [2] profile at social network is considered as one of the crucial tasks for research communities. It will help to cybercrime as well as their parents for understanding their friendship. The structure and dynamics of social relationships and interactions depends among individuals or groups. The algebra of graph theory somehow provided a natural way to model the social networks using mathematical structures [3]. The nodes used to represent the profile and edges used to represent the relationship among them to quantify the strong and weak ties at given threshold [4]. The graph neural network provides an extensive way to compute the connection on everything and measure the activity [5]. The problem arises when the expert wants to understand the pattern of connected network [6] based on true friendship (*t*), Neutro-friendship (*i*), False Friendship (*f*), and Liberal (*l*) independently using the expert Turiyam cognition [7-8]. Same time its implementation is one of the major issues as the social network contains large amount of data. To achieve this goal, the current paper tries to extend the Turiyam set and its algebra with implementation in this paper for dealing the social network data. Same time some other real-life applications of Turiyam set is discussed with an example.

Turiyam graph [9] given a way to deal with unknown [10] profiles beyond the three dimensions. It is a generalization of a neutrosophic [10-11] or picture graph [12] where true (*t*), false (*f*), indeterminacy (*i*) and liberal (*l*) membership can be independent [-4, +4] or dependent [0, 1] as per the expert requirement. The refusal degree can be computed using complement operator 1-(*t*+*i*+*f*+*l*) [13]. Hence Turiyam set is distinct from any of the available sets on various parameters [14]. The Turiyam set adds a fourth dimension to represent the human consciousness while making social network friendship and a refusal degree for resolving the conflict [15]. It is nothing but an extensive representation of data using four valued logic [16-20]. It helps in dealing quaternion [21] data and its mathematical exploration [22] with several extensive applications [23-27]. The reason is neutrosophic sets fails at several places discussed in [28]. This paper focuses on dealing the social network data [29] and its characterization using Turiyam set.

One of the suitable examples of Turiyam set is dealing the conflict or voting analysis in a democratic country like India. It can be easily understood by the Table 1. The ruling party leader used to support the any law passed by the

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current government as true membership values (*t*). The opposition party used to reject the ruling party bill (*f*), the small leader or uneducated people used to confuse or uncertain about bill as Neutro Voters (*i*), the last is other country/Media or Court knows the impact of bill as Turiyam awareness (*l*). Everyone opinion is totally distinct from each other. It is one of the four dimensional independent Turiyam attribute data set.

Table 1: A Four valued Turiyam based Opinion

	CAA (Citizenship Amendment Act)	National Register for Citizen	Article 370	Uniform Civil Code
Ruling Party leaders or People get benefit	*t*	*t*	*t*	*t*
An Opposition Party leader	*f*	*f*	*f*	*f*
Some regional Party or Other independen leader or uneducated Public	*I*	*I*	*I*	*I*
Other Country, Court/ Media	*l*	*l*	*l*	*l*

In this paper this logic is used for characterization of friends in a given social network as by assigning different degrees of friendship. The motive is to characterize the true (*t*), false (*f*), Neutro (*i*) and Liberal (*l*) friends in the given social network. The objective is to find true ID, fake ID. It will help in labeling the social network ID as leader, follower, moderator or liberal. One of the significant outcomes of the proposed method is towards crime pattern and its prevention analysis beyond the concept lattice representation [30]. It will be helpful for many enforcement agencies, companies, election campaigns, based on their interests and behaviors.

Other parts of this paper are organized as follows: Section 2 provides some related studies about the current paper. Section 3 provides proposed method and its illustration in Section 4. Section 5 provides some real-life examples for data with Turiyam attributes. Section 6 provides discussion, followed by conclusions, acknowledgements, and references.

2. Preliminaries

Turiyam set provides a way to explore the unknown or undefined objects based on Human consciousness. It means the representation of Turiyam set is based on time which changes the interpretation of data at given phase of time. It can be characterized as follows [13-17]:

(i) The first state is the waking state. This state provides a way to represent those events which everyone is aware in their daily life. It can be represented as true membership value as (*t*).

(ii) The second state can be considered as dreaming state which is false state. It can be denoted (*f*).

(iii) The third state is the state of deep sleep or unconscious state (*i*).

(iv) The last one is super consciousness or full awareness state. It can be represented as Turiyam or Liberal State (*l*).

The last one liberalization state is much related to child. It is the doctrine of temporal state. It contains several ontological states for an object and its persistence based on defined time. It means the children extend his/her awareness in other dimensions based on true, false or third state. It means the Turiyam Set may contain 4-tuple: truth (*t*), Indeterminacy (*I*), falsity (*f*), and liberalization (*l*). Each of the dimensions is independent to each other as: $-4 \leq t + i + f + l \leq 4$.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 value which can be characterized independently in [0, 1]. $T = \{<k; t_t(k), I_t(k), F_t(k), l_t(k)>: k \in \xi\}$. In case of dependent can be represented $0 \leq t + i + f + l \leq 1$.The last one is refusal state which can be computed as 4-(*t*+*i*+*f*+*l*) in case of four valued

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independent. It means the refusal degree depends on types of independencies in case of three independent values the refusal degree will be 3-($t+i+f+l$) and vice versa. It can be observed in cricket data sets. In case of two independent event the refusal degree can be computed as 2-($t+i+f+l$). In case of dependent event or normalized event the refusal degree can be computed as follows: 1-($t+i+f+l$). It can be observed in any self-driving or robotics path or social network analysis. In the next section the preliminaries about Turiyam logic are given for understanding the elementary school child awareness and their exploration.

Turiyam set analyzes both dependent and independent Events [13-17]**:**

- **Dependent events:** The aspects (t, i, f, l) are not entirely independent and are influenced by each other. For example, in social network analysis, the connections between individuals might influence their perceived truth and falsity of information.
- **Independent events:** The aspects are considered independent with minimal influence on each other. For example, in self-driving cars, the path planning might consider obstacles (truth), sensor uncertainty (indeterminacy), potential collisions (falsity), and alternative routes (liberalization) without direct dependence between them.

General Range:

- **Independent Aspects:** Each aspect (truth, indeterminacy, falsity, liberalization) is mentioned as being independently characterized within **[0,1]**.
- **Turiyam Value:** The overall Turiyam value is described as having various ranges depending on the type of data and relationships between aspects:
- **Universal neutral values:** 0
- **Universal false cases:** -4
- **Universal truth cases:** +4

Specific Cases:

- **Dependent Events/Normalized Events:** Refusal degree: 1 - (t + i + f + l)
- **Two Independent Events:** Refusal degree: 2 - (t + i + f + l)
- **Three Independent Events:** Refusal degree: 3 - (t + i + f + l)
- **Four Independent Events:** Refusal degree: 4 - (t + i + f + l)

It can be observed that the Turiyam set provides a way to represent the unknown data [2, 10, 17, 18] and its exploration based on human consciousness [7, 13-15]. It is distinct than any other available sets [14]. Due to which Turiyam set is applied in several fields for various application [21-27]. However still many researcher mailed me about its applications and implementation. In this paper authors tried to characterize the social network friends and its characterization using Turiyam set. Same time the author provides several applications of Turiyam set.

4. A Proposed Method

In this section a method is proposed for four ways characterization of Social Network data sets and its analysis as given below:

Step 1: To achieve this goal the author, need to find types of connections on social networks as given below:

- Close Friends
- Acquaintances
- Family Members
- Colleagues/Professional Contacts
- Interest-Based Connections
- Online-Only Friends
- Mentors/Role Models

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- Support Network
- Casual Contacts

Step 2: Try to characterize each Type of friendship in four ways:

(a) **True Friends:**

- Consistent and meaningful interactions beyond likes and comments.
- Share personal experiences, offer support, and have a genuine connection.
- Online interaction fosters positive emotions and well-being.

(b) **False Friends:**

- Engage in negativity, drama, or manipulate you online.
- Don't know each other, but friends on social media
- Criticize in comment section

(c) **Neutro-Friends:**

- Inconsistent or confusing interactions.
- Mixed positive and negative experiences, leaving you unsure about the connection.
- Limited understanding of the friendship's potential.
- Like classmates but not friends

(d) **Turiyam or Liberal Friends:**

- Acquaintances with limited interaction like neighbors
- One-sided connections lacking reciprocity. Like celebrities, public figures, political groups
- Limited online persona with unclear intentions.
- Confusing and contradictory interactions.
- Exploring or adding unknown profile in social network as Tinder

Step 3: In this way the type of friends can be characterized as based on membership value as follows:

True friends (*t*): they know each other personally

False friends (*f*): they don't know each other but friends on social media

Neutro-friends (*i*): they are classmates, but don't know much about each other

Turiyam or Liberal friends (*l*): Celebrities, government account handles, customer support groups, large community pages, professors, mentors, guides, help groups

Step 4: It can also characterized using the defined parameters as shown in Table 2.

Table 2: Characteristics of each category

	True friends	**False friends**	**Uncertain friends**	**Turiyam friends**
Like each other posts	Yes	No	sometimes	Yes, but less consistent
Comment each other posts	Yes	No	sometimes	Yes, but just for formality
Share reels	Yes	No	No	Yes, only general information
Mention in posts and reels	Yes	No	No	No

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High level of engagement	Yes	No	No	No
give reply and responses	Yes	No	sometimes	Yes, but more in forma way
do video calls	Yes	No	No	No
Long conversations	Yes	No	No	No
Post pictures of them or stories	Yes	No	No	No
Collaborate and provide mutual support	Yes	No	No	sometimes
Membership	*t*	*f*	*i*	*l*

Step 5: The data can be collected via any online platform like Facebook, Instagram, Tinder, or LinkedIn for the analysis. In case anyone is having 40 percent true friends in his/her social network, 20 percent as Neutro Friend on Social network, 10 percent as false friend at social network and 30 percent as Turiyam or Liberal friend as Social Network. It can be easily represented as Vertex of Turiyam graph as A: (0.4, 0.2, 0.1, 0.3).

Step 6: In similar way the membership-value of other node can be computed as B: (0.5, 0.1, 0.3, 0.1),

C:(0.3, 0.2, 0.2, 0.3), D: (0.4, 0.3, 0.2, 0.1)

Step 7: The computed membership values can be represented via Turiyam matrix as shown in Table 3.

Table 3: Turiyam set for 4 friends on social media

Node	True Followers	Uncertain Followers	Rejected Followers	Liberal Followers
A	0.4	0.2	0.1	0.3
B	0.5	0.1	0.3	0.1
C	0.3	0.2	0.2	0.3
D	0.4	0.3	0.2	0.1

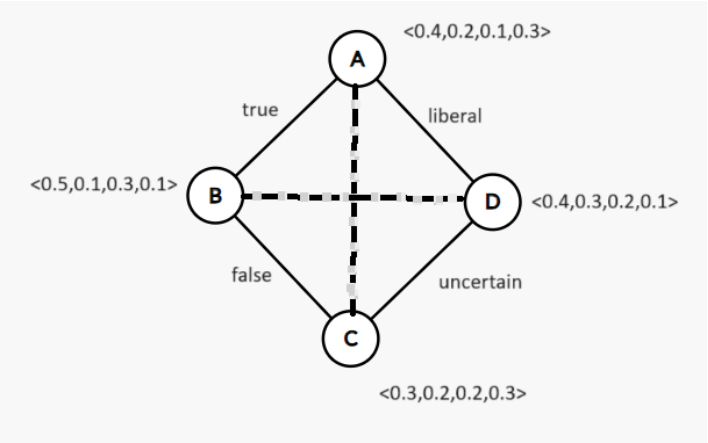

Figure 1 : A Turiyam graph visualization of Table 3.

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Step 8: The Table 3 can be visualized using the Turiyam graph as shown in Figure 1 for knowledge processing tasks.

Step 9: The strong relationship among four types of friends can be analyzed based on edges of the Turiyam graph.

Step 10: The same data can be visualized using Histogram in case someone unable to analyze the four way Turiyam graph as shown in Figure 2 based on each profile.

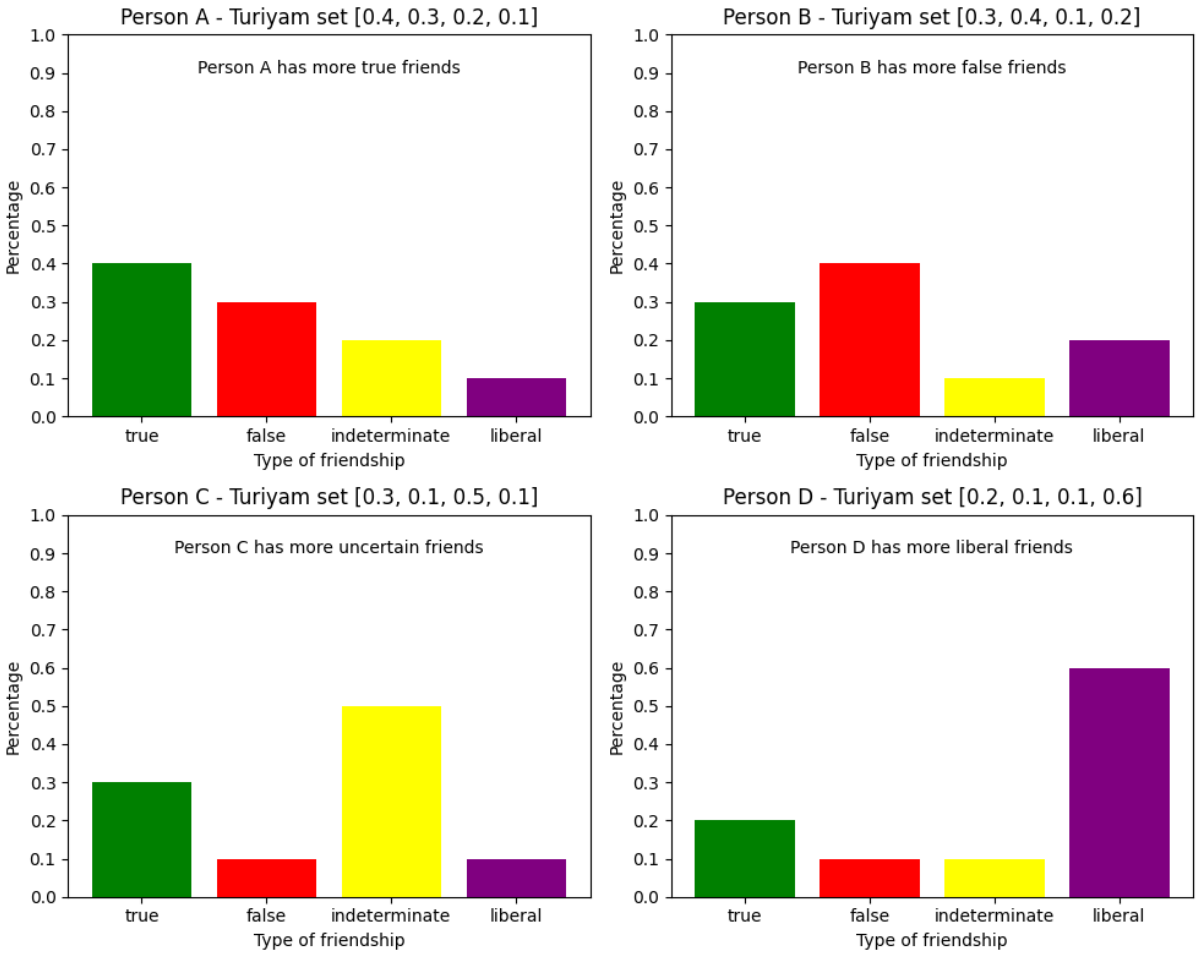

Figure 2 : The Four Way Data visualization of each profile

Step 11 : The computed four valued logic between nodes helps in improving the decision making system using t—norm as follows: [**min (t_1, t_2), max (i_1, i_2), max (f_1, f_2), min (l_1, l_2)**] between the nodes as shown in Table 4.

Table 4 : four valued logic between edges

Edges	**values**
AB	(0.4,0.2,0.3,0.1)
BC	(0.3,0.2,0.3,0.1)
CA	(0.3,0.3,0.2,0.1)

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DA	(0.4,0.3,0.2,0.1)
AC	(0.3,0.2,0.2,0.3)
BD	(0.4,0.3,0.3,0.1)

Step 12 : It can be implemented as:

Input

A, B, C, D Turiyam sets (A, B, C, D are represented as 0,1,2,3 in code respectively)

AB, BC, CD, DA Labels

Model

Turiyam graph Model

Step 12(i) : import the required python libraries and create a graph object using tensor module

```
import torch
import torch.nn as nn
import torch.optim as optim
from torch_geometric.data import Data
from torch_geometric.nn import GCNConv, global_mean_pool
```

```
# Define the graph data
node_features = torch.tensor([[0.4000, 0.2000, 0.1000, 0.3000],
                              [0.5000, 0.1000, 0.3000, 0.1000],
                              [0.3000, 0.2000, 0.2000, 0.3000],
                              [0.4000, 0.3000, 0.2000, 0.1000]], dtype=torch.float)

edge_index = torch.tensor([[0, 1, 2, 3],
                           [1, 2, 3, 0]], dtype=torch.long)

edge_features = torch.tensor([[0.4000, 0.2000, 0.3000, 0.1000],
                              [0.3000, 0.2000, 0.300, 0.1000],
                              [0.3000, 0.3000, 0.2000, 0.1000],
                              [0.4000, 0.3000, 0.3000, 0.1000]], dtype=torch.float)

edge_labels = torch.tensor([0, 1, 2, 3], dtype=torch.long)
```

The above graph object acts as **input (training data)** to the GNN Model

Step 12(ii) : code a GNN model class as follows

```
# Define your GNN model
class GNNModel(nn.Module):
    def __init__(self, input_size, hidden_size, num_classes):
        super(GNNModel, self).__init__()
        self.conv1 = GCNConv(input_size, hidden_size)
        self.conv2 = GCNConv(hidden_size, num_classes)

    def forward(self, x, edge_index):
        x = self.conv1(x, edge_index)
        x = torch.relu(x)
        x = self.conv2(x, edge_index)
        x = nn.functional.softmax(x, dim=-1)  # Softmax
        return x
```


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Step 12 (iii) :Instantiate GNN and Training loop

```
# Train the GNN model
num_epochs = 100
for epoch in range(num_epochs):
    # Forward pass
    logits = model(graph_data.x, graph_data.edge_index)
    loss = criterion(logits, graph_data.y)

    # Backward pass and optimization
    optimizer.zero_grad()
    loss.backward()
    optimizer.step()

    # Print average training loss over the epoch
    if (epoch + 1) % 10 == 0:
        print(f'Epoch {epoch + 1}/{num_epochs}, Loss: {loss.item()}')
```

Output –

```
Epoch 10/100, Loss: 1.3767929077148438
Epoch 20/100, Loss: 1.3617544174194336
Epoch 30/100, Loss: 1.3364677429199219
Epoch 40/100, Loss: 1.2967156171798706
Epoch 50/100, Loss: 1.2450637817382812
Epoch 60/100, Loss: 1.1876696348190308
Epoch 70/100, Loss: 1.123593807220459
Epoch 80/100, Loss: 1.0496596097946167
Epoch 90/100, Loss: 0.9726165533065796
Epoch 100/100, Loss: 0.9038283228874207
```

Step 12(iv): Predict the labels for remaining edges
Remaining edges acts a **test data** for trained gnn model for predictions as **output**

```
# Remaining edges
remaining_edges = torch.tensor([[2, 0], [3, 1]], dtype=torch.long)
remaining_edge_features = torch.tensor([[0.3, 0.2, 0.2, 0.3], [0.4, 0.3, 0.3, 0.1]], dtype=torch.float)
```

```
with torch.no_grad():
    # Forward pass to get predicted logits
    predicted_logits = model(remaining_data.x, remaining_data.edge_index)

    # Apply softmax activation
    predicted_probs = nn.functional.softmax(predicted_logits, dim=-1)

    # Predicted labels are obtained by selecting the index of the maximum probability
    _, predicted_labels = torch.max(predicted_probs, dim=1)

# Print predicted labels and probabilities for each remaining edge
for i, edge in enumerate(remaining_data.edge_index.t()):
    print(f"Predicted label for edge {tuple(edge.numpy())}: {predicted_labels[i].item()}")
    print(f"Predicted probabilities: {predicted_probs[i].numpy()}")
```

Output -

```
Predicted label for edge (2, 0): 0
Predicted probabilities: [0.3442408  0.19046037 0.1885538  0.27674502]
Predicted label for edge (3, 1): 1
Predicted probabilities: [0.2574598  0.31325975 0.20118983 0.22809063]
```


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The GNN has predicted that AC have probability of uncertain friendship, BD have a probability of strong friendship. (label prediction is numerically encoded, 0 – strong friendship, 1- uncertain friendship , 2 – false friendship, 3- Turiyam or liberal friendship)

In the above way, the Turiyam graph can be implemented for social network analysis.

Complexity: It can be observed that the proposed method traverses each node twice for the given edges and number of epoch. In this way the proposed method takes maximum O (num_epochs * E * $V^{\wedge 2}$) , where E and V are the number of edges and nodes in the main graph and num_epochs is the number of training epochs.

In the next section some other real-life example for data with Turiyam set is given for exploring this topic in near future.

5. Some other relevant examples for Data with Turiyam attributes

In this section some of the real-life example given for data with Turiyam set as given below:

Example 1: (Online Shopping and E-Commerce)

- True degree (t): A person is sure about purchasing a product from Amazon/Flip kart
- Indeterminate (i): A person is not sure about buying and thinking whether to purchase.
- False(f): A person is not interested to purchase
- Liberal (l): A person is Liberal, it is he is just surfing and scrolling does not have any intention to purchase, i.e. he is just exploring.

Example 2: (Languages)

- True degree (t): A person is speaking a true language that is correct (for example Telugu).
- Indeterminate degree (i): A person is speaking a mixed language with another language (For example, Telugu, Hindi Mix).
- False Degree (f): A person is speaking some other language that is clearly not Telugu but another language like Hindi.
- Liberal Degree (l): Here, it is a universal language like Sign Language using Symbols, which are commonly understood by everyone.

Example 3: (Mobile Networks and Wi-Fi Systems)

- True Network (t): Membership degree could represent the strength of the signals; the signal is strong and detectable.
- Neutro Network(i): Indeterminacy degree might reflect the uncertainty in connection, where the signal is unstable.
- False Network (f): Non-membership degree could indicate there is no signal.
- Liberal (l): Liberal degree may represent situations where the Wi-Fi is turned off or the signal is out of range.

Example 4: (Financial Risk Assessment)

- True Risk (t): Membership degree could represent the likelihood of an investment being profitable.
- Neutro Risk (i): Indeterminacy degree might reflect the uncertainty in predicting market trends.
- False Risk (f): Non-membership degree could indicate the lack of profitability in an investment.
- Liberal or Turiyam risk (l): Liberal degree may represent situations where investors choose not to engage in certain financial activities, like may decide not to participate in high-risk ventures, such as startups or speculative markets, might deliberately avoid investing in specific economic sectors due to ethical concerns or anticipated market trends.

Example 5: (Medical Diagnosis)

- True Diagnoses (t): Degree of certainty a specific symptom points towards a particular disease.

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- Neutro Diagnoses (*i*): Incompleteness of medical history or unclear test results.
- False Diagnoses (*f*): Likelihood of the symptom being caused by another factor.
- Liberal or Turiyam Diagnoses (*l*): Relevance of a rare or uncommon condition to the patient's presentation.

Example 6: (Self-driving Cars)

- True driving (*t*): Confidence level in the car's perception of its surroundings (e.g., object detection, road markings).
- Neutro Driving (*i*): Presence of unclear weather conditions or sensor malfunction.
- False Driving (*f*): Likelihood of misinterpreting a situation, like crossing when the red light is on.
- Liberal Driving (*l*): Availability of alternative routes or emergency protocols in case of unexpected events.

Example 7: (Cyber security Threat Detection)

- True Threat (*t*): Confidence level in identifying a cyber attack based on network activity.
- Neutro Threat (*i*): Difficulty in differentiating between normal and malicious activity.
- False Threat (*f*): Possibility of a false alarm triggered by benign network behaviour.
- Liberal Threat (*l*): Potential consequences of missing a real attack or taking unnecessary security measures, like unnecessary fear of a security threat.

Example 8: (Love and Relationships)

- True Love (*t*): A person truly likes or loyal with the other person or vice versa.
- Neutro Love (*i*): A person is not sure about their relationship; sometimes likes and does not like at other times.
- False Love (*f*): A person does not like the other person or vice versa.
- Liberal Love (*l*): A person is Liberal. A student knows that love is time pass. I need to focus on study this time. They are not care about these things.

Example 9: (Job Search)

- True Job Search (*t*): The job profile exactly matches with the skills and aspiration of the candidate.
- Neutro Job Search (*i*): The job has some matching with the candidate's goals and skills.
- False Job Search (*f*): The job is completely different from the skills and competency of the candidate.
- Liberal Job Search (*l*): The job is liberal, i.e., it may be a new possibility that is emerging and can be explored.

Example 10: (Drivers)

- True driver (*t*): The drive is driving properly as per traffic rules and regulations
- Neutro Driver (*i*): he is still in learner driver and makes some mistakes
- False Driver (*f*): Does know driving or does not follow rules while driving
- Liberal Driver (*l*): he is an expert driver and knows exceptionally well, expert in the field

Example 11: (Teachers/Instructors)

- True Teacher (*t*): The teacher is teaching only what is in curriculum and syllabus.
- Neutro Teacher (*i*): Teaching is deviating or ignoring some parts in syllabus.
- False Teacher (*f*): He is not teaching the course or teaching different things from the curriculum. He used to give free marks without teaching.
- Liberal or Turiyam teacher (l): He is an expert in the subject and teaching what is required exactly using extra material references. He teaches the students for their future enhancement beyond the marks and feedback.

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Example 12: (Students)

- True student (*t*): he is studying only what is there curriculum and syllabus
- Neutro Student (*i*): he is only studying few parts
- False student (*f*): student is not studying what is there in curriculum
- Liberal student (*l*): he is studying beyond syllabus and gain extra knowledge to perfect the subject

Example 13: (Media broadcasting and news channels)

- True News (*t*) : The media/channels are covering the correct news
- Neutro News (i): The media covers partially correct and misinterpreted news based on fulfill their agenda.
- False news (*f*) : The media reports fake news.
- Liberal degrees (*l*) : They are showing advertisement or something based on their consciousness to fulfill their conduit metaphor. These types of news covers based on consciousness.

Example 14: (Traffic Flow)

- True Traffic (*t*): Traffic is very high and heavy in the region
- Neutro Traffic (*i*): The traffic flow becomes less predictable during rush hours, causing fluctuations in vehicle speed. It changes based on situation like natural disaster or flood.
- False Traffic (*f*): The roads are free and smooth movement of vehicles.
- Liberal or Turiyam (*l*): Traffic regulations are relaxed during late hours, allowing for more flexible Movement for top leaders, Emergency patients etc. It become closed for general public.

Example 15: (Customer Satisfaction in shops and restaurants)

- True customer (*t*): Customers consistently rate services as excellent in customer satisfaction reviews
- Neutro Customer (*i*): Customer comes sometime and rate the services or may be staff changes or due to workload.
- False Customer (*f*): The customer never eats those food due to different regions. Hence their feedback will be consider as false. It might possible that the customer from rebel group of restaurant.
- Liberal or Turiyam Customer (*l*): During peak hours, service standards may be relaxed to accommodate a larger volume of customers like during festive seasons and exhibitions. These types of customer gave feedback based on consciousness rather than biasing.

Example 16: (Fact-Checking and Authentic Information)

- Fact (*t*): Identifying and verifying factual information in articles through reliable sources.
- Neutro Fact (*i*): Articles with claims that are difficult to verify due to limited information or conflicting sources.
- False fact (*f*): The articles with proven misinformation or inaccuracies. It may be influenced by someone or rebel group to drag the others.
- Liberal or Turiyam fact (l): They are still under research and have to be verified after completion of research. These are the true fact that each one of knows the truth based on inner consciousness. The inner consciousness is nothing but Turiyam fact.

Example 17: (Choosing what to wear)

- **True wearing (*t*):** Selecting clothes based on elements such as the temperature, the formality of the occasion, and personal comfort.
- **Neutro Wear (*i*):** Adapting to unpredictable factors like sudden weather changes, attending social events with ambiguous dress codes, or accounting for mood swings influence clothing choices.
- **False wearing (*f*):** Dismissing obviously inappropriate options, such as avoiding a heavy coat in the summer or refraining from wearing beachwear to a business meeting.
- **Liberal or Turiyam wearing (*l*):** Embracing a variety of fashion trends, considering cultural norms, and incorporating individual preferences to craft a unique and adaptable wardrobechoice.es to make a personalized and adaptable choice.

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Example 18: (Time Management)

- True Time Management (*t*): A person usually finishes tasks on time.
- Neutro Time Management (*i*): Sometimes unexpected things happen, making it hard to stick to your schedule.
- False Time Management (*f*): A person often misses deadlines or leave tasks unfinished.
- Liberal or Turiyam time Management (*l*): It's okay to take breaks or relax sometimes, as long as you manage your time well overall.

Example 19: (Healthcare Accessibility in a state)

- Health Care (*t*): A patient usually has no trouble getting medical help when you need it.
- Neutro Heath Care (*i*): Sometimes it's harder to see a doctor or get treatment due to long waits or paperwork.
- False heath Care (*f*): patient struggle to get medical care because it's too expensive or far away.
- Liberal or Turiyam Health Care (*l*): The patient might try different health options, like seeing a specialist or using natural remedies, if you're not happy with traditional healthcare.

Example 20: (Team Performance in Sports)

- True performance (*t*): A cricket team often wins games and plays well together.
- Neutro Performance (*i*): The draw matches can be considered as Neutro performance.
- False Membership (*f*): A team loses a lot or doesn't work together effectively.
- Liberal or Turiyam Performance (*l*): The Team player understood that win, defeat or draw is nothing but just sports spirit required. The team values sportsmanship and fairness also matters. Hence the players reflected true sportsman spirit in the game. It can be considered as Turiyam or Liberal values.

Example 21: (Democracy)

- True Democracy (*t*): Everyone has equal right to vote.
- Neutro Democracy (*i*): It depends on current party. The members of ruling party consider as more powerful than other. It means partial autocracy and partial democracy.
- False Democracy (*f*): The country has no democracy or voting right.
- Liberal or Turiyam Democracy (*l*): The ideal democracy, every one considered as equal beyond the voting right. The unknown region or rule which needs exploration.

Example 22: (Conflict Analysis)

- True Conflict (*t*): There is a conflict of interest arises based on defined parameters.
- Neutro Conflict (*i*): The conflict is motivated by third party to enjoy.
- False Conflict (*f*): There is no conflict as per defined parameters.
- Liberal or Turiyam Conflict (*l*): The person knows that these types of conflicts are nothing but just time pass. Let us ignore or do our work. These types of liberal people live in Turiyam conflict zone.

It can be observed that the Turiyam set and its application is totally distinct from Neutrosophic set [28]. In near future the author will try to focus on exploring some other mathematical metric for dealing the data with Turiyam attributes.

6. Discussion

Recent time four-dimensional data visualization is considered as one of the crucial tasks. Some of the potential papers are compared in the Table 5. These works highlight the growing awareness of the limitations of binary models in representing social networks and the increasing interest in approaches that embrace uncertainty and multi-valued representations. While Managing Uncertainty in Social Networks and Strong and weak ties lay the groundwork for understanding tie strength, works like Everything is connected provide powerful tools for network analysis. Two, Three, Four, Infinity and Fourth Dimension Data Representation propose novel models for capturing relationship complexity, while Neighborhood-based uncertainty generation acknowledges the need for uncertainty quantification within these models.

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Table 5: Some distinction among recent papers related to this study

Author work on the topic	Advantages	Pitfall
Adar & Re (2007)	*Contextual Background *Imprecision and Uncertainty *Probabilistic Databases *Application Building Blocks *Commercial Applications	*Limited Empirical Evaluation *Simplifying assumptions *Overlooking potential challenges *Lack of comparison with other methods *Limited Scope
Dunn (2019)	*Comprehensive Overview *Insightful Analysis *Accessible Style *Original Contributions *Future Directions	*Limited Scope *Technical Complexity *Philosophical Assumptions *Lack of empirical Evidence
N. Belnap (1975)	*Conceptual Exploration *Philosophical Insights *Ethical Implications	*Complexity *Practical Implementation *Limitations
Veličković, P. (2023)	*Universal Language *Permutation Equivariance And Invariance *Variety Of Types *Wide Applications *Potential For Discovering hidden Structures	*Learning Without a graph *Hardware Compatibility *Beyond Permutation Equivariance *Need For Geometric Graphs *Complexity and Scalability
Singh, P. K. (2021)	*Novel 4D data rep. and Turiyam Context *Theoretical framework with math models *Demonstrates potential applications *Discusses future directions	*Lack of empirical evidence *Assumes math knowledge *No comparison with existing methods *Does not discuss limitations
Han et al. (2014)	*Capturing Uncertainty *Efficient Algorithms	*Computation Overhead *Identifying Relationships
Wang et al. (2016)	*Introduced strong/weak ties concept *Weak ties key for job/social mobility *Provided empirical evidence *Influential in sociology, psychology Implications for policy/networks	*Theory not universal *Survey data limitations *Concept may not apply to digital networks *Lacks discussion on *limitations/challenges
Said et al. (2022) .	*Hybrid Approach *Real-Time Traffic Information *Traffic Light Optimization	*Limited to Specific Techniques *Complexity and Implementation Challenges

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Singh, P. K. (2023*a*)	*Precise Representation *Handling Dark Data *Medical Data Analysis	*Complexity and Interpretability *Limited Familiarity: As a relatively new construct, the Turiyam set lacks widespread familiarity. Researchers and practitioners need to invest time in understanding its properties and applications
Abulaish et al. (2012)	*Conceptual Differentiation *Structure of Online Friendship	*Limited Scope *Generalization Challenges
Basher et al. (2022)	*Generalization of Neutrosophic Ideas *Symbolic Turiyam Group *AH-Substructures	*Mathematical Complexity: *Interpretation Difficulty: *Practical Implementation
Singh, P. K. (2023*c*)	***Exploring Unknown Objects**: The Turiyam set serves as a prominent tool for exploring unknown or undefined objects . ***Child Development**: The elementary school provides a suitable context where children explore unknown objects. During this stage, a child's Turiyam cognition develops based on consciousness . ***Characterization of Learning:** 1.True Learning (t): Represents accurate understanding. 2.False Learning (f): Indicates incorrect information. 3.Uncertain Learning (i): Reflects ambiguity. 4.Liberal Learning (l): Represents knowledge that may not be immediately required but can be explored later. ***Quantum Cognition**	*Mathematical Complexity *Interpretation Difficulty *Practical Implementation
Ganati et al. (2023*a*)	*Handling Uncertainty *Graphical Representation *Application in Social Networks	***Limited to Turiyam Environment**: The concept of Turiyam graphs is applicable only within the Turiyam environment. It may not directly address uncertainty scenarios beyond the four defined degrees.
Ganati (2023*b*)	*Precise Handling of Uncertainty: *Four Dimensions: Membership values (t) Unknown values (i) Non-membership values (f) Liberal values (l) *Applicability:	*Mathematical Complexity: *Interpretation Difficulty: *Practical Implementation:
Singh (2022*a*)	*Precise Representation *Democratic Context *Conflict Resolution *Dynamic Data Handling	*Complexity *Interpretation Challenges *Application Scope
Singh (2022*b*)	*Precise Characterization *Exploration of Four-Dimensional Cognition. *Method for Handling Undefined and Unknown Data	*Complexity and Interpretability *Limited Familiarity
Ani et al. (2023)	*Symbolic Turiyam Matrices *Moore-Penrose Inverse *Algebraic Approach *Existence of Inverse	***Limited to Non-Singular Matrices**: The study assumes non-singular square matrices. Extending the approach to singular or non-square symbolic Turiyam matrices remains an open

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		question.
Deng and Papadimitriou(1990)	*Efficient Exploration *Eulerian Graphs *Algorithm Relevance	***General Deficiency**: While they address deficiency-one graphs, the problem of exploring a graph with general deficiency remains briefly discussed. This limitation arises when the graph deviates significantly from being Eulerian

It can be observed that the current paper is distinct than other paper shown in Table 5 in many parameters. It is believed that the proposed method will be helpful for the young researchers working in four dimensional or data with Turiyam set. In near future the author will focus on complex valued representation of Turiyam attributes [21] and its connection with Quaternion fuzzy set [31] with an illustrative example.

7. Conclusion

This paper focused on exploring the data with Turiyam set and its characterization. The graphical visualization is also discussed with its implementation using social network example. To achieve this goal, the proposed method takes $O(\text{num\_epochs} * E * V^{\wedge 2})$ time complexity. The code is written using Python torch library. The proposed method is compared with some of the recent methods related to four-dimensional data in Table 5. Same time some other real-life examples are also discussed which contains Turiyam attributes. It shows that the Turiyam set able to analyze the data contains human quantum cognition more precisely than other sets.

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