Predicting Links in Complex Network using Fuzzy Logic
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Abstract — This Complex networks has become significant part of the digital world. Many large scale problems can only be handled using complex networks. Evaluating the optimistic link in these networks is still a challenging issue. Link prediction in directed network is attracting growing interest among many network scientists. Compared with predicting the existence of a link, determine its direction is more complicated. It proposed efficient solution named Local Directed Path to predict link direction. By adding an extra ground node to the network, one can solve the information loss problem in sparse network, which makes the method effective and robust. As a quasi-local method, link prediction using fuzzy logic can deal with large-scale networks in a reasonable time. The comparison is made between existing and proposed technique based on parametric analysis. The overall objective is to evaluate various shortcomings in them.

Keywords — Fuzzy logic, Link prediction, bivalent values, k-statistics, f-measure, sensitivity.

I. INTRODUCTION
Wireless complex network is the one in which there exist connectivity of each node with every other node. Wireless mesh network is one of the most reliable networks available to be used. The topology which is used wireless mesh topology. The mechanism is generally expensive in nature. The wireless Complex network will consist to nodes, routers and gateways etc. Mesh topology is reliable and offer redundancy [2]. The redundancy is the one in which same data is repeated again and again over the network. The radio nodes are used over the mesh network. There are number of parameters which are used within the wireless mesh network. The coverage area of the mesh nodes is known as mesh cloud. The nodes which are connected over the wireless mesh network are of different types. Some of the issues which are associated with the Wireless Mesh networks are:

i) Coverage Area
ii) Supra System
iii) Total Cost of ownership
iv) Security

Fig 1: Showing Structure of Mesh Network
All of the above said factors will decide the success or failure of the network. The cost factor is very important since every user may not afford the cost associated with the system.

In a given network what is major challenge encountered is inference of links whose occurrence is anticipated in future on basis of the edge, node and topological characteristics they possess thereby leading to a fundamental problem known as link prediction. In a network representation, at a particular instance of time, main objective is to predict what and all links in the network will occur in next instance of time. The nodes refer to people or entities in social terms and the edges represent linkage, interaction between the entities in social networks.

Fuzzy logic involves method of reasoning much alike human reasoning. It produces acceptable yet define the result as a response to ambiguous, contradictory, out of bounds, incomplete, distorted fuzzy input. The concept of fuzzy logic resembles the task of decision making in human brain that comprises of all in between possibilities between digital terms Yes or No. which range in between yes or No. This was observed by fuzzy logic inventor Lofti Zodeh. Fuzzy logic is dependent on input possibilities levels to determine definite output [5]. Fuzzy logic may have two values and infers two possible solutions. Fuzzy logic is a flexible machine learning approach accompanied with multi – valued logic allowing intermediate values. Interpretation and execution of commands is taken care by inference mechanism seen in fuzzy logic approach. The existing work concentrates on the directed algorithm in which bivalent values are considered
only. The bivalent values indicates multi facet values which are absent in the existing system. The existing system does not consider the parameters which are considered in the proposed system.

II. LITERATURE SURVEY
The existing work is being done toward complex network. The connectivity problems has legion of techniques associated with it. S. Selvakennedy et.al [2] this paper describes the rural area data transmission through the WSN is considered in this case. The checking of malicious entry is difficult in this case. Large number of users interacts with the WSN and checking credibility of each is exceedingly difficult. The WSN opt for large number of security mechanism. The security mechanisms which are used could involve authentication and authorization. In wireless sensor network knobs life starts only with the power usage, connecting with another knobs. In processing the data and transferring the gathered data a lot of energy depletes. It is unsafe to replace the batteries which are depleted or drained the power in many cases like surveillance applications. Thus in order to beat such power efficiency problems many researchers are trying to find power aware protocols. A.B Khan et al. [4] this paper suggests how to form a dataset for the given problem. Today database are huge so extracting data from the database using genetic algorithm is complex task. Learning techniques are employed in order to make algorithm collect the data which is required. Collecting data and training process is not a simple task. In this paper it is suggested that how we can collect and train the algorithm to achieve desired objective. Dataset formulation is easy using this algorithm. Supervised learning mechanisms are followed in this case.

Xiaojie Wang et al. [5] In that paper, they propose an effective alternative called Local Directed Way to anticipate url bearing. With the development of a supplementary ground center point to the system, we handle the data diminishing issue in thin structure, which makes our methodology convincing and solid. In that paper, we offer thought with respect to anticipating url bearing in guided frameworks and propose LDP strategy. With the choice of a supplementary ground center point and numbering what number of guided ways, we extend the LP approach to manage guided cases and add a semi neighborhood rundown to predict the course of association.

Evan Wei et al. [6] In that paper, they facilitate the thin associated study directly into an organized discourse and condense the late study works on the hyperlink forecast errand. We isolate the current url expectation strategies into three courses: the hub savvy similarity based procedures tries to find a suitable separation rating for 2 questions; the topological configuration based methods offer consideration regarding abusing both nearby or overall strategies that may viably depict the framework; probabilistic outline based systems attempt to comprehend a tight plan that may digest the interpersonal organization.

Panagiotis Symeonidis et al. [7] in that paper, they incorporate the pondered a vertex collocation page (VCP) for the objective of topological url evaluation and desire. VCPs offer just about signify information about the enveloping adjacent arrangement of stuck vertex sets. The VCP procedure offers another item for space forces to get a handle on the guideline advancement segments inside their frameworks and to analyze url course of action parts in the benefit sociological, normal, physical, and other association.

Buket Kaya et al. [8] incorporate a story probabilistically weighted extension of the Adamic/Adar figure for heterogeneous data frameworks, which we use to display the possible amazing things about grouped verification, especially in circumstances when homogeneous associations are to an incredible degree inadequate. We in this manner show some direct inadequacies of customary unsupervised url desire.

Catherine et al. [9] in this paper, they propose a convincing choice called Local Directed Way to predict url course. With the development of a supplementary ground centre point to the structure, we handle the data reducing issue in thin system, which makes our methodology fruitful and capable. In that paper, we offer thought with respect to predicting url bearing in guided frameworks and propose LDP technique. With the alternative of a supplementary ground centre and counting what number of guided ways, we extend the LP approach to manage guiding events and add a semi adjacent record to anticipate the direction of association.

III. PROPOSED SYSTEM
The proposed system will have certain objectives associated with it. The proposed system will consider fuzzy system. The fuzzy system constructs the fuzzy inference system. In this case rules of fuzzy are created. The proposed system accomplishes the desired results through the use of sink node elimination so that shortest path is detected. The optimality is achieved in this case. The clustering coefficient is also considered. The clustering coefficient will make the clusters connectivity high or low. The clustering coefficient is selected on the basis of relationship that has to be expressed between the various nodes. It is given through the following equation

\[ Q = \frac{1}{4n} \sum_{ij} (A_{ij} - \frac{k_i k_j}{2m} (S_i S_j + 1)) = \frac{1}{4n} \sum_{ij} (A_{ij} - \frac{k_i k_j}{2m} S_i S_j) \]

Eq-1
The clustering coefficient will be utilized on the basis of distinct node attributes. The proposed system is based on the following algorithm:

Algorithm fuzzy (Data)
   a) Data=Data[]
   b) Initialize U=[u_0]
   c) Perform the following steps for every center vector C^k=[c_j] with U^k
   d) \[ c_j = \frac{1}{\sum_{i=1}^{N} (x_{ij}^k)_{n-1}^{2}} \]
   e) \[ if \ (u^{k+1} - u^k) < \delta \ then \ stop \ otherwise \ return \ to \ step \ c \]
   Where u indicates membership function values \( \delta \) is the prescribed tolerance. X is the value from the dataset or input value.

The proposed system also takes into consideration path length which is calculated using the following algorithm.

Algo path (Graph G, Node n)
   a) Obtain Adjacency(A)=Adj(G)
   b) Set i=1
   c) Repeat while i<=n
   d) Check Adj_i
   e) If(Adj_i>0)
   f) Accept the node(AC_i)=N_i
   g) Else
   h) Reject the node
   i) End of if
   j) Move to the next node
   k) I=i+1
   l) End of loop
   m) Calculate Modularity(Q) using Eq 1

The algorithm efficiently calculates the value of the path length and overhead as listed through the results.

IV. RESULTS
The simulation and results indicate that the proposed technique produces better result as compared to the exiting technique. The simulation is created in MATLAB. The simulation when executed at first place following screen will be displayed

Fig 2: Showing Complexity degree in terms of Graph
The graph once produced link prediction will going to take place. The result produced in terms of chart will be as follows

Fig 3: Showing the link prediction in terms of edges and degree of distribution
The result from the above diagram indicates that proposed technique predict the links much quickly as compared to the previous work. The parametric analysis is given by:

A. K-STATISTICS: In insights, a k-Statistics is a base fluctuation impartial estimator of accumulates. Cohen's kappa coefficient is a measurement which measures between rater understanding for subjective (unmitigated) things. It is for the most part thought to be a more hearty measure than basic percent understanding estimation, since \( \kappa \) considers the agreement happening by possibility. The condition for \( K \) is:

\[ K = \frac{po - pe}{1 - pe} = 1 - \frac{1 - po}{1 - pe} \]  
(2)

Where po is the relative watched agreement among raters, and pe is the speculative likelihood of chance understanding, utilizing the watched information to figure the probabilities of every onlooker haphazardly saying every class.

B. SENSITIVITY: Sensitivity is an absolute quantity, the smallest absolute amount of change that can be detected by a measurement. It is a degree to which a system will respond to change in climatic conditions.

\[ \text{Sensitivity}= \frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}} \times 100 \]  
(2)

C. F-MEASURE: The F-score is frequently utilized as a part of the field of data recovery for measuring look, archive order, and inquiry grouping execution. Prior works concentrated essentially on the F1 score, yet with the multiplication of expansive scale internet searchers, execution objectives changed to place more accentuation on either accuracy or review as is seen in wide application. It considers both the precision \( p \) and the recall \( r \) of the test to compute the score. The traditional F-measure or balanced F-score (\( F_1 \) score) is the harmonic mean of precision and recall:

\[ \text{Precision}=\frac{[\text{relevant documents]}}{[\text{retrieved documents}]}/[\text{retrieved documents}] \]  
(3)
Recall= \frac{[relevant \ documents] \ of \ retrieved \ documents}{[relevant \ documents]} \quad (4)

F_1=2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}} \quad (5)

Table 1: Showing values of existing and proposed technique based on parameters analysis

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values Of Existing Technique</th>
<th>Values Of Proposed Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-Statistics</td>
<td>0.3357</td>
<td>0.804</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0.846</td>
<td>0.955</td>
</tr>
<tr>
<td>F-Measure</td>
<td>0.849</td>
<td>0.953</td>
</tr>
</tbody>
</table>

Fig 4: Graph showing values of existing and proposed technique

Fig 4 is showing that the proposed technique has more kappa-statistics than the existing technique. It shows that proposed technique has more sensitivity than the existing technique and also higher F-measure than the earlier technique. Hence the proposed technique is showing better results than earlier algorithms.

V. CONCLUSIONS

From the above comparison it is clear that the Fuzzy algorithm will generate faster results as compared to previous algorithms. The Fuzzy will go through the nodes eliminating sink nodes hence consuming less time than normal. With the help of proposed system not only link between the nodes is detected but also direction of link is also identifies which is more complicated. Hence link is predicted with least amount of time and optimality. The modularity of the proposed system is also better as compared to the existing system.

REFERENCES


