Use of Degree Centrality Principle in Deciding the Future Leader of the Terrorist Network

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ABSTRACT

Terrorist activities are becoming is a World-wide phenomena, increasing the need of sophisticated tools to sharpen counter-terror activities. Internet is practically flooded with the information related to terrorist attacks but getting useful, relevant and precise information still appears to be a difficult task. Information related to terrorist is gathered with sophisticated tools, are useful only if appropriate analyzing is done. Social Network Analysis is used all-round the World to analyze such information. This article emphasis on the degree centrality principle; a graph theoretic concept, to understand such covert networks. Studies suggest that degree centrality is indication of importance of the node in the network. In this article degree of terrorist networks in Jammu and Kashmir is calculated and interpreted. In the end this paper shows the correlation of different centrality principles with each other.

Keywords : Terrorist Network, Social Network Analysis, Centrality Principles, Degree, Role Analysis

I. INTRODUCTION

Terrorist Networks

Terrorist / Terrorist Organizations exchange information, personnel, money or idealogies during their working. They communicate with each other using satellite phones, ciphered mails, encrypted messages etc during execution of their plans. These exchanges create association between terrorist / terrorist organizations creating terrorist network. The network having terrorist / terrorist organizations as nodes and their association as links between nodes is called terrorist network. The general terminologies used for studing other common networks cannot be used to study terrorist network because these networks posses unique characteristics as mentioned below:

➢ Incompleteness: Terrorist / Terrorist Organizations maintains secrecy during their operations and interaction through covert ways which helps the hidden nodes to remain hidden in the network. Existence of the missing nodes in the terrorist network leads to imcompleteness of the network.

➢ Fuzzy boundaries: Hidden nodes present in the terrorist network makes it impossible to outline a solid boundary of the network.

➢ Agile: In terrorist network the main focus is concentrated on the completion of task rather than presence of nodes. Absence of any node will be immediately replaced by the other node. Hence topology of terrorist network is very agile.

➢ Covertness: Terrorist network operates on the principle that more covert the network is greater are its chances of successfully completing the task. Moreover some nodes are hidden to such extent that it becomes impossible to find the traces of their existence [1].

Role Analysis

Nodes in terrorist networks plays different roles for survival of the network. Every node in the terrorist network do not hold equal magnitude and importance. Role of any node in the network is affected by its relationship with other nodes too. Some nodes are simply pheripheral nodes and acts as a bridge to pass on the information where as some nodes are sustainer nodes which assures smoothe working of the terrorist network. Some nodes are leader nodes where as some are simply gatekeeper nodes. Role Analysis used to understand the role of different nodes in the terrorist network [6]. Centrality principles are used for this purpose and determine which is the leader node in the network. The role analysis helps in making counter terrorist activities more effective as important nodes can be removed to efficiently destabilize the terrorist networks [13].

Social Network Analysis and Centrality Principles

Terrorist network are special kind of social networks, hence since last decade Social Network Analysis is used in planning counter terrorist activities [2]. Social Network Analysis is a study of different social networks i.e. the network consisting of human being and using graph theoretic concepts and multivariate analysis[3] to understand and analysis them. Social Network Analysis is used to study communicational and behaviorial patterns of the actors with each otherin the network [5]. This helps on bringing fore the linkage patterns of these actors. Social Network Analysis focuses on characteristics interaction of the actors rather than characteristics of actors.

Centrality Principles are graph thereotic concepts which can be used as Social Network Analysis tools to decode terrorist network. Centrality Principles are applied to the network to find the most central node but the centrality of any node is relative and may vary with context. It is used to decide whether any network is evenly distributed or not. It decides the importance of the node based on its position in the network for e.g. the position of any node may effects its structure, its influence etc in the network. Universally accepted centrality principles like degree, closeness, betweenness and eigen vector can be used to understand, analysis and decode the terrorist networks [4]. Different centrality principles have different meaning of the node in the network.

➢ Degree: Degree indicate the measure of direct connections to any paricular node. It indicates the leader node in the graph.
➢ Betweenness: Betweenness is the measure of extent to which a node falls in the geodasic path with other node. It indicates the gatekeeper node in the network.
➢ Closeness: Closeness indicates the frequency of the times any node falls in the shortest path between one node and every other node. It indicates sustainer of the network.
➢ Eigen Vector: It focuses on the gravity of the node with respect to its connection with other influencial nodes. It indicates prestige of any node.

II. RESEARCH LITERATURE

Researchers all around the world are working in the field of Social Network Analysis and some of the insteresting findings are mentioned as follows:

Azad studied 26/11 Mumbai terrorist attacks to understand the terrorist network created by 10 terrorist involved in the attacks. These 10 terrorists were constantly in touch with their pakistani handlers. Azad created a terrorist network using the details of telephonic conversation available on media after the attack. He considered 6 areas (The Taj Mahal Hotel, Gateway of India, The Oberoi Trident Hotel, Chhatrapati Shivaji Terminal, Café Leopold and Nariman house) which were under terrorist attack as nodes and the conversationof terrorist with each other as links. He applied Social Network

Analysis tools and centrality principles to understand and analyse this attack and categorized the role of different terrorist in this network. The value of different centrality principles were calculated using mathematical formulas and the author was able to successfully evaluate the leader and the mastermind of the 26/11 Mumbai attacks. The results of this study were compared with the real senario and the author concluded that Social Network Analysis tools can be successfully used to decode and analyse terrorist network and help in making counter terror activities effective [7].

Hopkins studied working of al-Qaeda terrorist organization in detail. He used Maple 13 tool available in open source for data collection related to this organization from news articles, journals, government reports, etc. The terrorist network graph created considering members of al-Qaeda network as nodes and association between members as links. The pin wheel terrorist network graph aided the author in studing dark networks in detail. The author penned down that specialized Social Network Analysis tools should be used to analyse dark networks as they shows unique characterictics of minimum weak ties and minimum visibility. Covert networks are special networks where key nodes may not even surface and unimportant nodes may have maximum links. These networks may also have coincidental "fake" nodes also and important nodesare hidden most of the time. The author analysed that basic essence of the drak network is the unshakable trust and belief of the members of the network in their ideology in the case of terrorist network it is their religion. The author realised tha fact that al-Qaeda network have hierarchical structure for leadership which enables the network to survive even if thekey player is removed from the hierarchy. This makes the destabilization of dark networks more difficult as removing a key node may lead to immediate replacement . Hence the low density networks were analysed using other parameters like associativity and clustering too [8].

Chaurasia and Tiwari introduced a new algorithm name Content Based Terrorist Detection Methology (CBTDM) in their study "Efficient algorithm for destabilization of terrorist network". The newly developed algorithm was a goos alternative replacement for old hierarchical algorithms. This algorithm was developed for intrusion detection of terrorist network using clustering technique and vector space models. The authors used dependency centrality as a factor to evaluate the importance of the terrorist in the terrorist network[9].

Saxena, Santhanam and Basu studied the working of seven terrorist organization including HuM, Let, KJHC, JeM, HuJI, JuM, SIMI, ISYF, JKLF, ISI, KZF and JKJeI in Jammu & kashmir. The authors developed a software named "T2" to integrate with other commercial tools for collecting the terrorist related data from different open source literature like newspapers, media reports, print reports, structured anad unstructured data available on internet. The collected data was classified into different sub-groups and categorized as organization-to-organization, person-to-person and person-to-organization groups based on their linkage information. The authors focussed on organization-to-organization links between seven terrorist organizations operating in Jammu & kashmir. They studied these terrorist network based on four paramaters i.e. degree, closeness, prestige and betweenness. The authors deduced that HuM has higest degree and is most active terrorist organization. The frequency of links between HuM and KJHC is highest making KJHC most central node. The results of this study were encouraging as the findings were valid for real situation in Jammu & kashmir. The basic limitation of this study was the focus of the research is limited to a single state [10].

Valdis E. Krebs in his article "Mapping Networks of Terrorist Cells" studied famous 9/11 terrorist attacks. Krebs collected every possible piece of information related 9/11 attacks available in open source for this exclusive study. The author used different graph thoery concepts and centrality principles to build a linkage matrix indicating the frequency of links of 19 hijackers involved. Krebs studied that association between terrorist generates relationships like Task or Trust. Task relationship among terrorist can be derive if they have spend time together in military camps or training during mission. Trust relationship can be derived between terrorist if they have spend time together in schools, have family contacts or live in same neighbourhood. Krebs created linkage map based on this information showing the strenght of relationships and successfully concluded that the highest links led to the leader of 9/11 attack "Mohammad Atta". This results were deduced by considering that relationship among terrorists is mostly depended on the time spend together. The major drawback of this study was that it was focussed on a single attack and hence other dimensional were ignored [11].

III. DEGREE AND ITS IMPLEMENTATIONS

Degree is the measure of direct links/ connections to any node. It indicates the strength of the node in the network by measuring direct connections. It shows how active a node is and its importance in the network. Degree centrality principle in social network indicates the leader in the network. It can be calculated by culmulating the direct links to the nodes. The degree of any node is mathematically represented as below [12]:

$$D = \Sigma \, A_i \text{ , where } i = 1,2,3,..,n$$

Degree Centrality in directed graph
We can say that X node has higher degree centrality than Y node in the below network as shown in Figure 1.
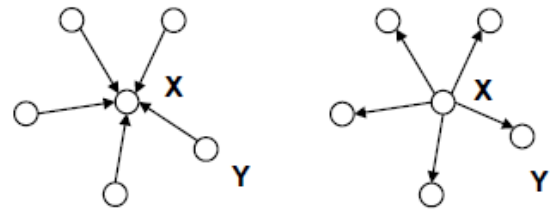
Indegree Centrality   Outdegree Centrality

Figure 1. Shows the degree centrality of nodes in the network in directed graph

Degree Centrality in undirected graph
Degree centrality in any undirected graph is directly proportional to the importance of the node in the network, for example, in social networks the person having many contacts/ friends is very important. The following Figure 2 shows the count of degree centrality for each node in an undirected graph.
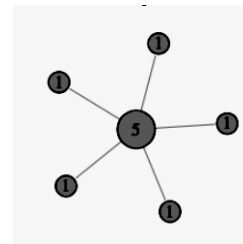

Figure 2. Shows the degree centrality of nodes in the network in an undirected graph

Figure 2 shows highly centralized network where one node is connected to the most of the other nodes in the network. In these networks, as some of the nodes are connected to most of the other nodes; hence, a single point failure becomes a critcialvissue. The network which are less centralized having even distribution of the links are far more reliable then centralized networks.

However there are situations where the degree is insufficient to measure centrality as mentioned below:

➢ When any network has multiple nodes with high degree it fails to express the real and accurate centrality of the network.

➢ Degree is unable of expressing the ability of the broker between different sub-groups existing in the network.

The system named "Terrorist Meta Tracker" is developed here to calculate the degree on 61 different terrorist organizations operating in india. The Terrorist Meta Tracker system repository is populated with sample data of the linkage information of 61 terrorist organizations collected from various genuine agencies like South Asia Terrorism Portal, government publications, news articles and reports on terrorism. For this study co-occurrence to two terrorist organizations in any terrorist attack was considered as link between them and the link is inferred to be relationship/ association between them. The Terrorist Meta Tracker system calculates the degree centrality of the terrorist organizations in terrorist network.

The following code of shows a function named degree() which calculates the degree centrality for nodes in the Terrorist Meta Tracker system. It is as follows:

```
public int[] degree(){
    int[] CPOutput = new int[62];
    Calculate_Link cl = new Calculate_Link();
    cl.Calculate();
    int degcoun=0,degsumcount=0;
    for(int x=0;x<=61;x++){
      for(int y=0;y<=61;y++){
        if((Calculate_Link.link[x][y]!=null)
&&(Calculate_Link.link[x][y]>0))
{
      degcoun=Calculate_Link.link[x][y];
        }
        degsumcount = degsumcount+degcoun;
        degcoun=0;
      }
      CPOutput[x]=degsumcount;
      degsumcount=0;
    }
```

return CPOutput;
}

Here Calculate_link[x][y] is an array containing link between x and y terrorist organizations. Degcount holds value of degree centrality for any particular terrorist organization.

IV. RESULTS

The following screenshot in Figure 3 shows the output for degree centrality in the Terrorist Meta Tracker system. The output displays the vertex number, name and value of degree for the terrorist organization.
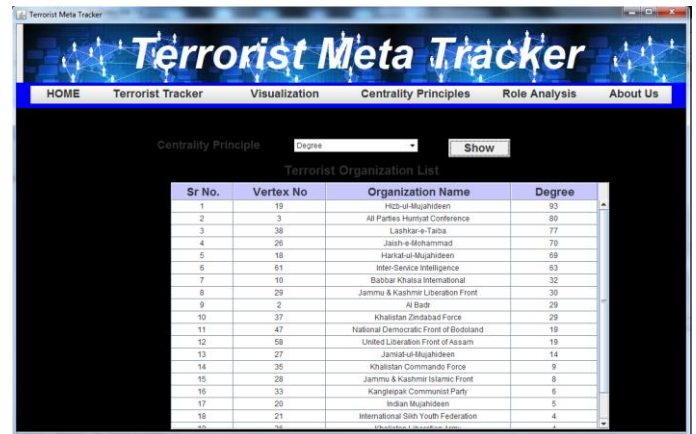

Figure 3. Shows the result for degree centrality for different terrorist organizations

Although degree is an unfussy centrality principle, it shows the importance/ activeness of the node in the graph. The results show that Hizb-ul-Mujahideen, All Parties Hurriyat Conference, Lashkar-e-Taiba and Jaish-e-Mohammad are the top four terrorist organizations having highest degree centrality.

During the degree analysis study, it was found that out of 61 only 13 terrorist organizations links were found. Moreover, from these 13 terrorist organizations the top five terrorist organizations share 76% of the links. The following Table 1 shows a list of the top 5 terrorist organizations with highest value of degree

centrality principle for Terrorist attacks in Jammu and Kashmir.

It is clear from Table 1 that Hizb-ul-Mujahideen, Lashkar-e-Taiba and All Parties Hurriyat Conference are prominent in the terrorist operations. One interesting observation is that All Parties Hurriyat Conference (APHC) has always isolated itself from terrorist operations but in this study its name appears in the top five prominent terrorist organizations. It is clear from this study that All Parties Hurriyat Conference (APHC) has connections with the prominent terrorist organizations in Jammu and Kashmir. Moreover Hizb-ul-Mujahideen having 19% of total degree appears to be the leader of the terrorist network.

Table 1. The list of terrorist organizations with highest value of degree centrality principle.

Sr No.	Vertex No.	Terrorist Organization Name	Degree centrality (%)
1	19	Hizb-ul-Mujahideen	19%
2	38	Lashkar-e-Taiba	15%
3	3	All Parties Hurriyat Conference	14%
4	26	Jaish-e-Mohammad	13.8%
5	18	Harkat-ul-Mujahideen	13%

The following Table 2 shows the list of terrorist organizations with the lowest value of degree centrality principle for Terrorist attacks in Jammu and Kashmir.

Table 2. The list of terrorist organizations with the lowest value of degree centrality principle.

Sr No.	Vertex No.	Terrorist Organization Name	Degree centrality (%)
	46	Muslim Mujahideen	0.9%
	37	Khalistan Zindabad Force	0.4%
	42	Mahaz-e-Azadi	0.4%

V. CORRELATION OF DEGREE WITH OTHER CENTRALITY PRINCIPLES

Correlation matrix of Centrality Principles

Usually, degree centrality is in positive correlation with other centralities like closeness and betweenness. Terrorist networks show different possible combinations of these principles as shown in the following table 3 and table 4 with their interpretation.

Table 3. Terrorist networks show different possible combinations of other principles with high degree

	Low Closeness	Low Betweenness
High Degree	Indication that a node is far from the rest of the network but it is embedded in a closed sub-group.	Indication that a node is having superfluous connections hence communication may bypasses it.

Table 4. Terrorist networks show different possible combinations of other principles with low degree

	High Closeness	High Betweenness
Low Degree	Indication that a node is a key player and it is connected to other important nodes in the network.	Indication that a node does not have many connections but node's few connections is very crucial for network flow.

Table 3 and Table 4 show the meaning of different possible combination of closeness and betweenness

with degree centrality. Along with degree betweenness and closeness are calculated by the Terrorist Meta Tracker system and different terrorist organization falling in this criteria were found and the results are shown in table 5 and table 6

Table 5. The output of the Terrorist Meta Tracker system in the form of a possibility matrix for Terrorist attacks in Jammu and Kashmir.

	Low Closeness	Low Betweenness
High Degree	1) Hizb-ul-Mujahideen 2) Al Badr	Lashkar-e-Taiba

Table 6. The output of the Terrorist Meta Tracker system in the form of a possibility matrix for Terrorist attacks in Jammu and Kashmir.

	High Closeness	High Betweenness
Low Degree	1) Mahaz-e-Azadi 2) Khalistan Zindabad Force	--

VI. RESULTS AND DISCUSSION

Here, role analysis in Jammu and Kashmir from the above table 5 and table 6 leads to the following conclusions:

- ✓ Hizb-ul-Mujahideen and Al Badr are the most prominent terrorist organizations in Jammu and Kashmir. These terrorist organizations have prominent influence in the network as they are not directly involved in communication with most of other terrorist organization but are still closely connected. Hizb-ul-Mujahideen can also be seen very regularly in media reports for their influence on terrorist networks in Jammu and Kashmir.
- ✓ Lashkar-e-Taiba is having multiple superfluous connections. The real world data also indicates that Lashkar-e-Taiba in Jammu & Kashmir.

- ✓ Khalistan Zindabad Force and Mahaz-e-Azadi acts as the key player in the network. These organizations have always distant themselves from other terrorist organizations and their names do not appear frequently in news or government reports but this study suggest that these terrorist organizations are playing crucial role in handling terrorist networks in Jammu and Kashmir.

VII. SUMMARY AND FUTURE SCOPE

Studying terrorist networks is very complicated task because information about such networks is not readily available. Data collection for such study is very vital task and for making this limited data more effective, efficient Social Network Analysis tools are required. Such tool allows generating clear picture of terrorist network and understanding such network even with limited information. During this study software named "Terrorist Meta Tracker" is developed to calculate centrality principles like degree, closeness and betweenness for 61 different terrorist organizations operating in India. The value of degree centrality is calculated and it was concluded that Hizb-ul-Mujahideen is the most prominent influential terrorist organization in Jammu and Kashmir. The law enforcement agencies can use confidential data with this tool and can analyse terrorist network. The deep understanding of these dark networks can help to destabilize them.

The result of this study is encouraging but terrorist networks are complex networks and should be analyse with other advanced techniques like adaptive neural networks, Swarm intelligence algorithms, Fuzzy logic and Genetic Algorithms to augment the results. Moreover the terrorist networks are very complicated which should be studied in multidimensional space.

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