



Community Detection: A Boom to Society

Mini Singh Ahuja¹, Jasmine²

¹Assistant Professor, ²Student (M.Tech.)

^{1,2} Department of Computer Science, GNDU,
Regional Campus, Gurdaspur, Punjab, INDIA.

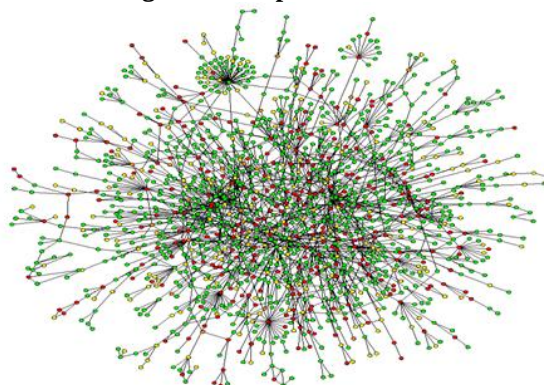
Abstract: In real world, there are many networks available such as social networks, biological networks etc. These networks have abundant information stored in them which can be extracted to help the society. So the analysis of complex networks has received a lot of attention from the scientific community during the last decades. Community structure is one of the properties of these networks. Community detection technique is used to find community structure within its complex networks.

Keywords: Complex Network, Community Structure, Applications of Community Structure

I. Introduction

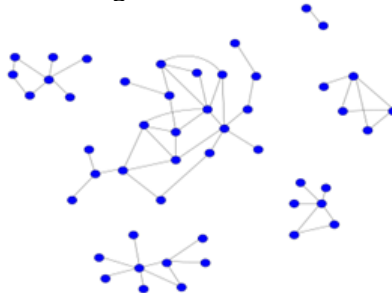
Huge graphs of true life are called complex networks. In the perspective of network theory, a complex network is a graph (network) with non-trivial topological features—features that do not occur in simple networks such as lattices or random graphs but often occur in real graphs. The complex networks are a set of many associated nodes that relate in different ways.

Fig. 1. A Complex Network



The nodes in an network are also called vertices or elements, which can be represented by the symbols $v_1, v_2, \dots, v_n$, where n is the total no. of nodes in network. The study of complex networks is a youthful and vigorous area of scientific research stimulated largely by the pragmatic study of real-world networks such as computer networks and social networks. In nature, one can get many diverse networks, meaning different kinds of nodes and associations e.g in a social network the nodes are people and the connections can be friendship relations. In the same the world, one can define connections in a different way, for example: two people are related if they are siblings. Apparently the network defined through the friendship connection is different than the one defined through the sibling relationship, because if two people are friends that doesn't mean that they are siblings and vice versa, however the nodes in each network can be the same. For example, Biological networks that we can get at atomic level are: genetic regulation networks, protein networks, neuronal networks and metabolic networks. On another level, we can get information networks (e.g. internet), social networks (e.g. facebook, scientific collaborators, swell of diseases) and ecological networks.

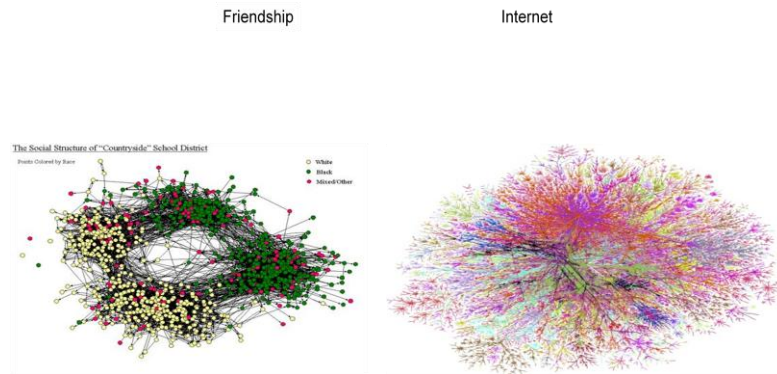
Fig. 2. Connections



This very effortless but amazing fact, that has made possible to create arithmetical models to recognize and to clarify the structural and sometimes dynamical properties of these networks. The learning of networks concerns

different fields in science, from neurobiology to algebraic physics. The most important study of these networks deals with their structures because structure is also associated to function.

Fig. 3. Friendship and Internet

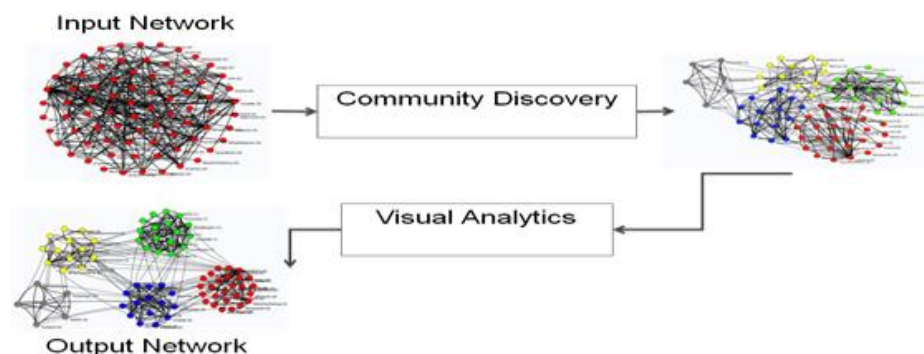


A. Collective Actions In Nature: The collective actions of systems such as shoals of fish, swarms of insects or fleet of birds, in which hundreds or thousands of organisms be in motion together in the same route without the evident leadership of a leader, is one of the most magnificent examples of major organization observed in environment. From the objective point of view, there has been a drive to try to find out and know the general principles that preside over the emergence of communal order in these systems, in which the interactions between individuals are most probably of short-range. During the last some years, several models have been proposed to account for the large-scale properties of flocks and swarms.

II. Community Structure

Much research effort has been stanch to develop methods and algorithms that can proficiently underline this hidden structure of a network, yielding a huge literature on what is called today community detection. Community detection is the most major sub-domains in complex network study. Community detection is vital for many reasons, including node categorization which entails homogeneous groups, group leaders or vital group connectors. Communities may relate to groups of pages of the World Wide Web dealing with correlated topics, to functional modules such as cycles and pathways in metabolic networks, to groups of correlated individuals in social networks etc. A community is a interconnected subset of nodes with denser internal links comparatively to the rest of the network. A community structure is a set of communities or more specifically a partition of the network node set. Communities are clusters of strongly associated nodes within a network. The nodes in a community should have more intra-community associations rather than inter-community connections. This type of structure brings out much knowledge about the network e.g. in a metabolic network the communities correspond to biological functions of the cell. In the web graph the communities correspond to topics of interest. Community detection is an important part of network study. The goal is simple: to detect how nodes in the graph have to be grouped into communities. Some algorithms totally partition the nodes; others allow for some nodes to be considered without community. Community detection has several applications: for example, signifying connections (say, Facebook) and formative network structure. Community detection can also been quite useful to derive features for categorization tasks where the data includes connections that are not easily adaptable into features.

Fig. 4. Community Detection Technique



A. Why We Detect Communities?

- Community discovery permit us to “make sense” of the primary structure of networks
- Understanding the interactions between vertices and nodes.
- Easy visualization and navigation of huge networks

- Forming the base for other undertakings such as data mining
- Understanding the complexity of networks

III. Applications of Community Structures

A. Lung Cancer: Joel J. Bechtel, MD, FCCP; William A. Kelley, MD, FCCP; Teresa A. Coons, PhD; Al. Gerry Klein, MD; Daniel D. Slagel, MD; and Thomas L. Petty, MD, Master FCCP(CHEST 2005) study described a community-based lung cancer identification project focusing on high-risk patients who receive general care in a primary care outpatient practice. Chest poster anterior radiographs, thoracic CT scans, and sputum cytology were offered to subjects with air flow obstruction. Case finding in high-risk patients in a primary care population can be accomplished at a relatively low cost [4].

B. Terrorist Group: Todd Waskiewicz has discussed about the work of terrorist group on social media sites who used friend of friend relationship to transfer their influences and ideas to others members of group through intermediate's so that to influence their propaganda. Social media pages are less prone to attack [5].

C. Ant Colony Optimization: Di Jin, Dayou Liu, Bo Yang, Jie Liu, Dongxiao He proposed a community detection algorithm MACO in his paper. This algorithm makes the ants' movement decision become more and more intelligent, and the trend that any ant remains in its own community becomes increasingly obvious [6].

D. Ring Search: Kwan Hui Lim, Amitava Datta(2013) proposed a community detection algorithm that directly detects the community centered at an individual of interest, without the need to first detect all communities. He proposed algorithm which utilizes an expanding ring search starting from the individual of interest as the seed user[7].

E. Health Social Network: Xiaoxiao Ma, Guanling Chen, Juntao Xiao(2010) provided an empirical analysis of a health OSN, which allows its users to record their foods and exercises, to track their diet progress towards weight-change goals, and to socialize and group with each other for community support [8].

F. Facebook: Emilio Ferrara s(2012) proposed the first large-scale community structure investigation of the Facebook social network. He crawled the facebook and detected the communities in it using two algorithms Label propagation and Fast network community Algorithm[11].

G. Link Prediction: Tsuyoshi Murata, Sakiko Moriyasu (2008) described an improved method for predicting links based on weighted proximity measures of social networks. The method is based on an assumption that proximities between nodes can be estimated better by using both graph proximity measures and the weights of existing links in a social network [12].

H. Dengue Fever In Peru: Oxford University described that community structure refers to the study of densely connected groups within the network using two algorithms i.e. Greedy and Newman algorithms [17].

I. Incomplete information Networks: Wangqun Lin, Xiangnan Kong ,Philip S. Yu(2012)studied the problem of detecting communities in incomplete information networks with missing edges and a hierarchical clustering approach is proposed to detect communities within the incomplete information networks[18].

J. Refactoring Software Packages: Wei-Feng, Pan Bo, Jianging Li(2013) given a novel approach to refactor the package structures of object oriented software. It proposes a constrained community detection algorithm to obtain the optimized community structures in software networks, which also correspond to the optimized package structures [19].

K. Recommendation Systems: Massimiliano Zanin constructed a good recommendation algorithm that could guide the customer through a great variety of items in an e-store, complex networks can help us in improving the result [20].

L. Fraud Events in Telecommunications Networks: Carlos André Reis Pinheiro proposed Community Structure to Identify Fraud Events in Telecommunications Networks .He describes community detection to define users and methodology to detect outliers inside the social networks [21].

IV. Conclusion

In this paper, we have tried to outline the researchers who used community structure to solve various practical problems of the society.Community Detection has become a boom to society.

VI. References

- [1]. Michele Coscia, Fosca Giannotti and Dino Pedreschi1, (1Computer Science Department, University of Pisa, Pisa, Italy , 2 KDDLab, ISTI-CNR, Pisa, Italy, 3Center for Complex Network Research, Northeastern University, Boston, USA), "A Classification for Community Discovery Methods in Complex Networks",2011.
- [2]. Wangsheng Zhang, Gang Pan_, ZhaohuiWu, Shijian Li(Department of Computer Science, Zhejiang University, China),Online Community Detection for Large Complex Networks
- [3]. Günce Keziban Orman, Vincent Labatut, Hocine Cherifi, (Galatasaray University, University of Burgundy),"On accuracy of community discovery algorithms"
- [4]. Joel J. Bechtel, MD, FCCP; William A. Kelley, MD, FCCP; Teresa A. Coons, PhD; Al. Gerry Klein, MD; Daniel D. Slagel, MD; and Thomas L. Petty, MD, Master FCCP," Lung Cancer Detection in Patients With Airflow Obstruction Identified in a Primary Care Outpatient Practice",2005.
- [5]. Todd Waskiewicz (Air Force Research Laboratory, AFRL/RIEA 525 Brooks Road, Rome, NY 13441-4505), "Friend of a Friend Influence in Terrorist Social Networks"

- [6]. Di Jin, Dayou Liu, Bo Yang, Jie Liu, Dongxiao He (College of Computer Science and Technology, Jilin University Changchun, 130012, China). "Ant colony optimization with a new random walk model for community detection in complex networks", 2012.
- [7]. Kwan Hui Lim, Amitava Datta (School of Computer Science and Software Engineering, The University of Western Australia Crawley, WA 6009, Australia), "A Seed-Centric Community Detection Algorithm based on an Expanding Ring Search", 2013.
- [8]. Xiaoxiao Ma, Guanling Chen, Juntao Xiao (Department of Computer Science, University of Massachusetts Lowell), "Analysis of An Online Health Social Network", 2010.
- [9]. D. Maloney-Krichmar and J. Preece. The meaning of an online health community in the lives of its members: Roles, relationships and group dynamics. In Proceedings of the International Symposium on Technology and Society, 2002.
- [10]. D. Maloney-Krichmar and J. Preece. A multilevel analysis of sociability, usability, and community dynamics in an online health community. *ACM Transactions on Computer-Human Interaction*, 12(2), June 2005.
- [11]. Emilio Ferrara (Department of Mathematics University of Messina V.le F. Stagno D'Alcontres n. 31, 98166, Italy), "Community Structure Discovery in Facebook", 2012.
- [12]. Tsuyoshi Murata, Sakiko Moriyasu (Department of Computer Science, Tokyo Institute of Technology W8-59 2-12-1 Ookayama, Meguro, Tokyo 152-8552 JAPAN), "Link Prediction based on Structural Properties of Online Social Networks", 2008.
- [13]. Günce Keziban Orman and Vincent Labatut, "A Comparison of Community Detection Algorithms on Artificial Networks", hal-00633640, version 1 - 19 Oct 2011.
- [14]. Catanese, S., De Meo, P., Ferrara, E., Fiumara, G., Provetti, A., 2011. "Crawling facebook for social network analysis purposes" In: Proceedings of the International Conference on Web Intelligence, Mining And Semantics. pp. 52:1 {52:8.
- [15]. Clauset, A., Newman, M., Moore, C., 2004. "Finding community structure in very large networks." *Physical Review E* 70 (6), 066111.
- [16]. Newman, M.E.J. "The structure and function of complex networks" *SIAM Review* 45 (2003) 167-256.
- [17]. Oxford university, "Community Detection in Relation to the Spread of Epidemics".
- [18]. Wangqun Lin, Xiangnan Kong, Philip S. Yu, "Community Detection in Incomplete Information Networks", 2012.
- [19]. Wei-Feng, Pan Bo, Jiang Bing Li, "Refactoring Software Packages via Community Detection in Complex Software Networks", 2013.
- [20]. Massimiliano Zanin, Pedro Cano, "Complex Networks in Recommendation Systems".
- [21]. Carlos André Reis Pinheiro, "Community Detection to Identify Fraud Events in Telecommunications Networks", Paper 106-2012.