

# Understanding Health Behavior Using Social Network Analysis

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**Abstract**—Health of a person plays a vital role in the collective health of his community and hence the well-being of the society as a whole. But, in today's fast paced technology driven world, health issues are increasingly being associated with human behaviors – their lifestyle. Social networks have tremendous impact on the health behavior of individuals. Many researchers have used social network analysis to understand human behavior that implicates their social and economic environments. It would be interesting to use a similar analysis to understand human behaviors that have health implications. This paper focuses on concepts of those behavioural analyses that have health implications using social networks analysis and provides possible algorithmic approaches. The results of these approaches can be used by the governing authorities for rolling out health plans, benefits and take preventive measures, while the pharmaceutical companies can target specific markets, helping health insurance companies to better model their insurance plans.

**Keywords**—Health behaviors, social network analysis, directed graph, breadth first search.

## I. BACKGROUND

**S**Ocial Networks are immensely impacting the behavior of the society which could be social, economic or health behavior. For example, The MD Anderson Cancer Centre in Texas, USA, moderated social networks such as “The Cancer Survivor's Network,” “Ask the Expert” and “The Anderson Network” to better understand the patients' experience and improve patient care.

## II. INTRODUCTION TO MULTIPLE SOCIAL NETWORKS

Internet is flooded with multiple social networks, catering the need of segmented & targeted audience; People prefer Facebook for personal connections and Linked-in for professional and twitter to tweets their thoughts.

## III. CATEGORIZATION OF MULTIPLE SOCIAL NETWORKS

Wu-Chen Su [1] categorized multiple online social networks in three different networks:

### A. Homogeneous Multiple Social Networks

When a single social network (SSN) have multiple small networks of same type then this type of network is referred as Homogeneous multiple Social Networks. For example network of different health groups in a SSN is an example of homogeneous network.

### B. Heterogeneous Multiple Social Networks

When a single social network has multiple small networks of different types then it is referred as Heterogeneous networks. As example cited by [1] that networks of authors, venue and paper in an academic social network is an example of heterogeneous network.

### C. Social Internetworking

When a user acts as a link between two different social networks then this is referred as Social Internetworking Scenarios.

## IV. DEFINING HEALTH BEHAVIOR & ITS TYPES

According to [11], health behaviors are “those personal attributes such as beliefs, expectations, motives, values, perceptions, and other cognitive elements; personality characteristics, including affective and emotional states and traits; and overt behavior patterns, actions, and habits that relate to health maintenance, to health restoration, and to health improvement”. Health Behavior can be categorized into four major types that involve activities of individuals which keep them healthy. The four major types are listed as follows:

- Daily practice of balanced diet, doing regular exercises etc.
- Preventive health behavior, which involves activities undertaken by individuals for the purpose of preventing or detecting illness.
- Quit smoking etc. and avoid risky behavior which involves activities of individuals that cause sickness in them, such as consumption of alcohol, tobacco and having unsafe sex etc.
- Finally, there is Sick-role behavior which involves activities of individuals that help them in recovering from a disease. It involves medical treatment etc.

## V. OVERVIEW OF SOCIAL NETWORK ANALYSIS

According to [2] Social Network Analysis (SNA) originates from the field of Social Science, Network Analysis and Graph Theory. Network Analysis is the mathematical analysis of problems which have a network structure and which are usually captured as a graph. A very early example of Network Analysis is from the city of Königsberg (now Kaliningrad), where the famous mathematician Leonard Euler used a graph to prove that there's no path that crosses each of the city's bridges only once. [2]

In Graph theory, a graph is a set of objects which are connected with each other by some links. In mathematical terms, the connected objects are known as Vertices and the

links that connect them are known as Edges. Social Networks can also be represented as graphs and they are known as Social Graphs. Fig. 2 is social graph of Namrata Mishra's Facebook network. Nodes are the friends and links are the friendship.

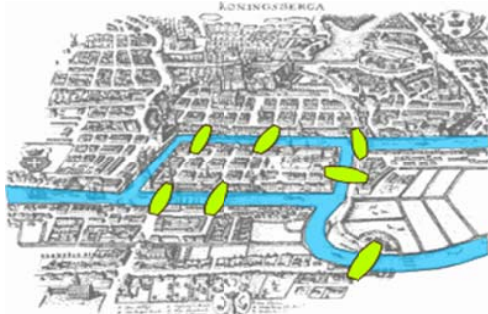


Fig. 1 Konisberge Bridge [2]

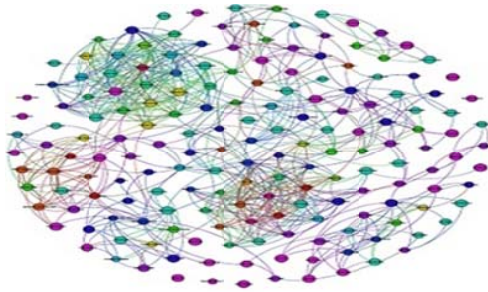


Fig. 2 Social Graph: Facebook

Social network analysis is a set of techniques, theories, concepts and methods that help in understanding social networks and relationships existing in these networks". Social Network Analysis can be best represented as Relationship Technology.

#### VI. USAGE OF SOCIAL NETWORK ANALYSIS

Social Network Analysis has gained significant influence in the field of anthropology, biology, communication studies, geography, life sciences, history, information and communication, political science, computer science and development studies. In a study, [4]., Professor of preventive medicines at the Keck School of Medicine of USC has mentioned the influence of social networks on health behavior. Considering this influence of social networks on health behavior, an approach has been proposed for perceiving health behavior using social network analysis. In this study homogeneous social networks are being analyzed, Traversal of graphs using BFS search algorithm will result into the homogeneous graph of health groups and health blogs.

#### VII. METHOD

Social networks can be represented as graphs which are known as Social graphs. In computer science terminology, a graph is a data structure which contains a finite set of ordered

pairs (edges) that connect certain entities called nodes. These graphs can be directed graphs or undirected graphs. For example, In Facebook, if X is friend of Y, Y must be a friend of X, So Facebook is an undirected graph. While in Twitter, If X flows Y, Y need not follow X, hence Twitter is a directed graph. This approach is proposing an algorithm considering Social Networks as Graphs. Say  $S(G)$  is a social graph of multiple locations.

References [5]-[10] played key role in developing this algorithm.

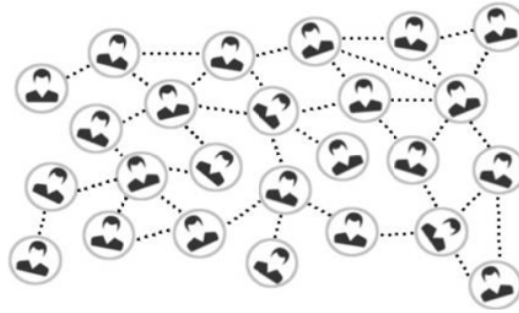


Fig. 3  $S(G)$  Social graph of multiple locations

Algorithm is analyzing health behavior of people in single location. So, from  $S(G)$  get a sub graph of a single location. It is known that to perform graph search there are two algorithms available, Breadth First Search and Depth First Search, this algorithm is using Breadth First Search Algorithm to get a sub graph of a single location.

Breadth First Search is a strategy for searching in a graph, where first gain access to a node and inspect it. Then, gain access to its neighbors and inspect them. This process continues till search ends. (Source: Wikipedia) Depth First Search is a strategy for searching in a graph, begin with a particular node and explore as far as possible along each branch (Source: Wikipedia)

Traversing  $S(G)$  using Breadth First Search algorithm gets a directed sub graph  $L(G)$  which is a location based graph.  $L(G)$  is a tightly coupled graph of location X.

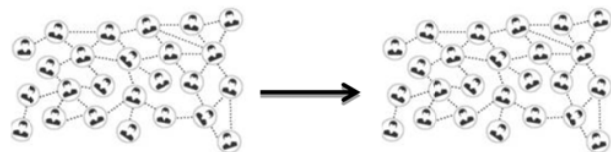


Fig. 4  $L(G)$  Social graph of multiple locations with Sub Graph of single location

Now, there is a single location graph  $L(G)$  to narrow down traversal get sub graph of health communities, health blogs and users in the location. As algorithm is analyzing health behavior of the people in that location, details of the active users in the health communities and health blogs are required, for which we are getting sub-graphs. Traversing  $L(G)$  using Breadth First search algorithm gets three directed sub graphs  $HC(G)$ ,  $HB(G)$  and  $U(G)$ .  $HC(G)$  is a tightly coupled sub

graph of health communities or forums in the location X. HB (G) is a tightly coupled sub graph of health blogs in location X. U (G) is a tightly coupled sub graph of users in location X.

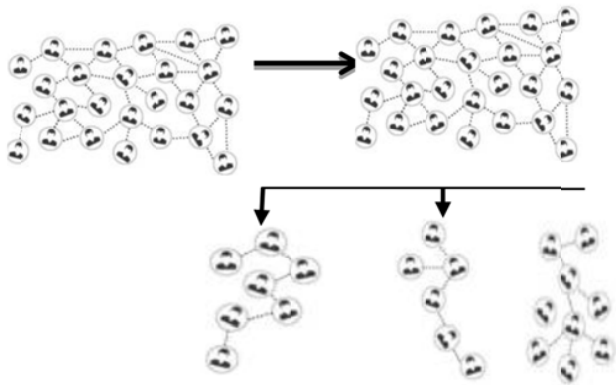


Fig. 5 Social graph of multiple locations with Sub Graph of single location and Sub Graph of users, health communities and health blogs in that location

TABLE I  
TRAVERSING GRAPH HC(G) USING WEB CRAWLERS IDENTIFIES DATA

Number of Users	Variables
Visiting health communities	U1
Visiting health communities more than 10 times a month	U2
Visiting health communities less than 10 times a month	U3

TABLE II  
TRAVERSING GRAPH HB(G) USING WEB CRAWLERS IDENTIFIES DATA

Number of Users	Variables
Contributing to health blogs	U4
Contributing to health blogs more than 10 times in a month	U5
Contributing to health blogs less than 10 times in a month	U6

TABLE III  
TRAVERSING GRAPH U (G) USING WEB CRAWLERS IDENTIFIES DATA

Number of Users	Variables
Drink	U7
Smoke	U8
Like health blogs/communities/pages	U9
Have health blogs as favourites	U10
Taken Health related surveys	U11
Have at least 10 doctor friends	U12
Contributed in quit smoking surveys / blogs	U13

TABLE IV  
MAPPING OF HEALTH BEHAVIORS WITH USERS CONTRIBUTIONS TO DIFFERENT ACTIVITIES

Locations Behavior	Higher percentage
Healthy Behavior	Users contribution in health groups and health blogs, Active users in health communities and blogs and Users taking health surveys
Risky Behavior	Inactive users in health communities & blogs and Users who drink & smoke.
Preventive Health Behavior	Users' contribution in health communities and blogs, Users' have at least 10 doctors' contacts and User's contribution in quit smoking blogs and surveys

Processing information from U1 to U13 gives the percentage of users contributing in health communities and

health blogs, active and inactive users in health groups, taking health surveys, drinks & smokes, have at least 10 doctors' friends and contributed in quit smoking surveys.

## VIII.RESULT

Facebook is the third largest social media platform available on the internet; this study have used Namrata Mishra's account this accounts have connections at various locations, which is a pre-requisite for the algorithm.

TABLE V  
RESULTS OF ALGORITHM ON NAMRATA MISHRA'S FACEBOOK NETWORK

Percentage of Users	Bangalore	Noida
Contributing in health communities & health blogs	53	16
Active users in health communities & health blogs	45	10
Inactive in health communities & health blogs	8	6
Taking health surveys	20	10
Drinks & smokes	55	82
Have at least 10 doctor friends	70	10
Contributed in quit smoking surveys / blogs	10	0

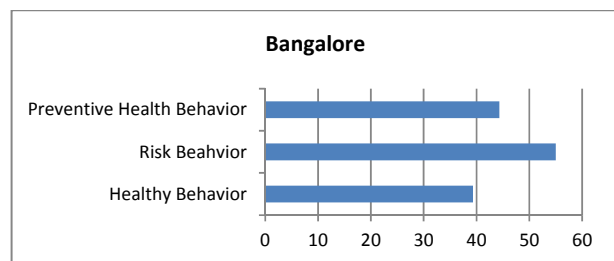


Fig. 6 Health Behavior percentage for Bangalore

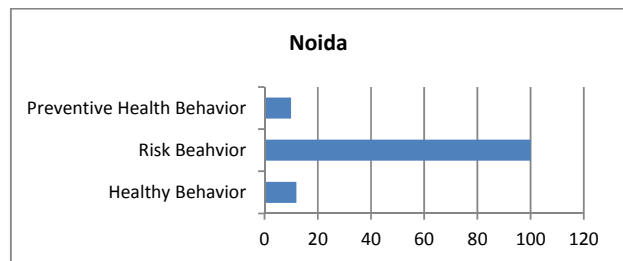


Fig. 7 Health Behavior percentage for Bangalore

## IX. DRAWBACK OF THIS APPROACH

Traversing graphs using breadth first search algorithm could be time consuming, where the algorithm can have incorrect data and privacy issues. Hence, there is a possibility of increase in time complexity of this approach.

## X.BUSINESS USAGE OF THIS APPROACH

The Government can roll out health plans and benefits based on the health behavior of residents in their respective locations. Research Institutes can focus their research on health behavioral issues. Insurance Companies can come up with specific plans based on the health behavior of people.

## XI. CONCLUSION

This paper illustrates an approach of using social network analysis to understand health behavior. The result of the proposed approach can be used by various governing and private authorities to grow their business and contribute for shaping a healthy society.

## XII. FUTURE WORK

This approach is limited to health behaviors; going forward this can be extended to identifying different kinds of diseases, sentiments in people, etc. Different data mining and big data analytical techniques can be used to analyze large set of data collected from Multiple Social Networks (MSN). This study focuses on the homogeneous MSN and can be extended to heterogeneous MSN.

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