An Eclectic Approach to Contact Tracing of Covid-19 Patients using Complex Networks

Nirmaljit Singh
Research Scholar
Department of Computer Science and Engineering
Sant Baba Bhag Singh University, Jalandhar

Dr. Harmeet Singh
Associate Professor
Dept. of Computer Science and Engg.
Sant Baba Bhag Singh University, Jalandhar

Abstract
Complex networks are key tools for learning the bond between the organization and purpose of complex systems. Complex Networks and their scale and need for realistic networks are increasing incessantly. Our life is full up of all kinds of networks. These networks have alike characteristics, enormous number of nodes and complex exchanges. Networks with complex topological properties are called complex network. Measurements are needed almost in every walk of existence. It is important to have knowledge of a variety of link prediction methods that the topic is part of Complex Networks. In this paper we will discuss the applications of Common Neighbor Technique of Link prediction for Contact Tracing of Covid-19 STML patients.

1. Introduction

From the research evidence in recent years, it has become obvious that complex networks are contender for breaking of collected works monotony. Complex networks are all over the place inside our universe. It is a forthcoming multidisciplinary territory of research that is scattered to many disciplines such as engineering, biology, sociology, physics and economics coupled biological and chemical systems, neural networks, social interacting species, the Internet and the World Wide Web. Complex networks are a vital part of our existence. Complex networks are characterized by vastly heterogeneous allotment of links, often spread through the presence of key properties such as heftiness. The network representation of these systems be worthy of the label of complex networks as there are properties that appear as a result of the global topological organization of the organization, and their topological structures cannot be inconsequentially described like in the cases of arbitrary or standard graphs. The Internet is an illustration of a complex network, which can be defined as huge group of interconnected nodes. A node can be whatever thing: a human being, an institute, a computer, a biological cell, etc. Interconnected implies that two nodes may be linked, for example, because two people recognize each other, two organizations trade goods or two computers contain a wire connecting the two of them. In complex networks there are a lot of characteristics that emerge as a consequence of the global organizational structure of the network. For instance, an observable fact known as “small world” is attributed by the existence of relatively small average path length and a relatively high number of triangles in the network

2. Contact Tracing

Contact tracing is very important in any infecteous pandemic. As defined by the CDC [1], contact tracing, also well-known as contact investigation, is the identification, monitoring, and maintaining of the individuals (contacts) who have been exposed to an infected individual and possibly infected themselves. This procedure prevents further transmission of disease by separating people who have (or may have) an infectious disease from people who do not. Contact Tracing [2] is a tool that is capable of helping slow the spread of infectious diseases, such as corona virus disease 2019 (COVID-19). In society using contact tracing, clinics, labs and hospitals send the names of group who have freshly been diagnosed with COVID-19 to their local health sector. It is significant to note that contact tracing [3] is a decades-old widespread practice in public health. It is not the same thing as "contact notification" or "digital observant" tools. These consumer apps, such as those formed with Google and Apple's API, are not contact tracing tools. These apps work as a way for the public to track if they have appear to come into contact with a person who has tested positive and entered that information into their phone.

Therefore the Contact tracing [4] is the process of tracking down a human being who has had an communicable disease and the people that person has potentially been in contact with. It's a confidential process that has been used by health departments for years to help stop the spread of infectious diseases and avoid outbreaks. Contact tracing is crucial part of good public health. It allows health departments to determine where there might be an increased risk of a COVID-19 epidemic. To facilitate an early alert to people who may have been exposed so they can take precautions and not further spread any disease. The public plays a important role in providing contact tracers with inclusive information, which helps to bound the figure of new cases.

3. Link Prediction

Link prediction methods are established by using properties of nodes and their relations in complex network. Complex networks are all over the place or in case we model real-world situations in conditions of networks, we repeatedly find out novel things.. With the help of Internet, The world emerges to be becoming smaller, and people are fitting ever more linked. Perceptibly, telecommunication has played a critical role in establishing this linked world as it is normally known, but with the union of telecommunication and data networks, it is difficult not to be connected anymore. Being connected has profound effects for the dissemination of information. While the first property appears in randomly generated networks, the second "emerges" as a consequence of a characteristic feature of many complex systems in which relations display a high level of transitivity [8]. The link prediction problem in complex networks craft predictions about the future organization of the network. Link prediction methods are developed by using properties of nodes and their relationships in complex network. The topologies of networks are extensively applied to learn the link-prediction problem in recent times. The Common Neighbors is a well accepted and efficient framework. Numerous variants of Common Neighbors have been proposed to enhance the resolution of contender links.

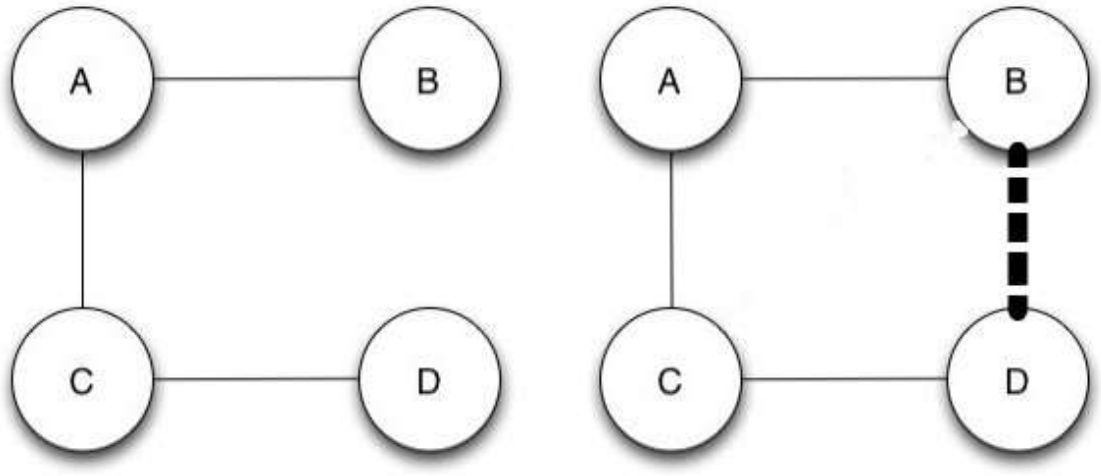

Fig 1: *Link Prediction predicts the possibility of link between B and D*

Because of the high experimental expenses of revealing the hidden interaction associations in these networks, the results of link prediction can direct the experiment scheming so as to reduce the cost and develop the victory rate of experiment. Predicting the loss and doubtful links of diseases-gene networks can assist to discover the mechanism of diseases, forecast and assess their treatment. Network is represented as a graph. The data in the network is signified by nodes, and the relations are represented by links. The future of non-connected links amid node pairs is predicted. Calculations such as likelihood of link formation in the future can be done according to the shortest path or link state between the two nodes. Link prediction problem has a wide range of practical applications in different fields. For example, in natural networks, such as protein-protein communication, link accessible between the nodes indicate they have a communication association. Furthermore, it can also find new drug targets and open up novel ways for drug development for prediction of a potential link between a pair of vertices, these vertices ordinary neighbors possibly will play unrelated roles depending on if they fit in or not to the same group.

3.1 Problems with Contact tracing Methods and Apps

The conduct of experimental survey is very cumbersome job. One of the biggest issues is making sure there's a significant group of people signing up. The apps, most of which are charitable, need a noteworthy number of users if they're ever going to be valuable. One more reason that digital contact tracing [5] hasn't been triumph is the technology itself. With Bluetooth uses radio waves, the similar spectrum employed by FM radio, Wi-Fi, and cell phones, getting a reliable signal can be challenging because radio waves can be interrupted by matter in the way, like telephone poles, walls, or tables. A mobile phone in someone's back pocket, or underneath their bag amid a clutter of other things, isn't going to be able to transmit as physically powerful a signal as a machine in someone's hand.\

3.2 Chronology of Basic Link Prediction Methods From CN to AA

Basic Link Prediction Methods based on similarity Index where proposed from 2001 to 2003 but Common Neighbour and Adamic Adar Methods stand apart till today in 2021.

YEAR	LINK PREDICTION TECHNIQUES/METHOD	PROPOSED BY
2003	Adamic Adar	Adamic A &Adar E
2003	Katz	Liben-Nowell &Kleinberg
2003	Jaccard	Liben-Nowell and Kleinberg
2002	Hub Promoted	Ravasz et al.
2001	Preferential Attachment Index[40]	Newman
2001	Common Neighbor Index[40]	Newman

Table1: Chronology of Link Prediction Methods From CN to AA

4. Novel Approach NirLink for patients effected with STML

To find patient zero, we aim to learn the reverse dynamics of contagion processes. Contact tracing[7] apps may help in manual tracing, in turn slowing the virus' stretch, but usage of an app does not turn into the individual protected from infection nor does it guarantee successful tracking without rigorous labor-intensive efforts. So far statements by those in authority have made nervous assertions about COVID-19 Contact Tracing app, likening the use of the app to the utilization of sunscreen or a digital vaccine. It is also imperative that the technical, legal and social challenges are tackled in synchronization. Novel legislation must be written within the framework of existing technological practices, particularly around Bluetooth tracking. Similarly, where technical compromises are made, they must be justified to the public with apparent, succinct explanations, in a manner that is see-through and open to inspection.

As a specific instance of our approach, the novel coronavirus, COVID-19, is intimidating our lives in the order of the globe. To eliminate the novel coronavirus, we may want to best use the collected knowledge about existing corona virus patient specially the patients with STML is Short Term Memory Loss. When a

human being experiences Short-Term Memory Loss [11], he or she be able to remember incidents from 20 years ago but is blurry on the details of things that happened 20 minutes ago. There are a big number of causes of short-term memory loss, a few which are a consequences of medical conditions and others that are linked to injuries or other exterior influences.

4. The Nirmalink Approach

Contact tracing is difficult in patients with STML, as these patients cannot help much with respect to their contact with different individuals in past. The contact tracing is a big problem. Here Facebook Friends and Whatsapp contact Links become utmost important. We propose a combination of methods called Nirmalink to provide an approximation for developing contact tracing app which will enable the scientists to find a group of people that came in contact to the patient in near past. With CN Approach[13] We find that the probability of collaboration is strongly positively correlated with each of these, and for the latter two that the relationship is close to linear over a large part of its range.

$$\text{count}(p,q) = \text{Neighbors}(p) \cap \text{Neighbors}(q)$$

and by combing it with Adamic adar Method [15]

$$A(x,y) = \sum_{u \in N(x) \cap N(y)} \frac{1}{\log |N(u)|}$$

The following Method is then refines by preferential Attachment for beter results. The Adamic/Adar predictor formalizes the instinctive idea that uncommon features are more telling; documents that share the phrase “for instance” are most likely less similar than documents that share the phrase “clustering coefficient. “By combining these two methods i.e. by firstly finding common friends and then applying rarer features approach of Adamic Adar methods we can perform contact tracing of persons with STML

5. Conclusion

Fascinatingly, in the majority studied methods so far, Common Neighbor method of link prediction gives better results than most others. We reexamined the role of CN and AA in predicting lost links from the perspective of a practical approach based on the shared information of network arrangements. For people with STML and Covid -19, a contact tracing method for app is proposed called NirLink. By no means forget the background of other methods it will help immensely in future endeavors. It can not only develop the prediction accuracy significantly, but also predict reasonable approximation for contact tracing.

6. References

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