Contact Tracing Assessment Across Multiple Places

Meljohn Ugaddan
meljohn.ugaddan@obf.ateneo.edu

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1 Introduction

Professionals like Doctors, Scientist and other health workers are looking for ways to stop and prevent the spread of Covid-19 through various means such as contact tracing, drugs and vaccines. These methods help us to minimize the negative impact of the virus such as hospitalizations, increasing number of infection, medical visits and death.

Traditional contact tracing is laborious and has many limitations such as only contacting the person who is close to the infected individual. Which is not enough, since the infected person could already have infected individual due to being not aware of having the the virus. As the economy reopens, after numerous lock downs, places like restaurants, stores and hardware shops have implemented a log for each customer that they are going to have in their area of premise. Each log has a name, contact information and time the person enters the area. These information will be later used to inform the people who enter to the premise to notify them to if someone in enters the area that is infected by the virus.

Suppose one of the person has contracted a virus, this proposed algorithm will get the people that is suspected to be contracted by the virus. These people must be notified to self-quarantine and observe themselves if they have the symptoms of the Covid-19 in order to prevent the spreading of the virus.

2 Review of Related Literature

In terms of related literature , there is one related application in [20b] Quezon City where each of individual is notified when there is person is positive in a establishment or place where they go they will be notified to self-quarantine and observe if they develop Covid-19 symptoms. This application is called Kyusi Pass, which is powered by Singaporean software app name SafePass. The way this application works is that each person who enters a public area must log in using QR code, then if a person who enters the area is contracted by the virus,

the app should notify all person who enter the same area where the infected person went in, to self-quarantine and observe if they develop symptoms of the virus.

Other regions or countries such as Europe, North America, and Singapore have developed apps based on smartphone Bluetooth technology that can notify users if they have been in contact with confirmed patients [Coh20; Kle20]. These apps use the Bluetooth signal strength to infer the distance between smartphones and define the user's exposure status based on the distance and time difference to individuals who are recently identified as infected. These software application requires user permission to be able to use.

There is a research that is based on the use of Neo4j Graph Database algorithm. This database system is based on a new type of database that is based on graph and it's algorithm that works in complex relationship than from traditional relational database system.[Arn14] Graph database is stated as scalable and flexible. On this research, they represented places and individual as graph, then they use Cypher Algorithm to construct an association graphs among the more likely to be infected or areas that can be high on concentration of virus.

[20a] Other digital contact tracing of implemented in Singapore involved mapping the activity of individual in the period of 14 days before the first occurrence of their symptoms. Once the identified individual is record to the electronic system called eHints (SingHealth-IHiS Electronic Health Intelligence System).

3 Methodology

3.1 Transforming Log File to Graph

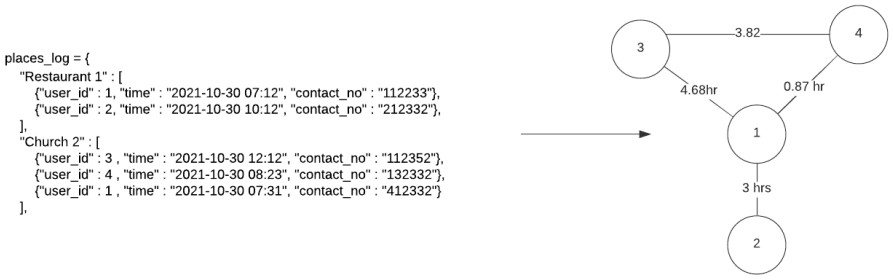

Figure 1: Log file to Graph

The first assumption from the algorithm is that, the initial data structure of the input is that a log of customer that is group in multiple places. In the figure 1, it demonstrates a converted graph that has 4 nodes. The log is constructed on a associative array that has a log of individual in each key. The connection of each node is define when they visited a the same place and the value of the

edge is define by the absolute value difference of time of the customer to each other. This transformed data into graph will be later necessary for the search algorithm for the exposed or vulnerable individual. The converted graph is undirected graph.

3.2 Breadth-First Search

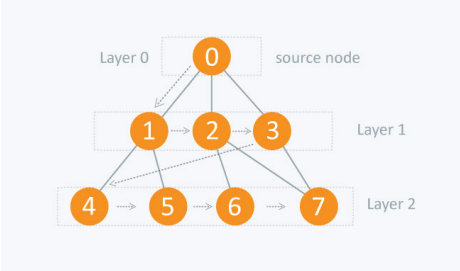

Figure 2: Breadth-First Search

As the log file is converted to graph, where each edge value pertains to the time difference of a node connected to another node. The algorithm uses breadth-first search algorithm to look for the exposed individual. The exposed individual is define on a 3 hour threshold. Meaning, edge that is connected to a an infected node who has less 3 hour edge value, is highly susceptible to the virus and the algorithm should return the details of the person. The

Algorithm 1 Breadth-First Search

```
while len(queue) > 0 do
    temp_queue = []
    for node from queue do
        current_node = graph_node
        for edge from current_node do          ▷ Use the transformed graph
            if edge ≤ three_hours then
                temp_queue.insert(current_node_edge)
                visited.insert(current_node_edge)
            end if
        end for
    end for
    queue = temp_queue
    if MAX_BREADTH ≥ breadth_level then
        break
    end if
end while
```

implemented algorithm in this application is shown above. Just like what usual

breadth-first search algorithm is, it uses queues to traverse first the node from the present depth. The additional part that is implemented the condition for the edge threshold and maximum degree level. The edge threshold is that we have 3 hours and maximum of 2 degree from the source node.

4 Results and Analysis

The Big-O analysis of the breadth first search algorithm in this application is *O(NM)*, where N represents as the number of nodes and M represents edges of each node. Also, here in this application, certain threshold are implemented. For the edge threshold, we have minimum of three hours. For the level threshold, the algorithm only select the node/user that is minimum of level 2. Other than that the algorithm assumes that other nodes that is not within the threshold doesn't assume that they are going to be infected by the virus.

```
Vulnerable Level :  1
    Person: 3  place: Restaurant 1  contact no: 1231231
    Person: 7  place: Church 2  contact no: 1231231
    Person: 13  place: Salon 1  contact no: 1231231
Vulnerable Level :  2
    Person: 11  place: Drugstore 1  contact no: 1231231
```

Figure 3: Sample Output

The Figure above is the sample output of the program. Here as an example, we defined node/person 1 as infected. The vulnerable level 1 is nodes that has degree 1 and the edge value of the destination node from the source node is within the 3 hour threshold.

5 Conclusion

Since the traditional way of recording contact tracing log form is already implemented, the algorithm that is created on this paper can be readily implemented with the current form that is used by public places here in Manila. The only additional process that will be included is that all of the log in multiple places must be combine in a single variable.

The algorithm was also able to improved the current application that is being used in the real world since it has added a certain level of threshold. Graph representation of our data allows the application to add certain complexity, in this case we have the degree level and the edge value threshold.

References

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