Collective Dynamic of Complex Systems (SSIE 523)

Term Project Report

Spread of Alcoholism in a Community

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ABSTRACT:

Networking is an approach to model complex systems comprising autonomously interacting agents. It can be used to model the dynamics of complex systems and the model can be adaptive in nature. The change in the characteristics of the individuals over time are based on the rules assigned. Since it is difficult to analyze the properties of the non-homogeneously connected networks by using numerical and mathematical methods. So, in these conditions network model can be seen as a boon to the modelers by representing the connection in detail. This project helped us to get insight on the concept of network model and use those principles to observe the alcoholism behavior of people in a closed community.

INTRODUCTION:

A network model designed as a flexible approach to representing objects and their relationships. A unique feature of the network model is it can be viewed as a graph where relationship types are arcs and object types are nodes. The network model's schema is not confined to be a lattice or hierarchy; the hierarchical tree is replaced by a graph, which allows for more basic connections with the nodes.
This model tends to be adaptive in nature were the they tend to interact with one another and keep evolving, often over the same time scales. The word "adaptive" comes from the concept that states and topologies can adapt to each other in a co-evolutionary manner.

Here this model is considered to be an **adaptive model** because

Case1: When considering a person (node-1) he may be surrounded by group of neighbors (lets say 5-6). Here, the nodes behavior is determined by the number of neighbors to whom he is connected with and what their habits are (in this case Non-drinkers, Social drinkers, Heavy drinkers).

Case 2: As mentioned in Case 1, consider the neighbors (5-6 assumed) who surround the node-1. Thus, in this case each neighbor connected to node-1 has the potential to be a node and that node will be connected to another set of random nodes(who can be termed neighbors).

Thus, in both Case 1 and Case 2, we can observe that, there is mutual interaction between each node, and thus when each node and their neighbors are connected among one another to forms a network structure.

Now, again considering Case 1 and Case 2, here as the behavior of each node is influenced by the behavior of the neighbor and as each node and as explained in Case 2 that each neighbor has the potential to be a node. There is a mutual influence between one another and the changes in one neighbor affects the center node and thus this is called an adaptive network.

MODEL ASSUMPTIONS:

The following assumptions are considered to make the toy model

1. The community is considered to be a closed community
2. The community assumed to have 3 different kind of population (nodes) with each category having a separate color to represent each kind.
    - Non-drinker (Green)
    - Social Drinker (Blue)

- Heavy Drinker (Red)

3. The nodes are randomly generated in the community.
4. The number of neighbors of each category (Non-drinker, Social Drinker, Heavy Drinker) connected to the node are completely random.
5. Each node is connected via links to (n) random number of neighbor’s.
6. Each link connected to a node is randomly assigned a weight and the weight ranges from (0-1).
7. Here the link weight highlights the influence of an agent on the node.
8. A person under strong influence can change to an other state depending on the type of the influencer.
9. A person can get a new neighbour or loose a neighbour randomly.
10. A threshold value is given as input and is compared with weight and it represent the resistance of change from one category to other. weight which helps to simulate the behavior of the node based on the influence of each neighbors to which the node is connected.
11. A non-drinker cannot directly change into an addict. He first becomes a social drinker and if the influence continues he changes to heavy drinker and vice versa.

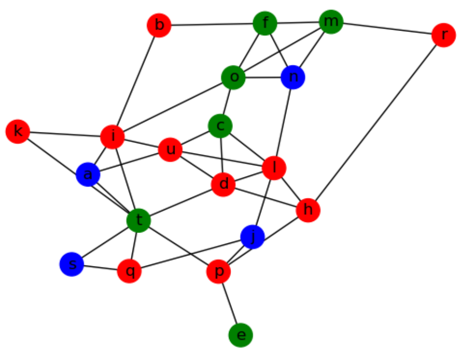

Figure 1. Example of Initial Random Layout obtained from the code based on the assumptions

MODEL WORKING:

1. A enclosed community of 20 people are considered randomly and are distributed based on colors Green-Non Drinkers, Blue-Social Drinkers and Red-Heavy drinkers.
2. A random number of links ranging from 20-50 is randomly linked between the nodes.
3. Each link is provided with a randomly assigned weightage of value ranging from (0-1). These random values represent the affinity (closeness) with the person.
4. A threshold value is provided as input and this value acts as a resistance value to represent the possibility of a person changing from one category to another.
5. Edges are added and removed randomly between 2 random nodes.
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7. The new edges are also given weights which are random too.
8. The summed weight is normalized by dividing it with number of neighbours for the given node.
9. If maximum of normalised weight > threshold then the state changes.

10. So, let’s consider an example were a node is connected to 5 different neighbors with weight values of 0.8 for 2 non-drinkers, 0.6 for 2 social drinkers and 0.3 for 1 heavy drinker then the sum of the 2 non-drinkers, social drinkers and heavy drinkers is divided by total number of neighbors to get the normalized weight for each (in this case 5).
11. So, the following values are obtained for the 3 kinds of individuals and the highest value is considered and (0.32, 0.24, 0.06) = 0.32 is compared to the threshold value and it determines whether the person color will change from initial color to other 2 colors.

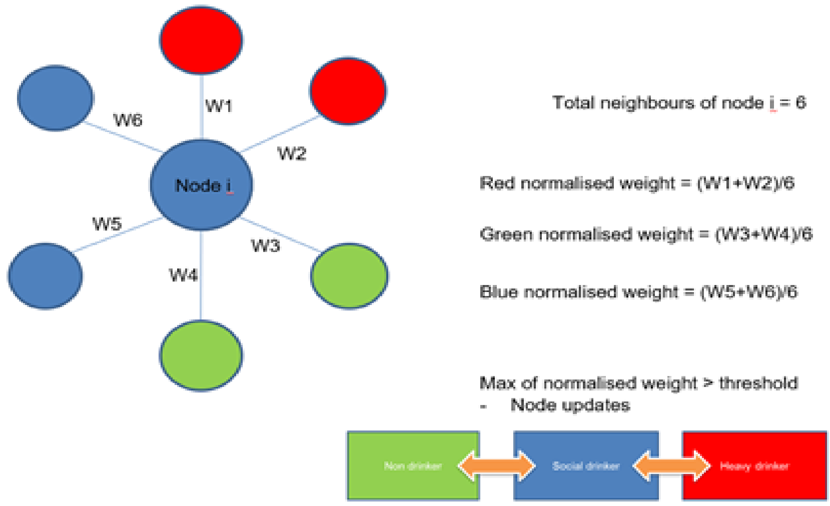

Figure 2: Explanation of the logic behind the code-Normalized weight comparison with threshold value.

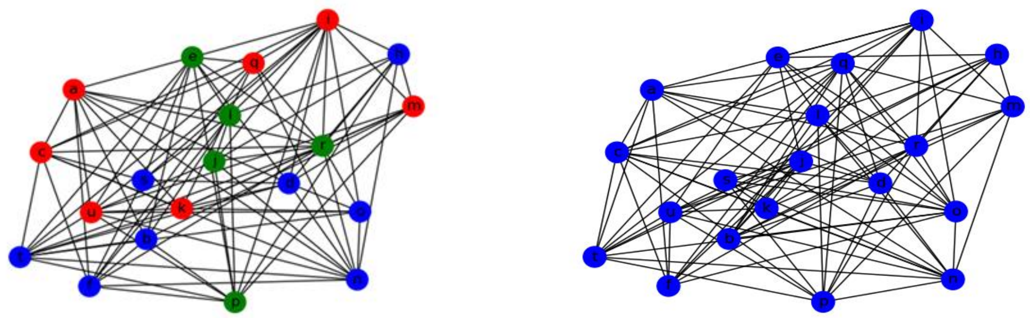

Figure 3 (a): Example of Layout obtained at 4000 steps with 0.5 as threshold value and Figure 3 (b): Example of Layout obtained at the end of 32850 steps with 0.5 as threshold value

OBSERVATIONS AND CONCLUSION:

By running the code, a dynamic network model has been generated. After running for about around 4000 steps or more we can observe all the nodes in the network tends to become one of the characteristics mentioned, which is the majority initially. There is also other possibilities like the second majority becoming the dominating factor. This is because of the stronger influence by the particular type of the node as we assigned the weights of the edge randomly.

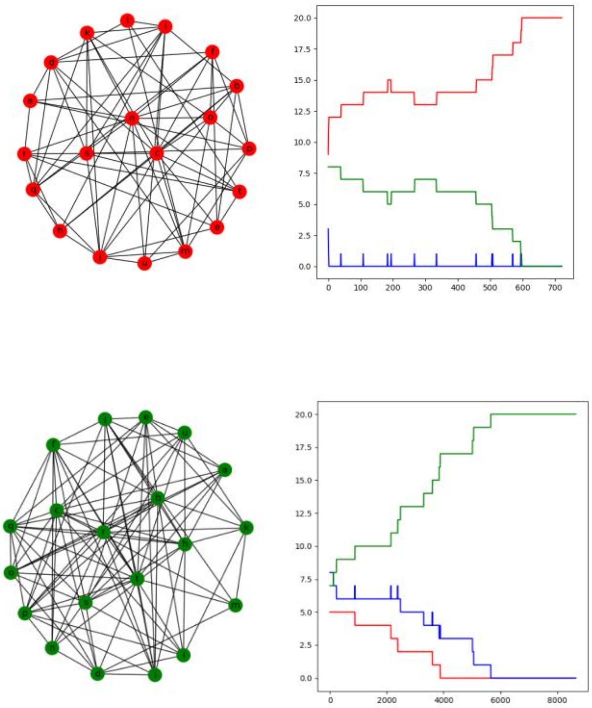

Figure 4 : steady state and steady state with second majority dominating

If the nodes are having equal distribution, (i.e. equal possibility of 1/3 for all the categories) the network takes a very longer time that usual to reach to a particular category. There are instance where the updating took 7000 steps to get to steady state.

FUTURE SCOPE:

Here we used limited number of nodes, but in future, this model could be used for open networks where we can also create and delete node. The network when closed as in the project, it can also be assigned resistance (threshold) for individual nodes. It could help predicting the exact and real behavior of a small network of people.

REFERENCES:

1. GreenFacts. 2018. Green Facts-Details on Alcohol. Cogeneris sprl. November 19. Accessed December 5, 2018. https://www.greenfacts.org/en/alcohol/l-2/01-number-people-affected.htm#0.
2. M. Melemis, Dr. Steven . 2018. addictionsandrecovery. September 25. Accessed December 5, 2018. https://www.addictionsandrecovery.org/alcohol-abuse-alcoholism.htm.
3. Sayama, Hiroki. 2013. "PyCX: a Python-based simulation code repository for complex systems education." Springer 1-10.