Take-home part of the final exam of the network science course

Hanie Hatami[1]

[1]*Department of Physics, Sharif University of Technology, Tehran, Iran*

A REPORT ON THE ARTICLE

background

In this paper, the authors examine how the structure of groups and their interrelationships in a population can influence the spread of an infectious disease. They argue that people who participate in group activities or shared environments, such as students enrolled in the same class or living in a dormitory, are exposed to frequent contact of physical proximity, which is known to mediate the spread of an infectious disease.

The key findings of this study are that changing the organizational form of groups in a population can be used as an effective strategy to reduce the severity of an epidemic. Specifically, they show that when group structures are sufficiently correlated (for example, two students in the same dorm are sufficiently likely to take the same class), outbreaks are longer but milder than in uncorrelated group structures.

In addition, by increasing the correlation between group structures, the effectiveness of interventions to contain the disease increases. They illustrate the practical relevance of their findings using data on housing and student attendance at the Indiana University Bloomington campus.

THE IMPORTANCE OF THE TOPIC OF THE ARTICLE

This paper is important because it provides a new perspective on how group structures can influence the spread of disease and provide potential strategies for disease containment. It highlights the role of network science in understanding and combating epidemics, which is particularly relevant in the context of recent global health crises. The findings of this study can have significant implications for public health policies and strategies to contain disease in group-structured populations.

In this article, the correlations between the network members are not given and they can be adjusted with different parameters, which makes our hands open to understanding the effect of the grouping of the members on the epidemic.

THE MODEL USED IN THE ARTICLE

The model used in this article includes a combination of theoretical modelling and data analysis.

The authors consider edge-colour graphs with specific parameters to simulate populations with artificial group structures. They adjust the correlation between the community structure of the layers by swapping the social memberships of the nodes.

The authors also use data on housing and student attendance at the Indiana University Bloomington campus. They optimize the allocation of students to dormitories based on their enrollment, which allows them to observe a two- to fivefold reduction in the intensity of simulated epidemic processes.

This combination of theoretical modelling and data analysis allows the authors to investigate how changing the organizational form of groups in a population can be used as an effective strategy to reduce the severity of an epidemic.

The model used in the article is based on colour edge graphs. In this model, the authors consider a population of nodes (individuals) that are part of different groups (classes, dorms, etc.). Each group is represented as a layer, and nodes within each layer are connected to form a community structure. The authors adjust the correlation between the layers' community structure by changing the social memberships of the nodes.

The method used in this study includes the simulation of artificial group structure populations using these color-edge diagrams with specific parameters. They simulate epidemic processes in these artificial populations and observe the intensity of the simulated epidemic processes.

GENERAL RESULTS OF THE ARTICLE

The authors found that when group structures in a population are sufficiently correlated, prevalence is longer but milder than in uncorrelated group structures. This means that if the probability of two students being in the same dormitory to attend the same class is high enough, the outbreak will be longer but less severe.

In addition, the effectiveness of interventions to contain the disease increases with increasing correlation between group structures. This suggests that strategies aimed at increasing the correlation between group structures can be more effective in curbing the spread of diseases.

The authors demonstrate the practical relevance of their findings using data on student housing and attendance at the Indiana University Bloomington campus. By optimizing the assignment of students to the dormitory based on registration, a two- to five-fold reduction in the intensity of the simulated epidemic processes was observed.

These results show the potential of changing the shape of the organization of groups in a population as an effective strategy to reduce the severity of an epidemic. They also emphasize the importance of considering group structures and their interrelationships in designing strategies to control the disease.

REBUILDING THE ARTICLE

For the first part, we took 2000 vertices and built the network exactly with the two layers mentioned in the article. And for 100 times the answer in which the disease disappeared in more than 50 days, we averaged and fitted the graph, and the first graph was obtained.

Here, the blue line is for the uncorrelated state, the green line is for intralayer correlation NMI=0.7 And the red graph is for maximum correlation. which is similar to the results of the article, which, of course, the article obtained for two correlations, and we calculated three correlations here.

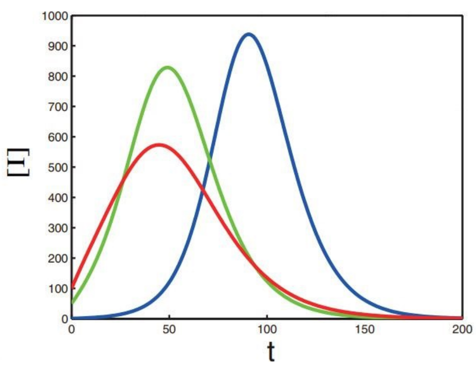

FIG. 1. Average fit of 100 responses

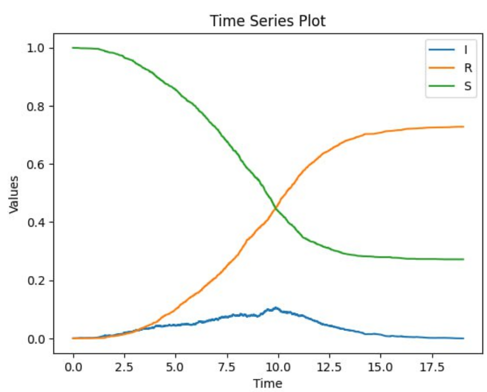

FIG. 2. A complete simulation SIR in mode NMI = 1 In time and normalized values

As discussed in the paper, we observe that the correlated mode has a smaller peak but ends later.

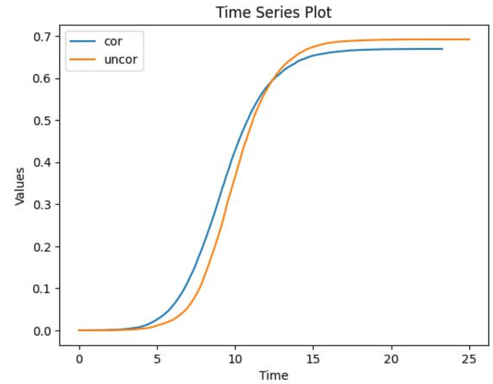

FIG. 3. D is the article of form A with normalized values (diagram r according to t)

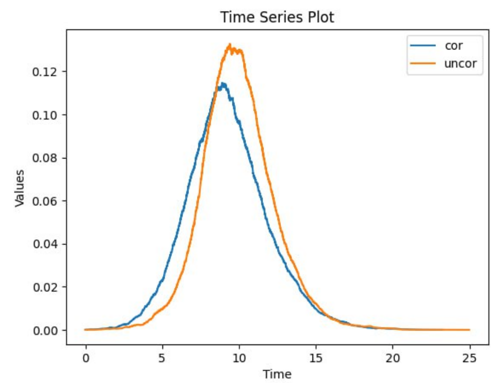

FIG. 4. g The article is in Figure A with normalized values (diagram I according to t)

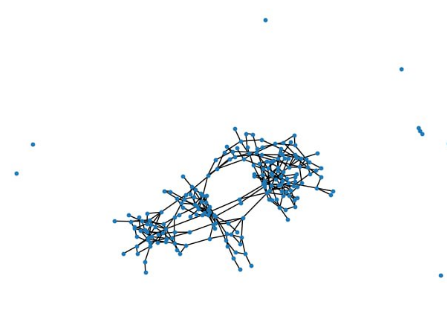

FIG. 5. Association according to the first layer (l=1)

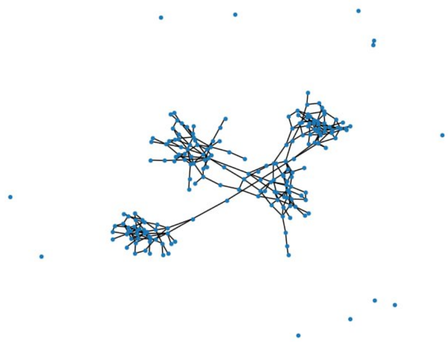

FIG. 6. Association according to the second layer (l=2)