Assignment 2 Designing a Small Social Network Model for Opinion Dynamics

1 author:

Jan Treur
Vrije Universiteit Amsterdam

Assignment 2

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Analysis and simulation of diffusion in networks such as information diffusion, rumor spreading, epidemic spreading, and opinion dynamics is an important field in social network modeling and analysis.

Assignment Outcomes:

After doing this assignment it is expected that you would understand the following terms:

- Network-oriented modeling for Social Networks by temporal-causal network models
- Conceptual representation of a Social Network model by role matrices.
- Impact of the connectivity, speed factors and step size Δt of a Social Network on its behaviour

Reference:

Book 2, Chapter 2 (Section 2.4).

A. Simulating the Dynamics of Opinions in a Small Social Network

In the first part of this assignment, you are asked to simulate the dynamics of the opinions of members of a small social network, by using the nonadaptive Matlab template provided in Canvas. The following graphical representation shows the relations between 10 persons. It is assumed that all connections are bidirectional and the weights of all indicated connections are equal to 1. It is assumed that the states X_i denote the opinion states of persons indicated by *i*. These opinion states depend on the person's previous opinion states and the weighted average of the opinion states of the person's neighbours in the network at the previous time point. A weighted average can be expressed by a scaled sum combination function.

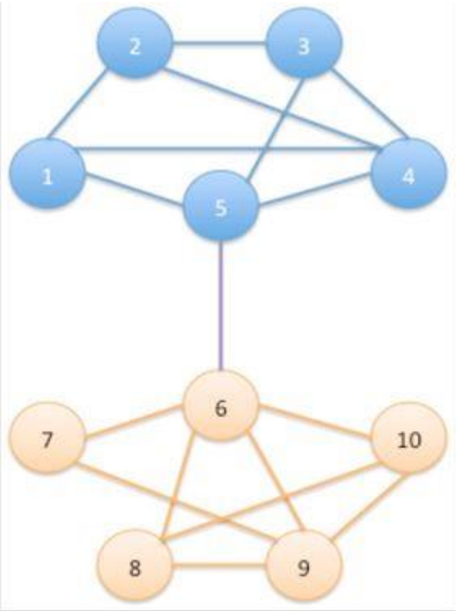

Fig. 1. A simple social network for 10 persons

To model the described opinion diffusion process for this Social Network, you can follow these steps:

- Specify role matrices for the Social Network in Fig. 1 for the three main characteristics of the Social Network model:

    - **Connectivity**
        - For role matrix **mb** follow the picture in Fig. 1
        - For role matrix **mcw** notice that the weight of all (bidirectional) connections is 1.
    - **Aggregation**
        - Role matrix **mcfw** for combination function weights: for all opinion states the scaled sum function is used as a combination function
        - Role matrix **mcfp** for combination function parameters: this combination function has one parameter (the scaling factor λ); for each state, the scaling factor is equal to the sum of the weights of the incoming connections to that state.
    - **Timing**
        - Role matrix **ms**: for now, you can assume that in **ms** the speed factor of all opinion states is equal to 0.25.

- Set the step size d*t* (which stands for Δ*t*) at 0.5.
- Set the initial values of the opinion states. The initial values can be 0.1, 0.2, 0.3, .. , 0.9, 1.0.

A1. Report the outcomes of this simulation (the graph with the simulation results).

A2. As you see, the trend in the changes of some opinion states changes after some time. For example, the opinion X_6 of person 6, in the picture indicated by node 6, in the beginning, has an upward trend and it becomes downward after some time. How do you explain this?

A3. Play around with the step size d*t*. What is the impact of these changes on your simulation results? Write down your findings. Illustrate them with one or two plots. Don't forget to reset the value of d*t* to 0.5 at the end of this question.

A4. Play around with the values of the speed factors. What is happening when you change all speed factors to a new value? What is happening when you change just some of them? Write down your findings. You can illustrate them with one or two graphs. Don't forget to reset the values of the speed factors to 0.25.

B. Communities and Bridge Connections

In social networks, a *community* refers to a group of persons (e.g., friends) who have strong connections with each other (many connections in the group), but they have only a few connections outside their own group. In very closed communities, in which members just communicate with the persons from the same community, the danger of radicalism is serious. In such cases, the role of a few connections to persons outside of the community (bridge connections) is important. In the network presented in Figure 1, we can classify the states according to two communities {1,2,3,4,5} and {6,7,8,9,10}, which are connected via one (bidirectional) bridge with two bridge connections (back and forth). In this part, we are studying the communities and the role of the bridge connections.

B1. Change the weights of these two bridge connections (from person 5 to person 6 and from person 6 to person 5) to 0.1. Do not forget to adjust the value of the scaling factor λ for these two states to keep it normalised. How does it affect the results?

B2. Cut the bridge by setting the corresponding two connection weights equal to 0. Again do not forget to adjust the value of the scaling factors λ for these two states. Report and explain the results.

B3. Assume that this bridge is only one-directional (just from person 5 to person 6). Again do not forget to adjust the value of the scaling factor lambda for the two states. How does it change the results? Don't forget to reset the values of the weights of the bridge to 1 and use the right values of the scaling factors λ.

B4. Change the initial opinion values of members of the first community by multiplying them by 0.1. What is the effect of these changes on the opinion values of the members of the other community? Why is the opinion value of person 5 a bit far from the other members of its community? After this, reset the initial opinion values.

B5. Change the value of the step size d*t* to 0.1 and 1. Report and explain the resulting graphs. After this, reset the step size to 0.5.

B6. Explore the following variations:

- Change the speed factor of the first state to 0. How does this change the results?
- Reset the speed factor of the first state and change the speed factor of one of the other states to 0. How does this change the results?
- Then set the speed factor of two states at 0. How does this change the results?

Compare the outcomes for these variations to Fig. 2.7 in Book 2, Chapter 2, Section 2.4.