Proposal for an agent model which has imagined human relationship

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Abstract: In this paper, we propose a multiagent model for dealing with interpersonal relationship. In traditional multiagent simulation, agents change their states by checking states of neighbor agents, but they do not tell states of neighbor agents or linked agents to other agents. Additionally, the agent model can not show that the agent misunderstands another agent's internal state. In this paper, we proposed a multiagent model based on "Socion theory". Agents of the model have imagined interpersonal relationships as their own internal states. And we also investigate the effect of telling information of other agents on spreading its own impression. We show that a hub agent's impression is spread widely compared to a fringe agent only using a strategy and communication pathway without influence parameter. We believe proposed model could be a foundation of multiagent models for dealing with interpersonal relationship.

1 Introduction

In this paper, we propose a multiagent model for dealing with interpersonal relationship. There are many studies of multiagent simulations for swarm behavior, group action, voting and migration [4] [3]. In common multiagent systems, each agent checks the states of other agents which are linked with the agent or are the neighbors. Furthermore an agent is able to affect other agents which are linked indirectly or are distant from the agent indirectly by using a chain of the affecting neighbors.

However, in most multiagent simulation, agents change their states by checking states of neighbor agents, but they do not tell states of neighbor agents or linked agents to other agents. The agents have only some parameters as internal states that show their own states, and have no structure that holds and conveys internal states of others as a part of their own state. Because agents have no information about internal states of other agents, it is uncertain that which agent affected the agent's internal state and how the agent was affected by it. Additionally, the agent model can not show that the agent misunderstands another agent's internal state or misreads interpersonal relationship around the agent. Furthermore, traditional maltiagent models think less about that an agent lies on purpose. But in real life, we often misread the mind of the other person and then sometimes make trouble. Also we occasionally tell a lie to save ourselves or our compeer. These things mean people do not behave on the basis of the true relationship with others. We believe people behave on the basis of their own imagined interpersonal relationships that were developed through communication with others. Therefore, to deal with interpersonal relationship in a multiagent simulation, agents need to have imagined information of other agents as their own internal states to show a situation of state that agents misread or do not know internal states of other agents or agents tell lies on purpose.

Therefore, we propose a multiagent model based on "Socion theory". Agents of the model have imagined interpersonal relationships as their own internal states. Imagined interpersonal relationship of each agent is updated on the basis of the information obtained from linked agents. Each agent obtains the information of an unlinked agent through linked agents, and then updates impression of the unlinked agent on the basis of the obtained information. In this paper, we linked agents with some pattern as a communication pathway, then we investigated how spread the impression of one agent to other agents when the agent do not change its own impression of others. And we also investigate the effect of telling information of other agents on spreading its own impression. We defined "Impression Management" that the agent tells false information of other agents purposely to spread its own impression. Then we conducted comparing simulation with some condition (impression management is enabled, impression management is disabled, complete graph and no imagined interpersonal relationships). The result of simulation shows proposed model could show pattern of communication pathway and the position in the pathway affect impression management without influence parameter.

2 Socion theory

"Socion theory" [1] is a model theory of agent based social network. The main feature of "Socion theory" is agent has a personal relationship from the agent's viewpoint in oneself separately from the actual relationship. In "Socion theory", the actual relationship is called C-net and the relationship from someone's

viewpoint is called P-net (see Fig.1). Every agent has self-P-net and act based on the relationship of the P-net (not C-net). Every P-net is imaginary personal relationship by agents, and has some differences from C-net. The differences lead to misunderstanding and misinterpretation.

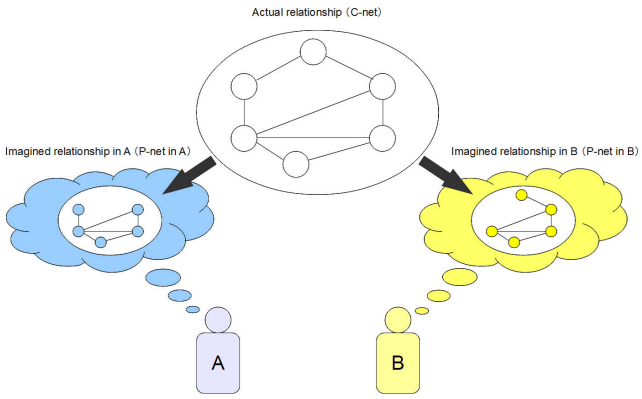

Figure 1: C-net and P-nets

In "Socion theory", every agent has impressions of other agents. The impressions are quantified a feeling of likes and dislikes for each other agent. In this paper, impressions is shown as I and can be 1 or -1 or 0. 1 means like, -1 means dislike and 0 means disregard or unknown. The agents a_i's impressions of agent a_j in C-net is shown as I_{ij} and the agents a_i's impressions of agent a_j in agents a_k's P-net is shown as I^k_{ij}. Because P-net is separate from C-net, there is no promise that I_{ij} and I^k_{ij} are the same. But the agents a_i's impression in C-net and agents a_i's impression in agents 's P-net is the same, so $I_{ij} = I^i_{ij}$.

In "Socion theory", human connections are shown as links, and agents communicate only with linked agents. Agents update their own P-net on the basis of the information that obtained through other linked agents. In this paper, the link between agents a_i and a_j is shown as l_{ij} and can be 1 or 0, $l_{ij} = 1$ means link is enable, $l_{ij} = 0$ means link is disable. Human connections are dynamic in general, but human connection links are static in this paper.

3 Socion model

We believe people develop their own imagined relationships by information obtained through communitaion with others, and then people decide behavior and impression of others based on the information. Therefore, each agent updates their impression in two steps as follows. First, obtaining information from all linked agent and updating the P-net on the basis of the information. Second, updating impressions of all other agent on the basis of the P-net. In this section, we explain about information obtained from other agents and rule of updating impression.

3.1 Updating P-net

Agents obtain the information about linked agents and about unlinked agents by different method. Agents update linked agent's impressions of others in their P-net only on the basis of the information that obtained from the linked agent. When a_i is linked with a_j, the formula of agent a_i updates about a_j's impression of another agent a_k in a_i's P-net is shown as Eq.1. While we can not communicate our feelings or impressions to others with perfect precision in the real world, agent can convey the impressions with no error to simplify problem in this paper.

$$I^i_{jk} = I_{jk} \quad (l_{ij} = 1) \tag{1}$$

Agents estimate unlinked agent's impressions of others by combining the information obtained from other agents which is linked with the agent. When a_i is unlinked with a_j, the formula of agent a_i updates about a_j's impression of another agent a_k on the basis of the information that obtained from the linked agents a_l is shown as Eq.3.

$$i_{jk} = \sum_{l=1}^{n} I^l_{jk} \tag{2}$$

$$I^i_{jk} = \begin{cases} 1 & (l_{ij} = 0, i_{jk} > 0) \\ I^i_{jk} & (l_{ij} = 0, i_{jk} = 0) \\ -1 & (l_{ij} = 0, i_{jk} < 0) \end{cases} \tag{3}$$

3.2 Impression Management

To investigate the effect of telling information of other agents to spread its own impression, we define a strategy that is named "Impression Management". "Impression Management" is a please-everyone strategy that tells false information of others purposely for spreading its own impression of other agents. If agent a_m implements "Impression Management" to spread its own impression, a_m tells "a_i like me" to a_j in case a_i likes a_j or "a_i dislike me" in case a_i dislikes a_j. When agent a_i is unlinked with a_j and is linked with a_m who implements "Impression Management", the formula of agent a_i updates about a_j's impression of another agent a_k on the basis of the information that obtained from the linked agents a_l and a_m is shown as Eq.5. If agent a_i is unlinked with a_m, a_i updates by Eq.3.

$$\acute{i}_{jk} = \begin{cases} \sum_{l=1}^{n} I^l_{jk} + I^m_{ij} & (k = m, l \neq m) \\ \sum_{l=1}^{n} I^l_{jk} + I^m_{jk} & (k \neq m, l \neq m) \end{cases} \tag{4}$$

$$I^i_{jk} = \begin{cases} 1 & (l_{ij} = 0, \acute{i}_{jk} > 0) \\ I^i_{jk} & (l_{ij} = 0, \acute{i}_{jk} = 0) \\ -1 & (l_{ij} = 0, \acute{i}_{jk} < 0) \end{cases} \tag{5}$$

3.3 Updating Own Impressions

In this paper, agents update their impressions based on POX model of Heider's balance theory [2] to sim-

plify problem. Fig.2 shows the 8 patterns of the relationships of a person (P), an other person (O) and an object (X) in Balance theory. The patterns are combinations of three impressions which are P's impression of O and X and O's impression of X, and "+" means friendliness and "-" means hostility. When multiplication of the three impressions is plus as shown in (1,2,3,4), the relationships are well-balanced. On the other hand, when multiplication of the three impressions is minus as shown in (5,6,7,8), the relationships are in balance and P's impression of X is prone to reverse to stabilize the relations. For example when P dislikes X, if P likes O and O likes X as shown in (5) in Fig.2, P tends to change his or her impression of X for the better and come close to (1). The same applies to (6,7,8) and these come close to (2,3,4). Agent a_i's impression of a_j is decided by B_{ij} that is sum of result of balance theory with other agents a_k's impressions in a_i's P-net (a_i is P, a_k is O and a_j is X) Eq.5. a_i comes to like a_j when B_{ij} is larger than zero, and comes to dislike a_j when B_{ij} is less than zero, and keeps the impression when B_{ij} is zero. But one agent which spreads its own impression does not change its impression because its purpose is spreading its first impression to other agents.

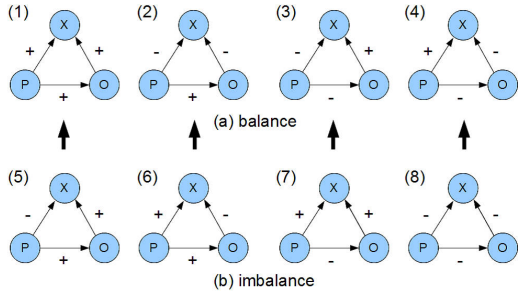

Figure 2: The 8 patterns of POX

$$B_{ij} = \sum_{k=1}^{n} I_{ik} \times I^{i}_{kj} \quad (6)$$

$$I_{ij} = \begin{cases} 1 & (B_{ij} > 0) \\ I_{ij} & (B_{ij} = 0) \\ -1 & (B_{ij} < 0) \end{cases} \quad (7)$$

4 Experiment

In this section, we conducted comparing simulation. We simulate 4 models as follows.

1. Socion model
2. No impression management
3. Complete graph
4. C-net model

Socion model is proposed model with "Impression Management", No impression management is without "Impression Management", Complete graph is proposed model with complete graph linking pattern, and C-net model is traditional model that agents have no P-nets.

4.1 C-net model

We also deal with a traditional model that agents have no P-nets as one of the comparison model. In C-net model, agents only compute balances of triangular links. If an agent has more than one triangular links between other agents, the agent computes balance of each triangular link and decides impressions by sum of them. Agent a_i's impression of a_j is decided by C_{ij} that is sum of balances with other agents a_k which is linked with a_i and a_j Eq.9. a_i comes to like a_j when C_{ij} is larger than zero, and comes to dislike a_j when C_{ij} is less than zero, and keeps the impression when C_{ij} is zero. Agent a_i does not update a_j if a_i is unlinked with a_j or a_i has no triangular link with a_j.

$$C_{ij} = \sum_{k=1}^{n} I_{ik} \times I_{kj} (l_{ij} = 1, l_{ik} = 1, l_{jk} = 1) \quad (8)$$

$$I_{ij} = \begin{cases} 1 & (C_{ij} > 0) \\ I_{ij} & (C_{ij} = 0) \\ -1 & (C_{ij} < 0) \end{cases} \quad (9)$$

4.2 Experimental condition

To confirm our model reflects difference between human network pattern, we conducted simulations using 8 agents with three pattern static linking (Hub-1 (Fig.3), Hub-2 (Fig.4), Random (Fig.5)). In "Hub-1", most agents have only one link that is connect to a hub agent and there are no triangular links. In contrast, every agent in "Hub-2" has more than one links. And "Random" is more similar to a complete graph. At the beginning of the simulation, each agent receives impressions of all other agents as first impressions. The impressions are 1(like) or -1(dislike) and are selected at random. We select one agent which spreads its own impression, and the agent does not change its impression. We ran each simulation 200 turn and judged on the basis of the condition at the end of the simulation. We execute the simulation 1000 times at each model, each linking pattern and each selected agent and compare differences of impressions between selected agent and other agents. The differences between agent a_i and others is D_i and is shown as Eq.10.

$$D_i = \sum_{j=1}^{n} \sum_{k=1}^{n} \frac{|I_{ik} - I_{jk}|}{n-1} \quad (i \neq k, j \neq k) \quad (10)$$

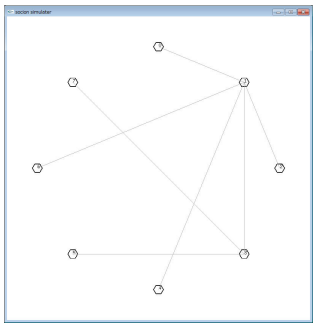

Figure 3: Hub-1

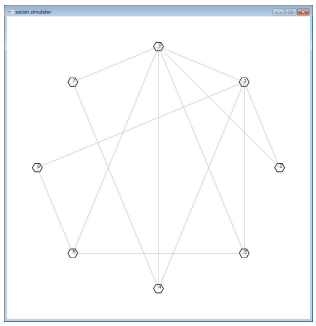

Figure 4: Hub-2

5 Results

The results are shown in Fig.6 (Hub-1), Fig.7 (Hub-2) and Fig.8 (Random). The vertical scale of the results are the differences computed by Eq.10. The results are pretty much the same at any of linking patterns without Socion model with "Impression Management". At these conditions, the degree of spreading of first impression is fairly constant independent of linking pattern and the position in the pattern (e.g., hub, periphery). Agent 1 and 3 in Fig.3 and Fig.6 and Agent 0 and 1 in Fig.4 and Fig.7 are the hub agents. At Socion model with "Impression Management", the result show these hub agents' can spread their first impressions more than other agents. If the linking pattern is close to a complete graph like Fig.5, there is no hub agent and the degree of spreading at each position is close to fairly constant as shown Fig.8.

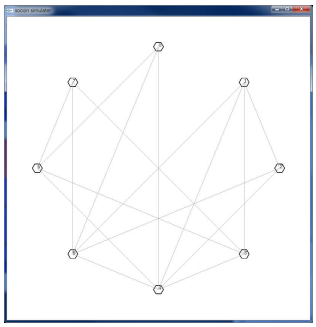

Figure 5: Random

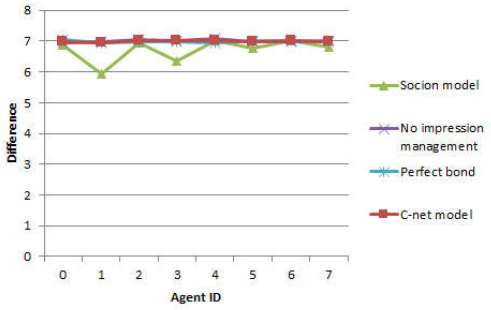

Figure 6: Result of Hub-1

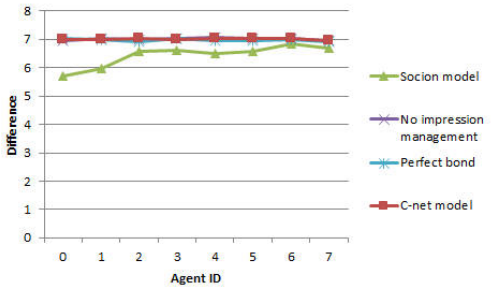

Figure 7: Result of Hub-2

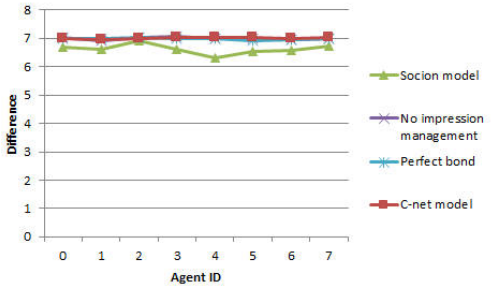

Figure 8: Result of Random

6 Discussion

The results of simulations show if the linking pattern is that most agent convey information to another agent via the specific agent (such as hub) and the agent implements "Impression Management", the agent tends to spread first impression more than other. Especially in "Hub-1", there is clear difference between hub and fringe because every agent except hub

has only one link that is connect to a hub. While linking pattern is similar to a complete graph like "Random", targets of "Impression Management" are on the decrease and agents can get more information from more agent. So the tendency will decrease with that linking becomes similar to a complete graph. In our simulation, we consider "Impression Management" affects all other agents because of using only a few agents. By contrast, in large-scale simulation, we consider "Impression Management" affects only a part of linking network without being implemented by large hub.

In this paper, we show that a hub agent's impression is spread widely compared to a fringe agent without influence parameter only using "Impression Management" and communication pathway. We will be able to do something similar by using influence parameter, but human influence to other people is unevenness and the person who influences some people can not always influence another person. We believe our proposed model is suitable for description of factions or groups than traditional models, because the model can show human influences based on communication pathway. Additionally, we believe our model will be able to show the influence of media such as newspapers, Twitter and Facebook by developing.

Human connection links are static in this paper but real personal relationships are dynamic, we should also consider dynamic connection of human network. Furthermore, balance theory and "Impression Management" are extremely simple rules compared with real world, we should develop these rules. Though there are some problems that need to be solved, we believe a model need to describe imagined relationship of each person to simulate human's purposefulness or strategy and our model could be a foundation of multiagent models for dealing with interpersonal relationship.

7 Conclusion

In this paper, we proposed a multiagent model based on "Socion theory". Agents of the model have imagined interpersonal relationships called P-net as their own internal states. To investigate the effect of telling information of other agents, we also defined "Impression Management" that tells false information purposely to spread its own impression. We showed that a hub agent's impression is spread widely compared to a fringe agent when the agent tells false information only using "Impression Management" and communication pathway without influence parameter. Though there are some problem that needs to be solved, we believe proposed model could be a foundation of multiagent models for dealing with interpersonal relationship.

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