

Influence of Social Relationships on Multiagent Persuasion

(Short Paper)

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ABSTRACT

Life-like agents have the potential to make e-shopping sites on the Web more attractive and persuasive; our interest is to determine how multiple life-like agents should behave as a team to persuade customers. To know how the social relationships among two agents and a human user impacts the effectiveness of persuasion from the viewpoint of the balance theory, we develop a multi-agent persuasion system. In the system, the agents construct a social relationship to the user, and they then try to persuade him/her to select items that they recommend. An evaluation shows that a balanced relationship yields better performance than an imbalanced one.

Categories and Subject Descriptors

I.2.11 [Distributed Artificial Intelligence]: Multiagent systems; H.5.1 [Multimedia Information Systems]: Artificial, augmented, and virtual realities

General Terms

Measurement, Performance, Design, Experimentation, Human Factors

Keywords

Life-like agents, Social relations, Balance theory, Persuasion

1. INTRODUCTION

As the Internet penetrates further into our society, a number of e-shopping sites, such as Amazon.com and eBay to name a few, are available on the Web and they have made a great success as a new approach to commerce that crosses borders electronically. If the e-sites are to become more competitive, they should become more attractive and more persuasive to the customers [1]. To this end, life-like agents or characters have the potential to make the sites attractive and persuasive. They can interact with the customers by chatting with gestures and can recommend goods to them more actively than conventional shopping sites [2]. For example, the French shopping site “Discounteo”¹ employs a

¹<http://www.discounteo.com/>

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life-like agent to support its customers.

Life-like agents have been researched in a number of universities and institutes. DFKI has been developing a number of systems that employ life-like agents for attractive presentation and sales[3]. Rather than emphasizing attractiveness, these agents will be expected to be persuasive in the future.

It is interesting to utilize multiple life-like agents to provide information or to recommend goods. eShowroom is an example of a system that employs multiple agents to provide information on products from different viewpoints [4]. Venus & Mars and Recommendation Battlers are other examples to retrieve or recommend Web information through multiple agents in a cooperative or competitive manner respectively [5]. When multiple agents are employed in a system, we need to know how they should behave as a team so as to enhance their effectiveness.

In this paper, we discuss how agents can be persuasive as a team from the viewpoint of the balance theory. The balance theory was originally formulated by Heider [6] and deals with social relationships among people. It is a scheme to analyze or understand a human group, where each member has positive or negative attitude to each other; it states that people tend to keep their relationships balanced. Nakanishi and his colleagues showed how a software agent can affect the relationship between two persons from the viewpoint of the balance theory [7].

We show that a balanced team of agents offers better performance than an imbalanced team with regard to persuading human users. Section 2 explains the balance theory, while Section 3 introduces a multi-agent persuasion system that first has the agents construct a social relationship to the user and then persuade the user to select items recommended by the agents. We discuss the dependence of persuasion performance on the social relationships among the agents and the user in Section 4 and related work in Section 5. We finally conclude this paper in Section 6 with a description of our future work.

2. BALANCE THEORY

The balance theory [6] discusses the social relationships among perceiver (P), another person (O), and target (X). Each relationship (P's attitude toward O, P's attitude toward X and O's attitude toward X) is labeled either positive (+) or negative (-). For example, if P's attitude toward X is negative, and O's attitude toward X is negative, and the relationships are balanced, P's attitude toward O is positive; we denote this tuple as (+, -, -). If the relationships are imbalanced, P's attitude toward O would be negative.

The balance theory states people tend to maintain their relationships to be balanced. When we deal with the social relationships among three people, we have 8 relationships (4 balanced and 4 imbalanced) as shown in Figure 1. In this paper, we discuss the social relationships among two agents and a human user. We show how the performance of the two agents in persuading the user depends on the relationships.

3. MULTIAGENT PERSUASION SYSTEM

To determine how balanced or imbalanced relationships impact the performance of persuasion, we implemented a multi-agent persuasion system. We need to build social relationships among agents and the user according to the balance theory before the agents persuade the user, so there are two phases: a construction phase and a persuasion phase.

3.1 Construction Phase

In the construction phase, we construct a social relationship among two agents and a user. A social relationship among them is consists of two relationships between each agent and the user and a relationship between the agents.

First, we asked the subject to answer a questionnaire of his/her tastes concerning liked/hated food, color, and TV program. Each agent then showed its preference on the user's tastes. When we create a positive relationship between an agent and the user, the agent agrees with the user's taste. On the other hand, when we create a negative relationship, the agent disagrees. We call this action of agent "A-H action."

Second, we created a relationship between the two agents. Each agent expresses its feeling toward the other agent. The user observes the interactions between the agents on the display. We call this action "A-A action." Each agent shows its attitude toward its partner, so the A-A actions are bi-directional.

We have 6 relationships among two agents and the subject based on the balance theory because the 8 relationships in Figure 1 can be reduced to 6 by exchanging O and X. Agents in the construction phase perform A-H actions and A-A actions to create one of the 6 social relationships.

We show examples of how the agents create a social relationship (+, -, -). We assume the user likes soccer and hates marathons. In this case, agent A1 agrees with the user while agent A2 disagrees through A-H actions as shown below.

A1: "I like soccer very much. We can stretch ourselves well."

A2: "My favorite sport is the marathon. I always enjoy this sport because I get so excited."

Then, each agent expresses its negative attitude toward the other through A-A actions.

A1: "I hate marathons."

A2: "I don't enjoy soccer."

A1: "I cannot agree with you."

A2: "I think our relationship is bad."

These interactions were repeated three times to cover the three tastes expressed in the questionnaire by the user.

3.2 Persuasion Phase

In the persuasion phase, the two agents attempt to persuade the user. We adopt "desert survival problem" to measure the performance of persuasion. The problem is to select items needed to survive in a desert after an airplane crash. In this problem, any item can be a correct answer [8].

In the system, each agent recommends one of three items categorized in a group; the user selects one item after listening to the agents' recommendation. An item recommended by an agent is different from the one recommended by the other agent. The agents just recommend an item and don't add any reason for the recommendation. We say that the user is persuaded by an agent when he/she selects the item recommended by the agent.

Speaking concretely, the agents recommend items from the group bedclothes consisting of blanket, futon and sleeping bag as below.

A1: "For surviving in the desert, I recommend you to have a blanket."

A2: "For survival you should select a sleeping bag."

The user then selected one of the three items. Each persuasion trial was repeated 6 times to select items from the following 6 categories.

Commodities: toothbrush, nail clipper, ear pick

Medicines: band-aids, stomach pills, headache pills

Blades: cutter, scissors, knife

Memories: letter, photo, postcard

Books: comic, novel, magazine

Bedclothes: blanket, futon, sleeping bag

4. EVALUATION

4.1 Procedure

We performed an experiment with the multiagent persuasion system mentioned in the previous section to evaluate the performance of persuasion. We asked 60 students of Kwansei Gakuin University to be the subjects. We split them into six groups; each with 10 students, and assigned each group to examine one of the 6 social relationships.

After the experiment, we asked each subject to answer questions that examined the construction of social relationships among the agents and the subject. We used six attributes (agreeability, empathy, likeness, good feeling, attractiveness, and affinity) to examine the relationship between the subject and each agent and between the agents. Each attribute was rated on a 1-to-5 scale where 5 is the most positive. The first three attributes were used to measure similarity in a relationship while the last three attributes were used to assess favorability [9]. The subjects were asked to rate the above 6 attributes for each of four relations; from the subject to agent A1, from the subject to agent A2, from A1 to A2, and from A2 to A1.

4.2 Result

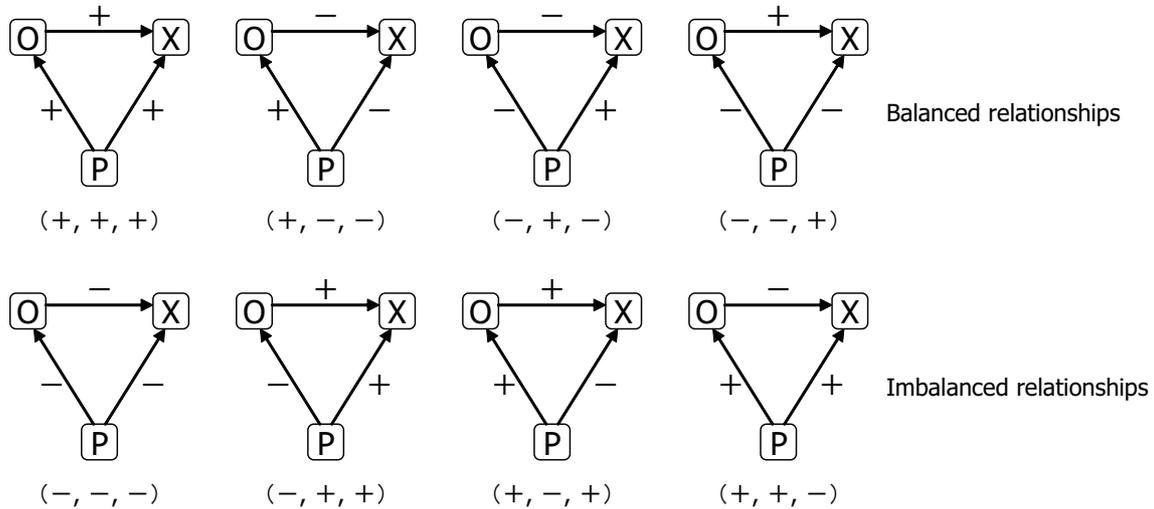


Figure 1: Balanced and imbalanced relationships among three people in the balance theory.

4.2.1 Construction Phase

To determine how social relationships are constructed, we asked questions after the experiment on the relationships among the two agents and the subject. The subject group, to which the agent A1 shows a positive attitude, gained positive impressions on the relationship because the scores are above 3 (neutral) (except for favorability). The other subject group, to which the agent showed a negative attitude, exhibited negative impressions because the scores are below 3 (except for good feeling and affinity). An unpaired t-test found that the differences between the two groups was significant (except for attractiveness and affinity). From these results, we can confirm that agent A1 succeeded in constructing positive or negative relationships to the subjects through A-H actions as intended. Likewise, agent A2 succeeded in constructing relationships to the subjects as intended.

The subject group that observed A1 showing a positive attitude toward A2, had positive impressions while the other subject group, who observed that A1 showed a negative attitude toward A2, yielded negative impressions. These results show that agent A1 succeeded in creating proper relationships between the agents as intended. The reverse relationship from A2 toward A1 is constructed as intended though the scores of agreeability and likeness are a bit low for the positive subgroup.

4.2.2 Persuasion Phase

We evaluated the performance of persuasion in situations where the two agents have the goal of persuading the user. The result is shown in Figure 2. The score shows the average number of items recommended by the agents that were also selected by the subjects. The score was a number from 6 to 0 because the agents recommended 6 items.

The social relationships were constructed through two A-H actions and an A-A action, so we first evaluated the effect of the two factors. The factor of A-H actions has three levels; both positive (+,+), both negative (-,-), and positive and negative (+,-), the factor of A-A action has two levels; positive (+) and negative (-). 2×3 ANOVA showed the interaction effect between the two factors ($F(2, 54) = 6.60, p < .01$)

was significant, so the combinations of A-H actions and A-A action does impact the performance of persuasion. This means neither the single relationships between the agents and the subject nor between the two agents affects performance, only the combination, or the social relationships as a team, affects it.

The interaction effect was analyzed using a simple main effects analysis. A-A action influenced the performance of persuasion in the A-H (+, -) condition ($F(1, 54) = 6.98, p < .05$) and the A-H (-, -) condition ($F(1, 54) = 5.77, p < .05$) as shown in Figure 2 (A) and (B) respectively.

A-H action influenced the performance of persuasion in the A-A (+) condition ($F(2, 54) = 5.12, p < .01$). The significant simple main effects of A-H action were further analyzed by Bonferroni's multiple comparisons. In the A-A (+) condition, the score of the A-H (+, +) condition was greater than that of the A-H (+, -) condition ($p < .05$) and the score of the A-H (-, -) condition was also greater than that of the A-H (+, -) condition ($p < .05$) as shown in Figure 2 (C) and (D) respectively.

As a summary, the above analysis showed that the following differences are significant.

- (A) (+, -, -) > (+, -, +)
- (B) (-, -, +) > (-, -, -)
- (C) (+, +, +) > (+, -, +)
- (D) (-, -, +) > (+, -, +)

All the differences are between a balanced relationship and an imbalanced relation, and the performance of balanced relationships always exceeds that of imbalanced relationships.

4.3 Discussion

As mentioned in the previous section, the combination of A-H actions and A-A action affects the performance of persuasion and balanced relationships offer better performance than imbalanced ones. When we pay attention to result (D) (see Fig. 2) as an example, the performance of (-, -, +) exceeds that of (+, -, +). This result means that

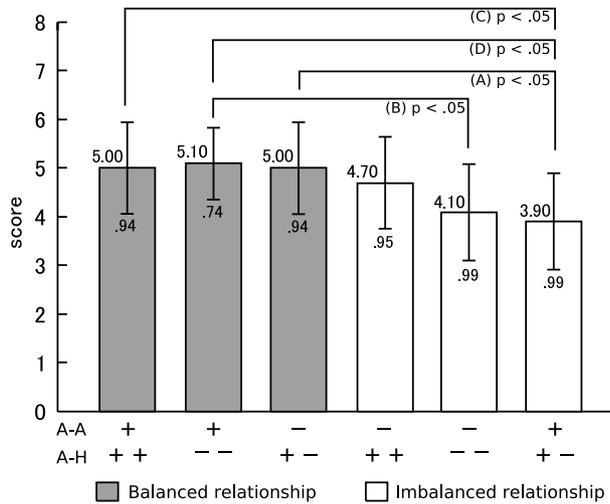


Figure 2: Evaluation result of persuasion phase.

a balanced team, even where both agents take negative attitudes toward the subject, shows better performance than an imbalanced team. This result confirms that the subjects are affected more by the social relationship of the team than the personal relationships between each agent and the subject. We, therefore, need to pay attention to the balanced social relationship among multiple agents when we develop a persuasion system consisting of multiple agents.

5. RELATED WORK

Persuasion has been investigated in the research field of multi-agent systems as a subcategory of negotiation [10]. For example, Ramchurn et al. [11] proposed a rhetorical model of persuasion, where autonomous agents exchange proposals that are backed up rhetoric arguments such as threats, rewards, and appeals. These works have interest in the game-theoretic aspect of persuasion on how agents can reach agreement. On the other hand, we have interest in the social aspect of persuasion when one or multiple agents persuade a human user.

Takeuchi and Katagiri showed that human subjects tend to agree with an agent that agrees with them [12]. They argued that a social relationship can be constructed even between a human and an agent and that it can influence the performance of persuasion. Suzuki and Yamada dealt with a system where two agents persuade a user [13]. In their setting, an agent persuades another agent and the user is indirectly persuaded by the agents by watching the role play. In this paper, our focus is the setting wherein two agents directly persuade a user.

6. SUMMARY AND FUTURE WORK

We evaluated the performance of persuasion in situations where two life-like agents persuade a user to determine how balanced and imbalanced social relationships influence the performance. Our results shows that balanced relationships offer better performance than imbalanced ones and we confirm that having a balanced relationship among multiple agents and the user is important for persuasion. As future work, we need to evaluate the performance of persuasion as a function of the number of agents. We are developing a

persuasion system that employs one, two, or three agents and that can establish different social relationships.

7. ACKNOWLEDGMENTS

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