Interpersonal Relationships in Group Interaction in CSCW Environments

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Abstract

When designing computer-supported work systems (CSCW) it is important consider the evolution of attitudes among the users and how the achievement of user individual and collective goals influences third person. This is especially important in situations where users do not know each other in advance and all of their interactions are mediated through the environment, since the environment is instrumental in forming the relationships. Therefore our focus is not on modeling existing user attitudes and relationships, but on finding out how people actually develop attitudes of liking or disliking other people when interacting in a CSCW environment in a collaborative-competitive situation, how they change their attitudes towards others when they realize their attitudes towards themselves and how the design of the environment influences the emergent social fabric of the group. This paper describes a game designed specifically as a tool for this study. It discusses the preliminary experimental results and some of the consequences for the design of feedback mechanisms in CSCW systems.

1. Introduction

The successful deployment of computer supported collaborative work systems (CSCW) requires taking into account social factors, like preexisting and developing attitudes, relationships between users, incentive mechanisms, organizational flows of control and information. There are examples of solid user communities that formed around pieces of technology (e.g. slashdot.com), but there are also hundreds of examples of failed ones.

Therefore it is important to study the sociological aspects of cooperation, to discover and describe existing relationships among people, existing organizational structures (Artikis et al., 2002; Sierra & Noriega, 2002) and incentives for cooperative action (Golle et al., 2001) in the domain of the application and to incorporate appropriate mechanisms in the system's architecture to accommodate them. However, modelling and adapting to existing user (organizational) roles is not sufficient. Empirical studies (Hummel & Schoeder, 1995) have found that "*… important point lies in the selforganized dynamics of the lateral cooperation process itself, where countercooperative as well as cooperative situations may emerge"*. The authors argued that *"the success of CSCW applications is strongly influenced by the self-organizing dynamics of lateral cooperation"*.

Our goal is to find out how people develop attitude of liking or disliking other people when placed in a cooperative and competitive situation where their only interactions are through a computer-based environment. We use a specially designed mutli-player game environment with rules that require the users to express and modify explicitly their attitude to the other players. As in a real CSCW environment, the attitude of each player has indirect impact on his/her success, since only through cooperation can all players maximize their scores. However, uncertainty in the other players' attitude towards the player and desire for reciprocation after unsuccessful rounds of the game may trigger the player to increase of decrease his/her level of liking which also models a realistic attitude formation and makes the game dynamic and unpredictable.

2. Related Work

There has been a lot of interest recently in the area of social sciences in general, and particularly in the area of business management in the development of "social capital" in a community or workplace, resulting from positive weak ties (Granovetter, 1973) as a way to promote cooperation, information flow and innovation at the workplace. People often think in terms of relationships with other people and their attitudes /feelings towards other people govern to a high extent their actions.

The question about how people actually develop attitudes to each other has been studied by social psychology. Some studies (Greenwald, Pickrell & Farnham, 1999) show that people tend to form their initial attitudes instantaneously, upon exposure. According to Haider's (Haider, 1946) balance theory, Newcomb's (Newcomb, 1953) symmetry theory and Osgood & Tannenbaums's (1955) principle of congruity, attitudes towards other people depend, among on the past experience and shared common beliefs or disagreements. A simpler reciprocating way of attitude change is to respond with the same attitude to the person from whom a certain attitude was experienced. For example, if somebody has behaved badly towards another one in the past, it is very likely that the second one will develop a dislike to the first one (without even trying to judge the motives). While such behavior could be modeled theoretically (e.g. the reciprocating "tit-for-tat" strategy in the iterated Prisoner's Dilemma) (Axelrod, 1984), attempts to explicitly model interpersonal relationships in computer environments have been made only recently (Predinger & Ishizuka, Rist & Schmitt, 2002).

Models of trust updated by reinforcement learning from experience (Yu & Singh, 2002; Yu & Singh, 2002a) and /or reputation, using other agents as a source of indirect experience (gossip) (Conte & Paolucci, 2002) have been proposed also in the area of multi-agent systems. These studies have been concerned with the emerging global properties of the system as a result of introducing trust relationships among agents (e.g. what types of equilibriums can be reached, how robust is the agent society with respect to "cheaters").

There are many research studies on the evolution of cooperation in CSCW environments, but they don't focus on the development of interpersonal relationships among the group members. There have been studies of CSCL environments using social analysis, for example (Nurmela et al., 1999), which measure the social network cohesiveness of the group to identify the prominent participants in collaboration. Studies of social networks among people have been carried out by social scientists (not in the CSCW area) for over twenty years. Usually these studies focus on the patterns of interactions within a group and analyze particular properties of the graph formed by the people (nodes) and their interactions (edges): density, cohesiveness, etc. Seemingly following this approach, other factors that seem to characterize effective collaboration, such as participation rate and role taking have been identified through analysis of the types of speech acts (Soller, 2002; Soller et al., 2002) and actions (Muehlebrock & Hoppe, 1999). Adaptation models providing guidance about what activities the participants should engage in to improve collaboration (Barros & Verdejo, 2000) have been proposed. However, most of this work is descriptive, and applied to settings where implicit social structures already exist, i.e. the users knew each other in advance and have established relationships and status.

With the advance of tele-working environments, there will be an increased need for CSCW environments supporting collaboration between users who have never met face to face and who don't know each other. Building up attitudes and social relationships in such environments happens exclusively during the process of collaboration, mediated through the collaborative environment and can therefore be strongly influenced by the design of the environment.

We propose that representing and reasoning explicitly about attitudes and relationships among users could provide a way to handle emerging self-organizing group dynamics. The design of the rules of interaction in the CSCW can encourage the development of positive attitudes and relationships and increase the motivation for the users to act cooperatively.

Multi-player computer games provide a good context for exploring emerging social relationships. A Swedish research project on a game called "Kaktus" (Laakolahti & Persson, 2001), allows teenage users to experiment different social behaviors and respond to various social pressures. "Sims Online", a multi-player simulation game allows (according to the advertisement) to: "Build a network of friends to enhance your power, wealth, reputation and social standing." Multi-player action games such as

"Dark Age of Camelot" provide an even better ground for studying dynamic social network issues. Recent surveys show that players are troubled by cheaters and saboteurs. The rules of the game (team-based player versus player conflict, no direct communication with the other teams, no ability to switch teams, etc.) set up a situation where given perfect game balance, on any given night, a player may lose 2/3 of his battles. This often leads to frustration, which leads to looking for someone to blame. Over time, teams that intended to be unified against a common enemy end up fragmented into smaller, tighter communities that bicker among themselves, only to reunite eventually and repeat the cycle.

3. Game Design

We propose a new way of exploring emerging interpersonal relationships in a computer-mediated environment by using specially designed multi-player games. In this way we can capture the time evolution of social networks of real people, not artificial agents, as with social simulation. The players form relationships (even though only for a short period of time, in the context of the game) and are more willing to reveal their attitudes to each other in a context of a game than in a real environment. The game allows studying the individual differences in the way people change their attitudes, which can help in designing individualized feedback or reward mechanisms in CSCW environments. The following sections describe the design of a web-based multi-player game called "Who likes me" in more detail.

The goal of the game is to send a packet to a given other player with minimum loss. In each round of a player chooses a destination player and sends a signed packet by passing to one of the other players. The selected player can take away a part of the packet or leave it untouched depending on whether s/he dislikes or likes the originator of the packet. Then s/he passes it to another player, and this continues until the packet reaches the destination or is destroyed by the other players. After each round each player can see if his/her packet has arrived and what proportion of it has arrived. He/ she can also see a system generated rough representation of the attitudes of other players towards him/her and can change his/her attitudes to the other players accordingly.

3.1 Game rules

A personal agent represents each player in the game, thus saving the effort of considering individually each packet passing through the player and ensuring consistency in the forwarding of packages according to the attitudes of the user towards the other players. The personal agent maintains a list of attitudes $\{a_1, a_2, \ldots, a_k\}$ of the player towards the other k players, which can take values between 1 (strong dislike) to 5 (strong liking). The player assigns the value of his/her attitude to each of the other players, thus "instructing" his/her agent how to play the game on her behalf.

During the course of the game, the personal agent decides to whom to pass each packet (both those originating from the player and from other players) and how much to take away from it, depending on the value of the attitude of the agent's user towards the originator of the package. The packet is sent to the agent of the most liked player $M \mid a_M = \max_i \{a_1, a_2, \ldots, a_k\}$. The agent that starts the round cannot send its packet directly to the destination. If the player dislikes strongly the originator R of the package, i.e., $a_R = 1$, the palyer's agent will destroy the packet so that the packet will not be passed further. Otherwise, the agent takes away n parts of the package where $n = 5 - a_R$ and a_R is the value of the attitude of the player to the originator R of the package. In this way, the more the user of the agent likes the originator of the package, the less the agent will take from it. To prevent infinite loops in the game, the agent will not send the packet back to its sender or to the owner of the packet. The round finishes when the packet reaches the destination player or is destroyed. Each game is played a given number of rounds. The player that has accumulated a highest score of passed packages with the minimal summative route length wins the game.

The agents do not reveal the attitudes of their players to either other agents or to the system. Players can view their own attitudes towards the others (player model) at any time. At the end of the round, each player can also see the system model, which is computed by observing the passing of the package -- how much each agent subtracts from the package en route. Only general qualification of the sign of the relationship "seems to like you" or "seems to dislike you" is presented to the player. Figure 1 shows the player model and the system model for a player.

3.2 Implementation

The game uses an Apache Tomcat server and has a two level multi-agent architecture. The first level, the Graphical User Interface, contains static and dynamic html pages. The interaction between player and agent, and between player and system are through Servlets. The second level is divided into two components: a FIPA-OS platform where the PlayerAgents reside and communicate, and the Core-System classes, which store and retrieve information about the game. Figure 2 shows the

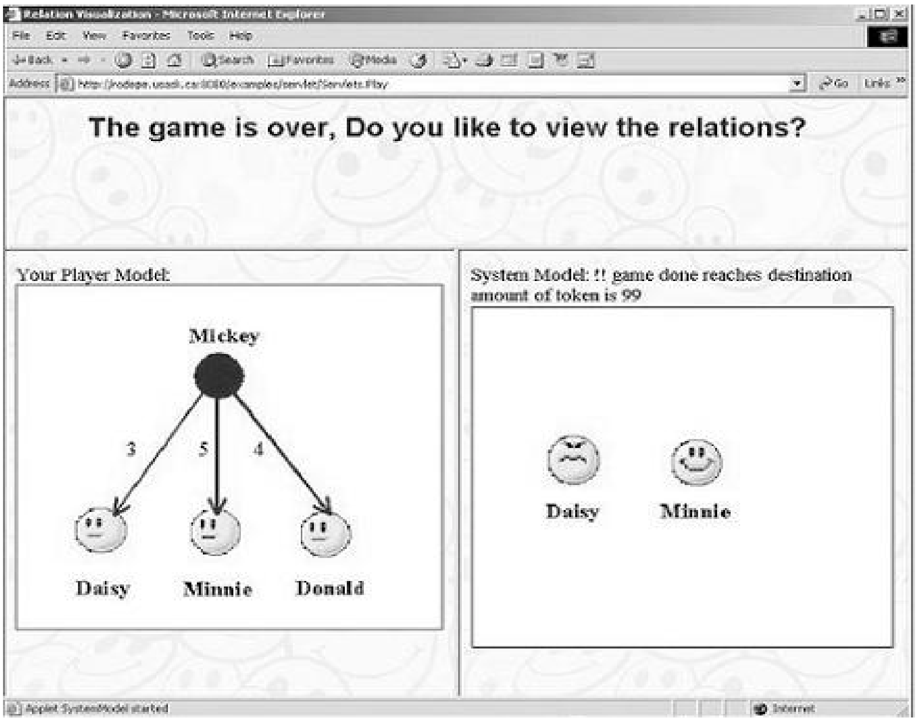


Figure 1: Player model and system model

high-level class diagram for the game. The clients have access to the html files and applets. They can enter information to the system and can view their relation models through applets. The server contains the servlets, agents and other java classes. The arrows in Figure 2 denote function calls.

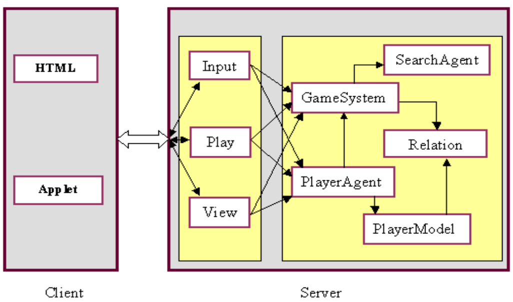


Figure 2: Implementation: high-level class diagram.

The Servlet class Input.java creates an instance of GameSystem and multiple PlayerAgents. The agents communicate via agent communication language (FIPA ACL). Every agent has an attitude model for its player that is based on the player's input. This model contains information about like/dislike attitude of the player to others in the system. Each agent makes decisions based on this model and the rules of the game, which are known by every PlayerAgent.

4. Experiment

We carried out a 45-minute experiment with the game. Six participants played fifty rounds of the game (i.e. packages sent by different players) and filled a survey form in the end. The participants had different gender, age, ethnic background, education, and interests. Aliases were used so the participants did not know who their opponents were. Each round of the game was played by five to six players (some players joined the game at a later stage). The players were given a general introduction about the game and the basic rules.

After every round of the game, the players re-evaluated their attitudes by comparing their own attitude models with the system relationship model and knowing the outcome of the round (if the packet arrived successfully and what amount was taken from it on the way to the destination) and changed their attitude values. Therefore, the routes for a packet to reach its destination were different for the different rounds. The shortest route was a package passed and destroyed by one player who strongly disliked the originator; the longest one involved all six players several times and reached the destination without being destroyed. If a sender had good relations with others and s/he selected to pass the package to a player who also has good relations with others, the packet was delivered to destination successfully. The shortest route of a package happened in two cases: when the originator passed the packet to his/her most liked other player and that player disliked strongly the sender, the packet was destroyed immediately. The second case was when the originator selected a player who liked strongly the destination-player, because it passed the packet directly to its destination. The longest route happened in a group where no one preferred the destination player to the other players and no one disliked strongly the originator. In this situation, the message was passed continuously in the entire group until it finally reached the destination. Therefore in a group where everyone likes everyone equally, the package can be passed for a very long time (generating a very long route) before reaching the destination. Therefore, there is an incentive for the players to create differential liking of others and build reciprocal relationships and "cliques" so that they can pass their packages faster. However, global strategizing in the game is difficult, since the possible routes and decrements of the packages are too complex to be predicted.

The questionnaires showed that players were trying to strategize locally by changing their attitudes towards the other players. Some general observations about how the players set their attitudes follow:

1. How people choose initial attitudes to another player.

- 4.35% of the players chose "strong like (level 5)"
- 30.43% chose "like (level 4)"
- 60.87% chose "neutral (level 3) "
- 4.35% chose "slight dislike (level 2)"
- None of the players chose "strong dislike (level 1)"

2. How players change their attitude to another player when they see the systems' classification of the other player's attitude to them (seems to like /seems to dislike):

(a) If the players find out that another player seems to dislike them:

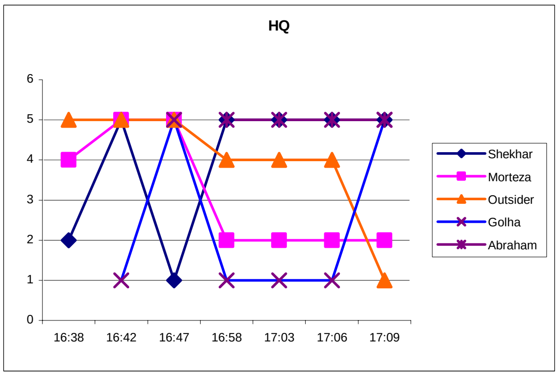
- 4.35% of the players changed their attitude to the player to "strong dislike" (level 1).
- 52.17% decreased their attitude level gradually (to the lower level) .
- 43.48% did not change their attitude.

(b) If the players find out that the other player likes them:

- 82.61% of the players incremented their attitude level gradually (to the higher level).
- 17.39% of the players did not change their attitude.

From these numbers it seems that the players had neutral to positive attitude disposition at start and were conservative in changing their attitudes. The individual players displayed different evolution in their attitudes, corresponding to the reactions described above.

Examples of the evolution of attitudes of two of the participants - HQ and Abraham (aliases) - towards the other participants are shown in Figure 3. Abraham reacted strongly to the fact that his package was destroyed by changing his attitude to all other players to "strong dislike" towards the end of the game. After realizing that he won't be able to play anymore, he changed his attitude values to the other players assigning randomly the full range of values. He commented in the questionnaire afterwards that he was annoyed with the other players and didn't know what to think about them.



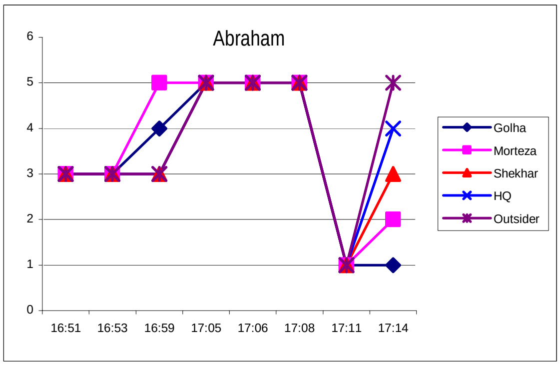


Figure 3: The evolution of HQ's and Abraham's levels of attitude towards the other players

Figure 4 shows the evolution of the *average level* of the attitudes held by each player towards the other players during the course of a game. All of the curves show the same pattern: starting close to a neutral level 3, gradual increase, then drop and then again increase. The evolution of attitudes of two players towards each other doesn't appear to follow a pattern of reciprocity, which can be explained with the delay in feedback (only after a round of the game the participant can see the system's evaluation of the others' attitudes towards him/her) and the complexity of the game which leads to inability to identify exactly the reason for the failure to send a package. Finally, the evolution of the group average level of attitude (Figure 5) seems to fluctuate significantly in a small interval above the neutral level 3 reflecting the generally cooperative spirit in the group of players (though events like Abraham's radical change of attitude contributed to increasing the amplitude in the end).

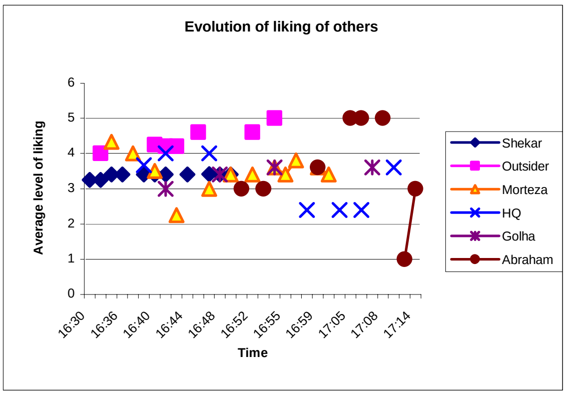


Figure 4: Evolution of average level of liking

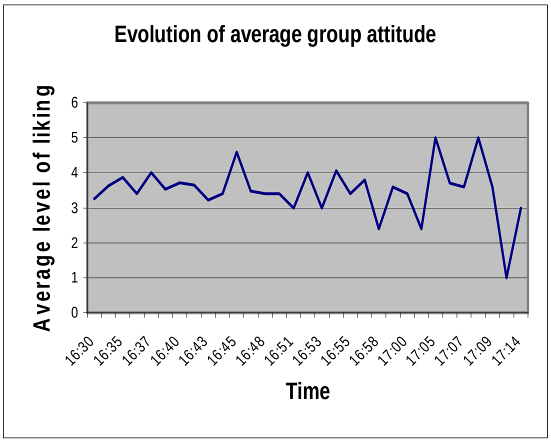


Figure 5: Evolution of average group attitude

5. Discussion

The results point to two main factors which influence how the players who are in a competitive situation change attitudes in response to events resulting from the attitudes of other people:

- *Individuality* (e.g. Abraham's radical attitude change).
- The *"rules of the game"* or the protocol of interaction.

Individual differences in switching attitudes can be seen in the readiness for change (some users change attitude immediately, probably following a strong emotional impulse, while some persist and keep a more rational approach). There are also individual differences in the reasons pointed out by participants for changing their attitudes. Some users stated that they reciprocated the attitudes of the other players; others changed attitudes only as a reaction to a failure, while others changed their attitudes strategically, to make the packets travel specific routes. Players also differed in the way they assign blame for their failure in a complex situation, which they can not understand because of the complex interaction of the factors involved. One possible approach (e.g. Abraham) is to blame everyone involved; another approach – focus on one particular person, for example to blame the closest (most liked) or the most disliked person involved in the situation (e.g. HQ in figure 3, who changed his attitudes to Golha and Shekhar from 1 to 5 and back to 1 at each failure / success / failure event, while keeping his previous attitudes towards the other players).

The rules of the game and the protocol of interaction, as well as the interface design define what feedback the user receives for his/her actions and how this feedback is given (e.g. amount of information, precision). Varying the amount of feedback or the form of feedback (e.g. using text versus emoticons) influences the user behaviour. For example, without the feedback about the other players' attitudes, or with a "gentler" feedback about total failure to send a packet, Shekhar most likely wouldn't have changed his attitudes towards the other players.

It seems that such individual differences need to be considered when designing CSCW systems. Feedback about success and failure need to be provided thoughtfully and in a way, adapted to the individual user. The feedback for user actions (both from the system, as well as from other users) need to be designed or channelled in a way to avoid developing negative attitudes in the users. While these conclusions are still quite general, we hope to be able to study the impact of various forms of feedback in our future work and come with specific guidelines.

6. Conclusions and Future Work

This paper argues for the importance of considering interpersonal relationships emerging among the users of multi-user applications, such as CSCW systems and for the use of computer games to investigate emerging user attitudes towards each other. The social experience of a multi-user environment, no matter how limited the communications medium, is a major component in determining how users will behave. Interpersonal relationships among users emerge in any social system, including those mediated by technology, and they play an important role in the patterns of interaction among people. Interpersonal relationships influence the level of cooperativeness and motivation of the users. There are not enough studies of how people actually develop attitudes to others in the context of a CSCW environments and how these attitudes evolve in response to events and realizing others' attitude towards oneself. As our next step we intend to run experiments with more participants by opening the game to players on the web. We shall investigate the role of the amount of feedback information on the attitude formation of the user (e.g. showing the degree of liking/disliking of others towards the user, or not giving any information). We will investigate if it is possible to alter the game in such a way as to cause everyone to strongly dislike each other over time, and if it is, to see if the relationships become static at this point or if people begin to reach out to one another again on a limited scale. Conversely, it would be interesting to find a way to alter the game rules to make everyone like each other over time and to see if they stay that way, or begin to take their successes for granted and gravitate towards neutrality over time.

Acknowledgement

We are grateful to the three anonymous reviewers for their helpful comments.

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