

Exploring Social Network Indices As Cues To Augment Communication And To Improve Social Practices

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Abstract. PASION is an ongoing European funded project whose objective is to provide a framework capable of providing augmented communication services for several multi-user applications. The goal of our work is to give users information based on SNA indices in order to increase the awareness of their social context, their collaboration and social interaction, and to create a sense of social presence at a group level. Augmented communication is created by automatically collecting any relational event among users in a defined period of time (e.g. user x sent an email to user y at time t). Social Network Analysis is used to extract some structural information (indices) (e.g. centrality, density, reciprocity...) from the set of communication events occurred. Those indices can be coupled with information based on context (e.g. location of the user) or physiological attributes (e.g. heart rate). These indices are provided directly to users in two different modalities: visually (by using different representations according to the context) or verbally (by sending messages to the users). Because the general goal is to influence users' behavior, these two modalities can also represent a way to implement a form of persuasive technology.

Keywords: social network analysis, feedback, persuasive technology, network visualization, location, social awareness, augmented communication, social presence.

1 Introduction

Despite the constant improvement of new technologies for communicating among remote people, Computer Mediated Communication (CMC) necessarily lacks of cues commonly available in Face-to-Face (F-t-F) interaction; different approaches, based on the exploitation of the possibilities offered by these new technologies, have been proposed to recover these cues [1,2,3]. Going beyond this idea, it is possible that cues

that cannot exist in F-t-F interaction, created on the basis of the peculiarity of these new technologies (e.g. automatic collection of data, availability of computational resource, use of displays), can be provided to users. This feature is central in PASION (Psychologically Augmented Interaction Over Networks), an ongoing European funded project which aims to build a framework capable of providing augmented communication services for several multi-user applications. The goal of the project is to give information, not available in a F-t-F situation, directly to users, with the purpose of make them more aware of their social context, of others' communicational activities and to increase social presence at the group level. The modification of these psychological would influence collaboration activities and interactions and modify performance [4,5,6,7].

Augmented communication is defined using two guidelines: from one side, it refers to the possibility of the provision of cues that are not present in face to face communication itself (e.g. a map representation of communication activities). Directly depending on the previous definition, augmented communication also means that the system, taking into account the group profile mainly based on the history of the interactions, is meant to support and influence the decision of which kind of mediated communication act a user should give place, in order to achieve projects goals (a better collaboration) and to improve performance and effectiveness while using a certain application (e.g. by showing a specific kind of map representation, building according to the context and the desired effect).

In section 2, the augmented communication system is described, together with the logical framework on its basis, namely Social Network Analysis. Constraints and requirements will also be illustrated. Therefore, different proposals for augmenting communication are described, focusing mainly on map based visualization. These visualization can be easily coupled with contextual information, as explained in section 3. Section 4 illustrates the objectives and consequences of augmented communication systems, using data from existing literature. Section 5 presents conclusions and a brief review of future works.

2 Using Social Network Analysis to display group properties

Augmented communication is created by providing cues built upon the automatic collection of any relational event among users in a defined period of time (e.g. user x sent an email to user y at time t). Every indices is calculated over the events collected during a pre-defined temporal window T from the actual moment, so they can vary continuously along time. Indices collection is separated from the cues provision based on indices themselves: cues are supplied according to application specific requests, but indices values are always available.

Social Network Analysis (SNA) is used to extract specific structural information (i.e. indices) from the pattern of communication among users. Those indices can be coupled with contextual information (e.g. actual location of the communication event initiator) or physiological attributes (e.g. heart rate of users currently communicating).

The direct provision of such an information directly to users entails an important issue: users' perspective is necessarily different from researchers' perspective,

because user do not know anything about network theories, social meaning of selected indices (an index have a meaning that depends strictly upon the relations on which it has been calculated) and their value. So, it is necessary to take this difference of perspectives into account, by providing cues that are easily understandable and directly tied to the social phenomena (e.g. a low level of cohesion inside the workgroup) they are describing.

Among the different indices that SNA is able to provide, we decided to focus only on few of them, following precise constraints:

- their meaning should be easily understandable for final users;
- there is the possibility to build an immediate and clear clue;
- because indices are extracted automatically and in real time, their computation should be not so computationally expensive;
- indices should be effective, i.e. their provision should be able to modify users' awareness, and they have to be related to performance in a specified task.

Some indices, focused on structural and locational properties of a network [8], have been selected, after a comparison of the previous guidelines, existing literature and studies conducted by project's scientific groups.

A first index chosen is degree centrality, because it easily expresses the idea of position of an actor (central vs. peripheral) inside a network. It is calculated both on the valued matrix and non-directional matrix of events. According to communicational events we are considering, it can be thought as a measure of participation or involvement of a user inside the communication flow with other users. In-degree centrality and Out-degree centrality can also be provided: the first one have been thought as a measure of user's prestige, while the other one as a measure of user's influence [8]. According to the nature of the context, these two definitions are not necessarily appropriate: consider, for instance, the presence of a spammer, that would have a high out-degree but it is hardly influent. So, great attention has to be paid in this context to the real meaning of these indices, because their social interpretation is always related to it (e.g. if the network under examination is a workgroup using a groupware application, the "influence" meaning here described can be accepted).

An index directly related to centrality is centralization [9], which expresses variation of centrality over the whole network. It can be considered as a measure of group hierarchy: a network is highly centralized when few actors occupy a central position and many actors occupy a peripheral position.

Reciprocity has been chosen according to the idea that it is strongly related to the collaboration among social actors [10].

The fourth index is density, that is able to express group cohesion; group cohesion can be seen as a basis of group identity [11]. It is related to odds of success and consensus reaching [12].

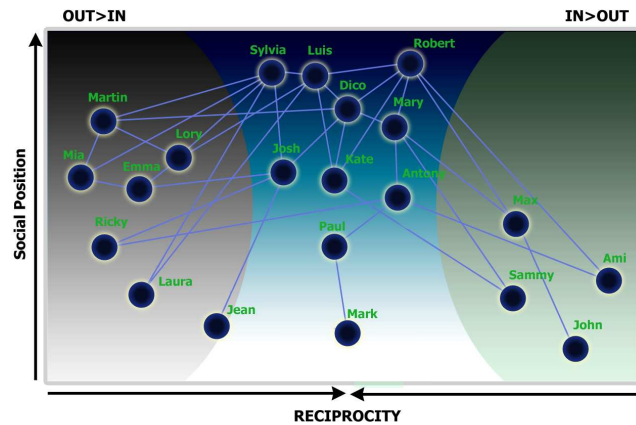
Cues are provided directly to users in two different modalities: verbally or visually (by using different representation of different indices according to the context). Verbal feedback consists in a short statement, provided by the media currently used (e.g. if a mobile phone is currently used, then the message would be provided by an SMS) and elaborated directly by the PASION application, which contains a short description of the social situation e.g. "Communication in the group is focusing only

on a short amount of persons; try to spread information more” (in this case, feedback expresses an high level of centralization in the group in a situation in which the systems knows from previous observations that the optimal situation is a more wide-spread participation of users).

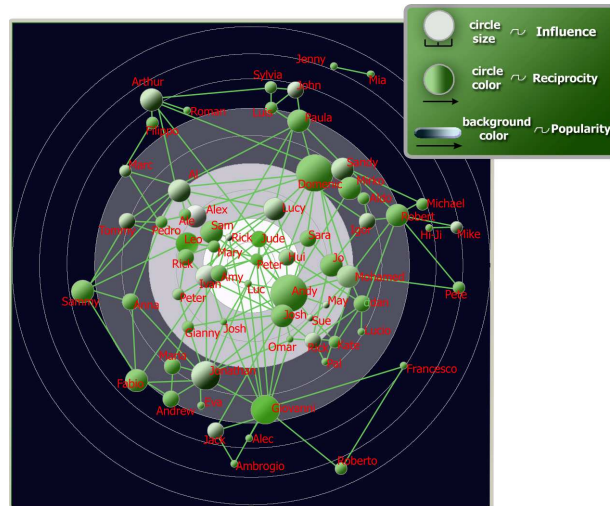
Visual representation are of two kinds: the first one simply refers to an iconographic representation of the social dimension i.e. reciprocity can be represented by a schematic snapshot of a group of people that are looking each other face to face (high level of group reciprocity) or not; the higher the value, the more people are looking face to face.

Another visual representation is based on graphs, where each graph displays the flow of information among users; on the same time, each representation is built in order to convey different information about a specific social dimension (e.g. centrality, reciprocity, cohesion and so on). This idea is very old in Social Network tradition: Chapin [13], developed a three-dimensional Cartesian coordinate system based representation of a graph showing sociometric status, out-degree and in-degree of every social actor. Other authors [14,15] has tried to augment graph by varying structural characteristics such as nodes dimension (e.g. the highest in-degree has the node, the bigger it is). An important challenge focuses on how make all the information needed immediately visible and understandable without a previous knowledge of SNA. The simple use of Cartesian Axis on which a single dimension (e.g. in-degree on x-axis and reciprocity on y-axis) could require too much time to be understood, against the constraint of immediacy, so reported dimensions needs to be as simple as possible. Dimensions can also be confused along the different axis, so a Cartesian coordinate system has to be carefully adopted. Our proposal focuses on the use of Cartesian axis, coupled with structural properties of nodes (such as colours, forms or dimensions).

Some different proposal has been thought, in order to make information conveyed by indices explicit (see figure 1).



1. a)



1. b)

Fig. 1. Two examples of proposed network representations. Nodes are here represented as circles, but they can easily be substituted by avatars, photos or other forms of individual’s representation. In the figure above (a), the higher the value of Social Position (one of the proposed “intuitive” label for degree centrality) of each actor, the upper his/her position on the y axis; if an actor is very reciprocal, corresponding node is placed in the middle of x axis. This choice have been made because reciprocity corresponds to a sort of symmetry of communication. If outgoing communication are more then incoming, corresponding node shifts towards right on x axis. In the graph below, popularity (in-degree centrality) is represented by colour, while influence is represented by the dimension of the corresponding node. Social labels here presented have been often associated to the corresponding indices inside bracket in SNA literature (see, for instance, Wasserman and Faust, 1994 [8], for a discussion about the social meaning of degree, in-degree and out-degree centrality).

One of the fundamental feature of an usable map is that this representation needs labels that are easily understandable by users: an user do not know anything about degree centrality, but, if referred to the valued matrix of events, it can correspond to a general measure of user participation or involvement. So, indices labels presented in figure 1 should be changed according to the context of the application.

3 Social Networks and location information

One of the major challenge of the PASION project is how to integrate map visualization like the one in figure 1 with contextual (mainly, actual location) information. These information are especially useful considering that PASION application are intended to be scalable, so they are usable with different media, from mobile phones to desktop PCs. The idea is to enhance awareness not only of the social structure of the group, but also on the location of the other users, to create better possibilities for coordination. There are some possible solutions:

- information about location can be given at the node level (by clicking on each node, a message with the actual location is shown);
- by integrating geo-data directly on social maps, using solutions like grouping nodes that are near to each others (figure 2), and where the color of the label for each node is directly related to a specific location.

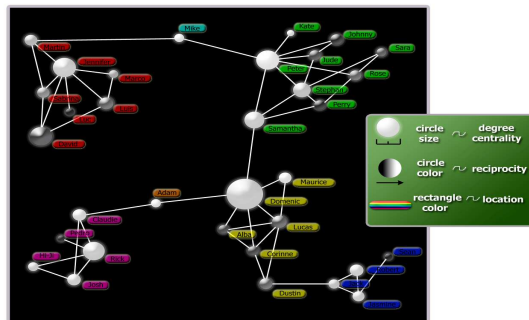


Fig. 2. In this graph, each label color corresponds to a different physical location of the corresponding user. This solution corresponds to a simple integration of location information directly in the graph.

The main idea behind our representation of the map of connections among users is to group nodes according to their actual location; the definition of the location is application depending and users choice. For instance, in a groupware application the criterion for a location can be mainly related to enterprise organization, i.e. the local office from where workers are acting, or to geographical criterion, i.e. the city from where a worker is writing an email. For instance, the different rectangle colors in figure 2 can refer to different local office of the same corporation. It is necessary that nodes considered near according to context definition need also to be near in the graph representation, built upon communication patterns, in order to create a kind of isomorphism with real world.

4 Empirical research on indices provision effectiveness

Our studies are currently focusing not only on the effect of feedback contents, but also on the feedback format itself.

Social networks displays have been proved to be effective tools to modify people behavior. Morris [6] find a way to increase elder people self awareness and confidence in the possibility of improving their social life; a social-network display has been created to let people watch and control their social activity, in order to envision possibilities to increase connectedness; author found that the system were

able to “invite change in a person’s social interaction without prescribing specific actions” (p. 33).

DiMicco, Pandolo and Bender [5], used a shared display, based on dynamically adjusting histograms, which showed how much each person has spoken during a meeting in relation to the others speaker. This approach is not very different by the one used by Gamberini, Martino, Scarpetta, Spoto and Spagnolli, [7] which used an histogram based representation about centrality and reciprocity in a cooperative gaming situation, based on the number of messages exchanged by participants of a team. While DiMicco, Pandolfo and Bender, [5] found that over-participators had a significant decrease in the amount they spoke, under-participators in the experimental condition did not change their level of participation in comparison with a control-group, Gamberini, Martino, Scarpetta, Spoto and Spagnolli [7] found a general increase in the rate of participation of players, if compared with a control condition with no feedback, and a more structured organization of the pattern of responses, together with an increasing in performance.

5. Conclusions and future works

One of the leading idea of our project is to implement these representation inside groupware applications: the awareness of communication patterns inside a specific workgroup, coupled with contextual information, can provide the possibility to reveal the hidden structure of social dynamics, to improve knowledge creation and sharing by making explicit “structural issues impeding or facilitating group effectiveness” (Cross, Parker and Borgatti, [16] p. 11).

Presented results are encouraging; our current researches are exploring which effects an augmented map representation, where information about indices are inserted, could have, if compared with other different representation. In particular, previous researches have suggested that social feedback can affect three fundamental areas: rate of participation, social awareness (and sense of being part of a group) and performance. Moreover, PASION planned living trial will also offer data which are able to support our hypotheses in a real contexts of use, giving a richer source of data and exploring different and complex aspects of those representations. A parallel activity inside PASION consortium tests representation usability: their learnability, how people use them and how they are understood and be more understandable. One of the main challenge is to understand how the context of use changes the effectiveness of representations different features.

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