Conviviality Masks in Multiagent Systems

(Short Paper)

Patrice Caire
CSC
University of Luxembourg
Luxembourg
patrice.caire@uni.lu

Serena Villata Guido Boella
Dipartimento di Informatica
University of Turin
Italy
{villata,boella}@di.unito.it

Leendert van der Torre
CSC
University of Luxembourg
Luxembourg
leendert@vandertorre.com

ABSTRACT

In this paper we study tools for conviviality to develop user-friendly multiagent systems. First, we show how to use the social-cognitive concept of conviviality in multiagent system technology by relating it to agent power and social dependence networks. Second, we define conviviality masks as transformations of social dependencies by hiding power relations and social structures to facilitate social interactions. Third, we introduce dynamic dependence networks to model the creation of conviviality using conviviality masks. We illustrate the use of conviviality masks with a multiagent teleconferencing application for virtual worlds.

Categories and Subject Descriptors

I.2 [**Artificial intelligence**]: Distributed artificial intelligence—*Multiagent systems*

General Terms

Agent theory, human factors

Keywords

Dependence networks, conviviality, virtual worlds

1. CONVIVIALITY MASKS

Conviviality is concerned with user-friendliness, and it is often identified with it. For example, one of the four themes of the European Community fifth framework program was entitled the "societe de l'information conviviale" (1998-2002) [10], which was translated as "the user-friendly information society." This translation refers to the popular definition of a convivial place or group as one in which individuals are welcome and feel at ease, but it ignores the scientific literature in human-computer interaction on tools for conviviality [7]. For a further discussion on the concept of conviviality and its use in computer science, see [4].

A drawback of identifying conviviality with user-friendliness is that "user-friendly" seems to emphasize the relation between user and machine, whereas the "use" of machines is typically associated with a concept called "affordance" and "conviviality" is concerned with social relations among users. For example, Wu [11] distinguishes among "affordance," "user-friendly" and "conviviality" to define good qualities of interaction with users in a system. If user-friendliness is interpreted as interaction between user and machine, then it refers typically to ergonomics standards and usability rules. Conviviality concerned with social relations among users is used in areas such as adaptive systems, augmented cognition and ambient intelligence [3].

In this paper we are interested in the social aspects of user-friendly systems and thus in conviviality. The research question of this paper is as follows.

> How to model and measure the creation of conviviality in multiagent systems?

Multiagent systems technology can be used to realize tools for conviviality. Tools for conviviality are concerned in particular with dynamic aspects of conviviality, such as the emergence of conviviality from the sharing of properties or behaviors whereby each member's perception is that their personal needs are taken care of [7], or Ashby's observation that enforcing conviviality for the majority reinforces non-conviviality for a minority [1]. Illich defines conviviality as "individual freedom realized in personal interdependence" [7]. We therefore model it using dependence networks [5, 8], representing on which agents and agent depends to fulfill its goals. An agent depends on a set of agents to fulfill one of its goals, when the set of agents has the power to fulfill the goal.

We define conviviality masks based on Taylor's idea that conviviality "masks the power relationships and social structures that govern societies." [9]

> A conviviality mask is a transformation of social dependencies by hiding power relations and social structures to facilitate social interactions.

We use a teleconferencing system for virtual worlds to illustrate conviviality masks, because such meetings are a rich source of non-convivial situations, which can be modeled using social dependencies among agents. E.g., meetings may not be convivial if participants fear to post comments, when they are not able to get their turn to talk, or when the discussion diverges due to irrelevant goals of the participants.

The conviviality literature discusses many definitions and relations with other social concepts, which we do not introduce in the formal model in this paper, referring to qualities such as trust, privacy and community identity. Also, in this paper we do not consider Polanyi's notion of empathy, which needs trust, shared commitments and mutual efforts to build up and maintain conviviality.

The layout of this paper is as follows. In Section 2 we introduce dynamic dependence networks to model conviviality masks for the creation of conviviality and we discuss how to measure conviviality in such networks. In Section 3 we discuss the example.

Cite as: Conviviality Masks in Multiagent Systems (Short Paper), P. Caire, S. Villata, G. Boella, L. van der Torre, *Proc. of 7th Int. Conf. on Autonomous Agents and Multiagent Systems (AAMAS 2008)*, Padgham, Parkes, Müller and Parsons (eds.), May, 12-16., 2008, Estoril, Portugal, pp. 1265-1268.

2. DYNAMIC DEPENDENCE NETWORKS

2.1 Formalization

To model Illich' notion of personal interdependence, we start with dependence networks developed by Conte and Sichman [8].

DEFINITION 1 (DEPENDENCE NETWORKS). *A dependence network is a tuple $\langle A, G, dep, \geq \rangle$ where:*

- *A is a set of agents*
- *G is a set of goals*
- *dep : $2^A \times 2^A \rightarrow 2^{2^G}$ is a function that relates with each pair of sets of agents all the sets of goals on which the first depends on the second.*
- *$\geq$: $A \rightarrow 2^G \times 2^G$ is for each agent a total pre-order on goals which occur in his dependencies: $G_1 \geq (a) G_2$ implies that $\exists B, C \subseteq A$ such that $a \in B$ and $G_1, G_2 \in depend(B, C)$.*

To model conviviality masks that introduce goals to make agent dependent on them, we introduce dynamic dependence networks. The dependence relations among agents can change in time due to the actions of agents. Dynamic dependence networks therefore extend dependence networks with the power of agents to create a dependency in the network.

DEFINITION 2 (DYNAMIC DEPENDENCE NETWORKS). *A dynamic dependence network is a tuple $\langle A, G,$ dyndep, $\geq \rangle$ where:*

- *A is a set of agents*
- *G is a set of goals*
- *dyndep : $2^A \times 2^A \times 2^A \rightarrow 2^{2^G}$ is a function that relates with each triple of sets of agents all the sets of goals on which the first depends on the second, if the third creates the dependency.*
- *$\geq$: $A \rightarrow 2^G \times 2^G$ is for each agent a total pre-order on goals which occur in his dependencies: $G_1 \geq (a) G_2$ implies that $\exists B, C \subseteq A$ such that $a \in B$ and $G_1, G_2 \in depend(B, C)$.*

The three place dependence relation reflects that the goals or powers of the agent are conditional and can be changed. In the dynamic dependence network, agents have the power to see to goals and to create new goal dependencies. The power to create goal dependencies combines the power to create goals, the power to create new powers, and the power to change the priority relation.

2.2 Reciprocity and coalitions

The power to change the goals of an agent allows to increase the conviviality of the dependence network due to the conviviality mask. The powers can be used in a positive way, with the aim to increase conviviality. However, they can be used also to decrease conviviality, by adding and removing goals and powers. Moreover, conviviality decreases dependencies in the sense that certain goals can be made irrelevant, or new skills can be assigned to agents to make them independent. This raises the question how to measure conviviality.

The degree of conviviality is related to reciprocity and coalition, because in a convivial space agents cooperate more easily with each other. Moreover, conviviality emerges more easily if there is the possibility of reciprocity. Consequently, the amount of interagent dependencies is a measure for conviviality. The amount and structure of interagent dependencies is also a measure for the environment facilitating the emergence of coalitions. Dependence networks have been used to define potential reciprocity based coalitions [2], which are sets of agents together with a subset of the dependencies for these agents, such that each agent contributes something and receives something from the coalition.

DEFINITION 3 (RECIPROCITY BASED COALITION). *Given a dependence network $\langle A, G, dep, \geq \rangle$, a reciprocity based coalition is represented by coalition $C \subseteq A$ together with dependencies $dep' \subseteq dep$, such that for each agent $a \in C$ we have $\exists G, B, D$ with $G \in depend(B, D)$ such that $a \in D$ (agent a contributes something) and $\exists G, B, D$ with $G \in depend(B, D)$ such that $a \in B$ (agent a receives something from the coalition).*

The definition can be extended to dynamic dependence networks, and the priority relation can be taken into account to define preferred reciprocity based coalitions. Like conviviality, coalitions emerge from sharing of properties or behaviors whereby each member's perception is that their personal needs are taken care of [2].

2.3 Conviviality measures

The conviviality measure starts from the number of dependencies presents in the dependence network that represent the system. This measure is low if there are few dependencies among agents: few coalitions become possible. However, the number of dependencies is not the only relevant measure, but also their distribution must be considered.

- Whether a dependence can allow an agent to enter a coalition, since he has some power which allows him to reciprocate.
- Whether the powers and dependencies are distributed on different sets of agents or not. In the first case, the risk of an unconvivial environment increases.

To increase this measure, there are several ways in which we can add powers creating new dependencies change a non convivial dependence network into a convivial one, such as the following.

- If an agent is dependent on a set of agents for a given goal, it could be made dependent for this goal also on other sets of agents. In this way his negotiation power for entering a coalition increases [2].
- If an agent is dependent on a set of agents, powers can be added to him to make him independent.
- If an agent is dependent on a set of agents, powers can be added to him to make those agents dependent on him.
- Powers can be removed from agents who are too independent to make them dependent.
- Goals can be added to independent agents to make them dependent on other agents.

During this measurement, we have to consider real and institutional powers at the same time, because both contribute to conviviality [4].

3. EXAMPLE

Consider a teleconferencing house on Second Life, as they are now emerging, where each person is represented by an agent and visualized by an avatar. Multiagent institutions or organizations are used to realize the above solutions to achieve conviviality by defining roles with their powers and responsibilities and realize the standard solutions. For example, a role of the Delphi method is that of "facilitator" coordinating the method and arbitrating the meeting, or so-called "rathole watchers" who have the power to take the turn if the discussion is diverging. Each agent has real abilities such as the use of language or the possibility to download material like pictures, as well as institutional powers such as the power to delete comments of other agents, the power to give the turn or, on the contrary, to revoke the turn (the functions that have this powers can be called rathole, as in real panels), the power to give an obligatory invitation to an agent, the power to give the permission to download some material from other agents, the power to give a restriction on parallel communication, or the power to assign or to match tasks. If an agent has the goal to delete a comment, he depends on the agent who has the power to do so.

3.1 Dynamic dependence network

EXAMPLE 1. *Consider the following dependence network* $DP1 = \langle A, G, dep_1, \geq \rangle$*:*

1. *Agents* $A = \{E, G, M, P, K\}$
2. *Goals* $G = \{g_1, g_2, g_3, g_4, g_5, g_6, g_7\}$
3. $dep_1(\{M\}, \{K\}) = \{\{g_4\}\}$*: agent* M *depends on agent* K *to achieve the goal* g_4*: knowledge on financial mathematics*

   $dep_1(\{K\}, \{M\}) = \{\{g_1, g_2\}\}$*: agent* K *depends on agent* M *to achieve goals* $\{g_1, g_2\}$*: the availability of financial resources and knowledge on marketing*

   $dep_1(\{K\}, \{P\}) = \{\{g_1\}\}$*: agent* K *depends on agent* P *to achieve the goal* g_1*: the availability of financial resources*

   $dep_1(\{P\}, \{M, K, G, E\}) = \{\{g_3\}\}$*: agent* P *depends on agents* $\{M, K, G, E\}$ *to achieve the goal* g_3*: to understand the conversation that has to be in English*

   $dep_1(\{E\}, \{P\}) = \{\{g_6\}\}$*: agent* E *depends on agent* P *to achieve the goal* g_6*: knowledge on human resources*

   $dep_1(\{K, E\}, \{G\}) = \{\{g_5\}\}$*: agents* $\{K, E\}$ *depends on agent* G *to achieve the goal* g_5*: material supply*
4. *Agent K prefers the availability of financial resources to material supply or to getting help on marketing:* $\{g_1\} >_{(G)} \{g_5\} >_{(M)} \{g_2\}$

Moreover, consider the following dependence network $DP_2 = \langle A, G, dep_2, \geq_2 \rangle$*:*

1. $dep_2 = dep_1$ *together with*
   $dep_2(\{M\}, \{E\}) = \{\{g_7\}\}$*: agent* M *depends on agent* E *to achieve the goal* g_7*: to read the technical report*

   $dep_2(\{G\}, \{M\}) = \{\{g_1\}\}$*: agents* $\{G\}$ *depends on agent* M *to achieve the goal* g_1*: the availability of financial resources*

Conviviality masks are a mechanism to turn dependence network DP_1 *into the dependence network* DP_2*. For example, without the mask agent* G *does not depend on other agents, whereas others depend on him, and it will therefore be difficult to motivate him to participate in a convivial way.*

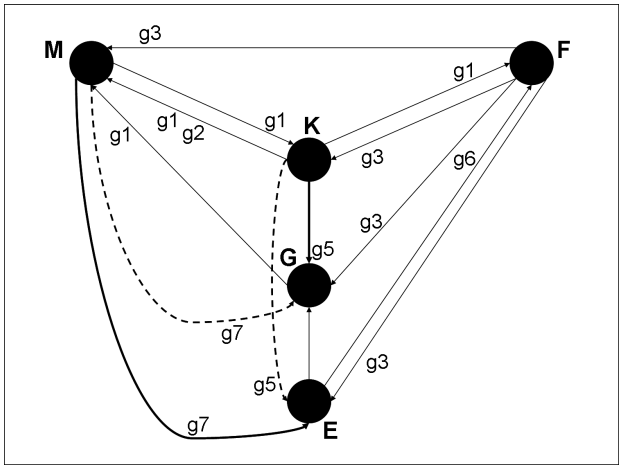

Figure 1: Following example 2, old dependencies (bold arcs) are replaced by new dependencies (dotted arcs) created by agents E and G. Notice that goal names do not change.

Example 2 illustrates that a dynamic dependence network can represent various static networks, by representing the two networks in Example 1 into a single dynamic dependence network.

EXAMPLE 2. *Consider the following dynamic dependence network* $DDP = \langle A, G, dyndep, \geq \rangle$*:*

1. *Agents* $A = \{E, G, M, P, K\}$
2. *Goals* $G = \{g_1, g_2, g_3, g_4, g_5, g_6, g_7\}$
3. $dyndep(\{M\}, \{K\}, \emptyset) = \{\{g_4\}\}$*: agent* M *depends on agent* K *to achieve the goal* g_4*: knowledge on financial mathematics*

   $dyndep(\{M\}, \{G\}, \{E\}) = \{\{g_7\}\}$*: agent* M *depends on agent* E *to achieve the goal* g_7 *if it is created by agent* E*: to read the technical report*

   $dyndep(\{K\}, \{M\}, \emptyset) = \{\{g_1, g_2\}\}$*: agent* K *depends on agent* M *to achieve goals* $\{g_1, g_2\}$*: the availability of financial resources and knowledge on marketing*

   $dyndep(\{K\}, \{P\}, \emptyset) = \{\{g_1\}\}$*: agent* K *depends on agent* P *to achieve the goal* g_1*: the availability of financial resources*

   $dyndep(\{P\}, \{M, K, G, E\}, \emptyset) = \{\{g_3\}\}$*: agent* P *depends on agents* $\{M, K, G, E\}$ *to achieve the goal* g_3*: to understand the conversation that has to be in English*

   $dyndep(\{E\}, \{P\}, \emptyset) = \{\{g_6\}\}$*: agent* E *depends on agent* P *to achieve the goal* g_6*: knowledge on human resources*

   $dyndep(\{K\}, \{E\}, \{G\}) = \{\{g_5\}\}$*: agent* K *depends on agent* E *to achieve the goal* g_5 *if it is created by agent* G*: material supply*
4. *Agent* K *prefers the availability of financial resources to getting help on marketing:* $\{g_1\} >_{(E)} \{g_5\} >_{(M)} \{g_2\}$

   Agent M *prefers to read the technical report to getting help on financial mathematics:* $\{g_7\} >_{(K)} \{g_4\}$

EXAMPLE 3. *In dependence network* $\langle A, G, dep_1, \geq \rangle$ *there is no potential reciprocity based coalition including agent* G*, because agent* G *does not depend on his colleagues so it does not participate in a coalition. Thanks to the conviviality mask, there is a coalition* $\{M, K, P, G, E\}$ *in dependence network* $\langle A, G, dep_2, \geq \rangle$*.*

3.2 Conviviality

Professional meetings are a good source for non-convivial situations in the sense of lack of positive relations among the participants. For example, suggestions from younger employees may not be taken in consideration, a boss may not allow diverging opinions, maybe exploiting that employees fear retaliation for disagreeing with him, tasks and aims of the meeting may be unclear, also due to fear of participants to be mocked, discussions may tend to go into side-issues without important decisions being made, and so on. Standard solutions for these examples distribute speaking time evenly by a protocol defining speaker, speaker time, turn taking and so on, allow the possibility to post anonymous comments using group decision software, make common agreements explicit using a blackboard, coordinate the meeting using an agenda containing the tasks, increase visibility, awareness and accountability by distributing the physical space to help social interaction [6], or introduce efficient decision making using management protocols like the Delphi method. These solutions may be seen as a conviviality mask in the sense that they change the social dependencies among agents such that a more convivial situation emerges.

Various aspects of conviviality are present in our example. The agents involved in the panel depends each other both for real dependencies (real goal of the agent) and for institutional dependencies but with the possibility to realize individual freedom. The emphasis on "community life and equality rather than hierarchical functions" [7] is represented by the anonymity giving a wide degree of freedom both to express the own personal opinion and to interrupt the turn of an agent – including the boss. Moreover, the system can assign to a specific agent a role, for example the one of facilitator if it "knows" that the agent will occupy this position in a good way or it can assign to him a role devoid of powers if the agent had an incorrect behavior. The public level of the institution is a conviviality mask, regulated by norms, giving a sense of security.

We aim to manage the degree of conviviality creating new dependencies that increase it, involving those agents that previously do not participate to the conviviality of the network. Thus, we allow to add or delete goals from the set of public goals of agents. For example, an agent who has some ability, e.g., he knows some technical information, feels excluded since none is depending on him and thus going to ask advice to him. The coordinator could put on the agenda of other agents the goal to know such information, making him dependent on the agent who feels unease.

Concerning powers, for example it could be necessary to disable the possibility that an agent speak a language such as French that is not understood by all the other agents, to avoid the formation of a majority which excludes the other or could be necessary to exclude an agent from the meeting disabling the possibility to intervene. Besides removing powers, it is possible to assign new powers. For example, an agent can be assigned the power of deciding who is speaking in the next turn. All agents who want to talk will depend on this agent.

When dynamic dependence networks are extended with beliefs, also other dimensions can be modeled. For example, if there are common beliefs previously decided, the coordinator has to put these beliefs in the set of beliefs of all the agents as for a due date for a delivery. If an agent has a belief that is completely irrelevant due to the conversation topics such as the possibility to put a time limit decided by the government, the coordinator can delete this belief. Obviously the agent may be not convinced privately, but as long as he participates to the meeting he has to behave consistently with this belief. Advanced software could even prevent that he communicates information which is inconsistent with the public beliefs.

4. SUMMARY

Conviviality is a social-cognitive concept which can be used in agent theory to realize requirements on user-friendly systems, to ensures that considerations on the user-friendliness of multiagent systems get the same importance and considerations on the functionality of the system, to model organizations and communities, emphasizing the social side of them as well as their legal side, and to take the inherent threads of conviviality into account when developing user-friendly multiagent systems. We therefore show how the concept of conviviality can be related to existing social-cognitive concepts in agent theory such as dependence networks, power and coalitions, based on Taylor's idea that conviviality a conviviality mask is a transformation of social dependencies by hiding power relations and social structures to facilitate social interactions. We propose a minimal extension to dependence networks called dynamic dependence networks, that can model conviviality masks. We use a teleconferencing system for virtual worlds to illustrate conviviality masks and the dynamic dependence networks.

Topics for further research are the role of institutions to enforce conviviality masks [4], and the use of our formal conviviality model in agent oriented software methodologies to develop user-friendly multiagent systems. The measures introduced in this paper are a first step to define such a methodology.

5. REFERENCES

[1] W. Ashby. Unmasking narrative: A semiotic perspective on the conviviality/non-conviviality dichotomy in storytelling about the german other. *Trans, Internet journal for cultural sciences*, 1(15), 2004.

[2] G. Boella, L. Sauro, and L. W. N. van der Torre. From social power to social importance. *Web Intelligence and Agent Systems Journal (WIAS)*, 5(4):393–404, 2007.

[3] L. Burzagli, P. L. Emiliani, and F. Gabbanini. Is the intelligent environment smart enough? *Universal Access in HCI*, pages 43–52, 2007.

[4] P. Caire. A normative multi-agent systems approach to the use of conviviality for digital cities. In P. Noriega and J. Padget, editors, *Proceedings of The International Workshop on Coordination, Organization, Institutions and Norms in Agent Systems (COIN)*, pages 15–26, 2007.

[5] C. Castelfranchi. The micro-macro constitution of power. *Protosociology*, 18:208–269, 2003.

[6] T. Erickson and W. A. Kellogg. Social translucence: an approach to designing systems that support social processes. *ACM Trans. Comput.-Hum. Interact.*, 7(1):59–83, 2000.

[7] I. Illich. *Tools for Conviviality*. Marion Boyars Publishers, London, August 1974.

[8] J. S. Sichman and R. Conte. Multi-agent dependence by dependence graphs. In *Procs. of The First International Joint Conference on Autonomous Agents & Multiagent Systems, AAMAS 2002*, pages 483–490. ACM, 2002.

[9] M. Taylor. Oh no it isn't: Audience participation and community identity. *Trans, Internet journal for cultural sciences*, 1(15), 2004.

[10] C. Weyrich. Orientations for workprogramme 2000 and beyond. Information society technologies report, Information Society Technologies Advisory Group, September, 17 1999.

[11] Y. Wu. What else should an hci pattern language include ? In *Procs. of Pattern Languages for Interaction Design: Building Momentum@CHI2000*, 2000.