Personal Agents for Implicit Culture Support

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Abstract

We present an implementation of a multi-agent system that aims at solving the problem of tacit knowledge transfer by means of experiences sharing. In particular, we consider experiences of use of pieces of information. Each agent incorporates a system for implicit culture support (SICS) whose goal is to realize the acceptance of the suggested information. The SICS permits a transparent (implicit) sharing of the information about the use, e.g., requesting and accepting pieces of information.

Introduction

Traditionally, multi-agent systems have been used for supporting humans in many £elds of their activities, such as, for instance, e-commerce, information retrieval and knowledge management. In particular, in knowledge management, agents are assigned to users in order to facilitate their interactions and help them to £nd and use relevant knowledge available in the organization in which they operate (Yu & Singh 2002). Moreover, agents can cooperate with one another autonomously, namely without the direct control of the users, and thereby limiting the interactions of users with the system. An agent can interact and cooperate with the other agents on behalf of its user in order to manage the user's social relationships, even when the user is not connected to the system.

In Knowledge Management, knowledge is categorized as being either codi£ed (explicit) or tacit (implicit). Knowledge is said to be explicit when it is possible to describe and share it among people through documents and/or information bases. Knowledge is said to be implicit when it is embodied in the capabilities and abilities of the members of a group of people. Experience can be seen as a way to access and share this kind of knowledge. In (Nonaka & Takeuchi 1995), knowledge creation processes have been characterized in terms of tacit and explicit knowledge transformation processes, in which, instead of considering new knowledge as something that is added to the existing knowledge, they conceive it as something that transforms it. Supporting by means of IT systems the transfer of tacit knowledge, namely experience, among people in organizations represents a challenge whose dif£culties are mainly in the need to explicitly represent tacit knowledge.

As argued in (Bonifacio, Bouquet, & Traverso 2002), an architecture for a knowledge management system should be designed with the distributed social form in which knowledge is created within organizations. Basic characteristics of agent-based systems, such as, autonomy, intentionality and sociability, can be used to design distributed knowledge management systems that allow us to overcome the limitation of centralized systems.

We propose a multi-agent architecture for distributed knowledge management systems based on the framework of Implicit Culture (Blanzieri & Giorgini 2000). The architecture extends a previous work (Blanzieri *et al.* 2001a) in which Implicit Culture was proposed for supporting interaction within a multi-agent system.

Implicit Culture can be informally de£ned as the relation existing between a set and a group of agents such that the elements of the set behave according to the culture of the group. Systems for Implicit Culture Support (SICS's in the following) have the goal of establishing an Implicit Culture phenomenon that is de£ned as a pair composed by a set and a group in Implicit Culture relation. Supporting Implicit Culture is effective in solving the problem of improving the performances of agents acting in an environment where more-skilled agents are active, by means of an implicit transfer of knowledge between the group and the set of agents. In particular, Implicit Culture can be applied successfully in the context of knowledge management. The idea is to build systems able to capture implicit knowledge, but instead of sharing it among people, change the environment in order to make new people behave in accordance with this knowledge. As a £rst step in this direction we have showed how information retrieval problem can be posed in the implicit culture framework and how the framework generalizes collaborative £ltering (Blanzieri *et al.* 2001b). In this framework supporting an Implicit Culture phenomenon leads to a solution of the problem of transfering tacit knowledge without the need to explicitly representing the knowledge itself.

A Multi-agent System based on Implicit Culture

In this section we present the multi-agent system based on the Implicit Culture we have developed for Knowledge Management applications. Each agent of the multi-agent architecture incorporates a SICS and contributes to propagate the information about the actions of the user to other agents. The SICS incorporated in the agents can be seen as a generalization of a memory-based collaborative £ltering that makes intensive use of similarity-based retrieval (Blanzieri & Giorgini 2000).

Basically, the system is a collection of personal agents that interact one another in order to satisfy the requests of their users. Each agent uses locally the SICS to suggest both its user and the other agents. Applying the SICS locally, each personal agent is able to provide suggestions from its perspective, namely on the base of the information it has collected observing the behavior of its user and those of the agents with which it has interacted with. Using the system, a user asks her personal agent about a keyword and the agent starts to search for documents, links, and references to other users, related to the keyword. The personal agent tries to suggest the user using the SICS and the observations done in the past on the user's behavior and on the behavior of the users whose personal agents it interacted with. Alternatively, the personal agent can submit the request to other agents which will treat the request as it were done by their users. In this case, however, the suggestions can include also other agents to contact. The selection of the agents to send the request is done applying locally the SICS again.

The system has been built using JADE (Java Agent Development Framework) (Bellifemine, Poggi, & Rimassa 2000), a software development framework for developing multi-agent systems conforming to the FIPA standards (FIPA). The architecture of a JADE agent consists of four main components: *Behaviors*, *Scheduler*, *Inbox* , and *Resources*. In our implementation we have:

- *Behaviors*, that an agent is able to adopt in response to different internal and external events. All tasks are implemented as behavior objects; we have a speci£c behavior for the SICS. A request from the user or from another agent actives the SICS behavior.
- *Scheduler*, that determines which behavior is the current focus of the agent and consequently it selects an action to perform.
- *Inbox* , a queue of incoming messages (ACL). It contains the messages coming from the user as well as those from other agents.
- *Resources*, consisting of beliefs and capabilities. The agent's beliefs are the information available to the agent and the capabilities are particular functionalities used in the behaviors. In our implementation the three main components of the SICS (observer, composer and inductive module) are three different capabilities and the observations and the cultural constraint theory are stored as beliefs. Additionally, each personal agent has beliefs about a local schema useful to organize the information available. This schema is not mandatory.

The agents interact one another using the FIPA-Iterated-Contract-Net Protocol, that starts with a call for proposal to perform a given action. In particular, we use the call for proposal for checking the availability of an agent to perform a search action. Differently, the user interacts with its personal agent using the the FIPA-Query Protocol. In our system we have extended the FIPA protocols in order to allows the agents to exchange each other feedback about how the users use the information suggested by their personal agents. We have introduced a third protocol that guarantees that the user informs the personal agent about the acceptance of the refusing of a suggestion, and that the personal agent informs about this the other agents it asked. In practice, the sending of an inform whose content is "accept" is triggered by an action of the user, e.g., following a link, maintaining it implicit. In this way each personal agent has access locally to information about the use of the information done by the requester.

The availability of the information about the uses of the suggestions permits to the agent to observe a wider number of actions permitting the transfer of knowledge between the users. Indeed, if the personal agent would limit its observations only to the actions performed by its user, the effect achieved by the user would be a simple personalization. With the communication protocol we have adopted, each SICS can observe also actions done by the users of the personal agents it has been put in contact to. It is worth to note that this is transparent to the user. As a summary, the personal agent acts on behalf of the user in a complex way. It uses the observations of the behavior of its user to provide a better service to the user herself (personalization) and to the other users (collaboration). Moreover, with the same goal, it integrates locally the observations of the user with the observations of the other users and contribute to propagate the observations of its own user in order to give feedback to the other agents. In other terms the user delegates to the personal agent the capacity of sharing information about the use of information.

The system is fully implemented in Java and XML.

Conclusions

We have presented a multi-agent system that exploits the architecture of the Systems for Implicit Culture Support in order to solve the problem of the tacit knowledge transfer in a knowledge management context. We have argued that the tacit knowledge transfer requires experience sharing and that the main dif£culty lies in the need of explicitly represent the tacit knowledge. Our approach aims to by-pass the problem of the explicit representation.

The system incorporates a SICS in each agent. The SICS is used in order to provide information to the agent's user and also to the other agents by means of a communication protocol between the agents. The SICS observes the local actions of its own user and, by means of a variant of the FIPA communication protocols, also the actions of the other users. The multi-agent architecture permits the exchange of

information about the users actions, thereby improving the range of the actions that each local SICS can observe. The overall effect is an implicit transfer of information about the use of the suggested items. In other words, the system supports the sharing of experiences in using different pieces of information.

Different areas of research produced related work. The main areas we consider here are Agent-Based Knowledge Management (AMKM) , Distributed Knowledge Management (DKM) and Computer Supported Collaborative Work (CSCW).

In AKMN area, hence adopting the agent paradigm, Yu and Singh (Yu & Singh 2002) has very recently proposed an agent-based referral system. Their system, called MARS, suggests to the user the experts she might contact in order to satisfy her knowledge needs. Each user has a personal agents that interacts by means of a mail server with the other personal agents supporting the user social networking. Both the systems share this functionality supported by a learning capability. However, our system differs from theirs from both architectural and theoretical point of views. Architecturally, MARS agents learn explicit models of their *neighbours* and *acquaintances* whereas our approach is memory-based and there is no explicit classi£cation of the other agents; our system adopts FIPA standards and JADE platform; £nally, our system is web-based and not mail-based. Theoretically, the presence of a shared ontology between the agents make MARS only partially distributed, because the ontology has to be £xed for all. Moreover, we emphasize the implicit support of knowledge by managing documents, links and reference to people in a uniform way by inserting the implicit transfer of knowledge among the goals of the personal agents.

A purely distributed approach to knowledge management is being consistently addressed in the EDAMOK project (Bonifacio, Bouquet, & Traverso 2002; EDAMOK). The system-development part of the project adopts a peer-to-peer architecture with an explicit notion of *context*. Based on the published material it is possible to sketch some differences. Architecturally, our agent-based approach relies on different architecture and technology and insert a learning functionalities in order to discover and propagate information about the other entities (agents or peers) in the system. Theoretically, their approach tends to solve *a posteriori* the problem of matching between the local perspectives (contexts) whereas our system tends to support the formation of compatible local perspectives.

In the area of CSCW, the management of tacit knowledge is receiving increasing attention (Jacovi, Ribak, & Woodcock 2001). Tacit knowledge is hard to be transmitted and shared in computer supported environment. Ribak et al (Ribak, Jacovi, & Soroka 2002) wrote:"By replacing face-to-face communication with telephone, e-mail, and instant messaging, we have also forfeited overhearing hallway conversations and the constant subconscious awareness of the state of our team and works environments". They ReachOut system allows for easy and partial-persistent question/answering conversational exchanges between groups of human peers. The effect is community building and awareness of the others. Tacit knowledge can be shared during the exchanges as it happens in face-to-face interactions. The main difference of our approach is that we aim to share tacit knowledge implicitly, namely without the need to communicate and be aware of the other users. The two approaches are complementary and could both gain from an integration.

Further work requires experimentation in the £eld, where the notion of implicit culture can be of great help in order to boost acceptance of the transfer of tacit knowledge, namely experience. Indeed, the user can be explicitly asked to participate at the knowledge transfer process without imposing any speci£c additional activity. On the other hand, accepting to have her own actions partially propagated in the multi-agent system can be facilitate by the idea of contributing to a culture and by the perspective of sharing its advantages.

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