A Multi Agent System Application to Support Communities of Practice: Preliminary Analysis

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Abstract: This paper presents a preliminary analysis for applying Multi Agent Systems to Communities of Practice. In this paper, we present some basic issues on Communities of Practice including a definition and some concepts, namely those of identity, trajectory and multi-membership. We analyze the adequacy of the Multi-Agent Systems technology to support Communities of Practice. We show how some characteristics of Communities of Practice can suggest different applications of Multi-Agent Systems, exploring one of the identified possibilities, more specifically the one related with a member's trajectory into and inside a community.

1 Introduction

The concept of Communities of Practice (CoP) has been used by several organizations to handle problems related to knowledge [BD98][BD00][We98][We00a][We00b] [WMS02]. CoPs have been deployed in a set of different contexts. Tech Clubs at Chrysler regroup in a community various specialists who were spread in different car platforms in order to enable knowledge sharing. The high-availability software community at HP succeeded in standardizing the software sales and installation processes. Eli Lilly used a CoP to solve problems related to duplication of effort, technology redundancy and ineffective transfer of work that occurred after having acquired a smaller company [WMS02].

Usually CoPs are not the main activity of a person in an organization. A community member has other activities like managing projects, programming, selling, etc. In this context, it is important that he could participate effectively and efficiently in his communities, which implies that support systems are highly desirable.

Multi-Agent System approaches in particular could provide the adequate technology for supporting such systems. Intelligent agents that are cooperative, proactive and adaptable could perform tasks to alleviate the increased workload of a person participating in a CoP. In this paper we present a preliminary analysis of some of their possibilities.

The paper is organized as follows: in Section 2 we present some basic issues on CoPs. In Section 3 we analyze the factors that we believe make MAS suitable for supporting CoPs. In Section 4, we demonstrate how some characteristics of CoPs can suggest different applications of MAS and we explore one of them. In the last section, we present some final considerations.

2 Communities of Practice

Organizations have been using Communities of Practice (CoPs) as a new approach to manage knowledge [WMS02]. Most organizations started concentrating their efforts on Information Technology (IT), building intranets, knowledge repositories and tools for improving communications. Such an approach gave them important advantages, like shrinking development cycles, shrinking costs and delivering better products or services. Nevertheless, the approach has some limitations [BD98][BD00][FP98][Mc00]. For example, most IT tools can handle "hard" knowledge (the knowledge that can be easily articulated and captured) in an efficient way but cannot do the same with "soft" knowledge (that includes experience and tacit knowledge) [HK02]. In this context, CoPs provide a new interesting framework for managing knowledge.

2.1 Definition

A CoP is defined as "a group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in the corresponding area by interacting on an ongoing basis." They exist as informal structures in any organisation, whether acknowledged or not. CoPs cannot be established (like a multifunctional team), but can be cultivated. It is possible to create an environment where they can thrive. In such an environment they are properly funded, they have time to develop, people participation is encouraged, their learning is valued and barriers are removed as indicated by Wenger et al. [WMS02].

The structural model of a CoP combines three elements: (i) a domain of knowledge; (ii) a community of people; and (iii) a shared practice. The domain defines a set of issues and legitimizes the community by affirming its purpose and value to its members. The "domain" motivates members´ participation and contribution and helps them defining what activities should be performed. The "community" creates the social fabric of learning and fosters interactions and relationships based on mutual respect and trust. This kind of relationship creates an environment encouraging people to share ideas, to expose their ignorance, to ask questions and to listen carefully.

The “practice” is a set of frameworks, ideas, tools, information, styles, languages, stories and documents that community members share. It represents the knowledge that the community creates, shares and maintains [WMS02]. The concept of CoP has been used to denote a different way to manage knowledge and has been generating interesting results [BD98][BD00][WMS02].

2.2 Some Important Aspects of CoPs

A CoP is a concept belonging to a wider theoretical framework called Situated Learning. A CoP is the place where a process of Legitimate Peripheral Participation takes place. In this process, newcomers become old timers, starting from a peripheral participation to a full participation as shown by Lave and Wenger [LW91]. In this context, the concept of *identity* plays a major role.

The identity of persons belonging to a community can be thought of as their signature. Through the concept of identity, newcomers feel more familiar with some communities than with others. However, when engaging in some of them, they keep forging their identity. A newcomer will learn the community practices, will become more knowledgeable in its domain and will share knowledge in such a way as to belong to this community. Belonging to a community helps to build an identity, because it helps to define what should be known and what can be ignored. Also, the identity is determined by communities to which one belongs or does not belong.

Identities are not static, they change in time. They have trajectories inside communities that represent the past, the present and the future of the members. Analyzing emblematic trajectories could help newcomers to have a glance of their perspectives and could allow old timers to revisit their own history.

Identities also grow in space, they cross boundaries among communities. People participate in various communities and they cannot use a specific identity for each of them. Multi-membership is an inherent aspect of identities. This multi-membership could be a bridge between different communities and constitute another way to expand identities as discussed by Wenger [We98][We00a].

The utilization of CoPs to manage knowledge has been already giving results but we think that other aspects like *trajectories* and *multi-membership* should be explored in order to better use the corresponding social structures.

3 Multi-Agent Systems

Multi-agent systems (MAS) have been deployed in various domains, like concurrent engineering, manufacturing [SNB01], knowledge management [BT02][TB02][TB03], computer communications [MV04] or e-commerce. They can be used to intelligently assist users in specialized and generic tasks. Specialized tasks include, among others, network management [MV04] or operation of CAE tools [MYA99]. Generic tasks can also be supported by agents and by MAS. For example: handling information (e.g. retrieving, filtering, synthesizing), making decisions (decision support systems) [Kl01] or capturing lessons learned by a project team [TB03].

3.1 Definition

For this work we considered that an MAS is a system composed by a group of possibly heterogeneous and autonomous agents that share a common goal and work cooperatively to achieve this goal [TB02].

3.2 Why Should MAS Be Applied for Supporting CoPs

MAS technology is adequate to develop applications for CoPs because it offers flexibility to support complex applications. Moreover, MAS offer the possibility to [BT02]:

- Evolve by the addition or suppression of agents,
- Include proactive services that run in the background,
- Interface to legacy software
- Run several options for the same service in parallel.

We think that the flexibility of MAS allows them to be the base for developing applications that are suited to the needs of a specific community. CoPs can differ from one another [WMS02]. For example, some community can privilege the use of asynchronous tools like email or *blogs,* while another will prefer using synchronous tools like chats. Probably, in such cases a good application for the first community is not so useful for the second one (e.g. a meeting scheduler).

Another factor requiring flexibility from the technology is that communities evolve. A Community has a life cycle: it starts, grows, matures and disappears [WMS02]. We think that in this context the tools used in the community should follow suit. In this case, the flexibility and the possibility to evolve inherent to an MAS can help to provide an always up to date set of tools for the community.

The activities of members of CoPs are performed in parallel with other activities like the activities of a project team [WMS02]. In this context, members do not have much time to dedicate to community tasks. An MAS can help them to decrease their workload by performing tasks that can be automated.

Although Hattori et al. [Ha99] do not refer to CoPs specifically; they argue that an MAS is attractive to support networked communities. The distributed character of this kind of community fits in a distributed architecture like the multi-agent architecture. They also mention that the support system should handle the dynamic nature of the community in which members change the way of participating. The last mentioned characteristic is that the individuality of the members is preserved in a community. They suggest that a personal agent should be used to preserve such individuality [Ha99].

Case et al. [Ca01] although not referring to CoPs also argue that intelligent agents are the ideal technological platform to provide services and solutions for building electronic communities because an intelligent agent is cooperative, proactive and adaptable [Ca01].

3.5 Related Works

In this section we describe classified some MAS applications in relation with the goal of supporting communities in general. For this purpose, we used a classification elaborated by Wenger et al. [We05].

A first group of applications, not designed to support communities, could help community members to perform daily activities more efficiently. In this group we find tools to: elaborate individual profiles [Ma01]; generate a personalized newspaper [CS98][GSA04]; support Web browsing [KM00][SMB01] and filter and retrieve information of distributed sources [BHB01][GSA04][JS02][PKB00] [SGK03][SMY02].

Another group could facilitate both synchronous and asynchronous communications among members of a community. In this group one finds tools to: indicate on-line presence [Ha99][Yo03]; schedule meetings [CWW03][LE98]; promote spontaneous synchronous meetings [Na04][RKD03]; provide smart support to meetings [Ch04] [HGG04][HK04]; direct e-mails to appropriate members [LSS04] and analyze and classify discussions boards [Ha99].

A third group could help communities to consult, save and organize information. This information can be stored in a knowledge repository, an organizational memory or in the Internet. In this group we find tools to: manage community bookmarks [KM02] [KLW01]; recommend documents [GP03][MM97]; filter and retrieve information collaboratively [Gl01]; capture lessons learned [TB03]; automate functions in a portal [BT02] and access organizational memory [AM96].

The fourth and last group includes systems designed to support communities. They include tools to: indicate the presence of a community member [GP01]; identify and form communities [Ha99][LDV99][Ro01][SM02][Wa02][Yo03]; support community activities [GP01][LDV99].

Some of the systems or applications contain a user profile in order to provide more personalized services. They are able to perform more personalized information retrieval or to find other persons with similar profiles, aiming at the formation of communities. Some profiles are elaborated by analyzing users' web navigation behavior; others are built by analyzing the documents a given user utilizes. As these profiles characterize the users, they could be considered like "glimpses" of the users' identities.

In the present work, we focus on different aspects of users' identities. We aim at characterizing (at least, partially) each member's trajectory in the community through parameters like the number of posts in a discussion list or the evaluation of the impact of his contribution to the community. In this sense, we think the system we envisage can support communities in a different way.

Analyzing the available systems, we could confirm that MAS are used to implement systems to support communities because of their distributed character and the possibility to offer intelligent services to the users.

4 Applying MAS to CoPs

4.1 Multi-Membership

Some features of CoPs can be explored in order to provide a better support. One of them is *multi-membership*. People usually participate in more than one community and each community contributes to build the identity of its members. For example, in an organization, a person might participate in a community interested in Java programming and also participate in another one interested in project management applied to software. His participation might be different in each community. In the Java community he could be one of the most knowledgeable and experimented member who contributes sharing his knowledge with newcomers. The same person could be a newcomer in the project management community. He could just start to lurk around the more experienced people. He could keep this status or could start participating more actively.

An MAS usually has users' profiles that can provide "a glance" of users' identities. With such profiles an MAS is able to offer intelligent services. For example, based on a good profile, an agent can perform better information retrieval. However, multi-membership raises some issues. Should the user have one profile for each community to which she belongs? If she has various profiles probably she will spend time managing them or will need to shift among them during her work. Maybe it is the only option for somebody who participates in CoPs supported by different systems. But should it be so in an organization with a single system? Is it possible to utilize only one profile for all communities in which a person participates? We think that such issues should be explored in order to develop better systems for supporting CoPs.

4.2 Trajectories

Another aspect that should be explored is the evolution of identities in time. Surely profiles should be dynamic. But we think that even dynamic profiles cannot represent the evolution of an identity inside the community.

In order to better explain our notion of trajectories, we are going to use an analogy between a formal association (e.g., a non profit organization) and a community. Usually to become member of a formal association, the candidates must subscribe. Paying the fee, the new members become eligible for some services. For example, they can receive newsletters; be invited to events promoted by the association or run for the presidency of the association.

In a distributed community, usually candidates do not pay any fee but probably would subscribe to a discussion forum. They are then entitled to access the community document repository or to participate in chats with other members. A community, like an association, allows different levels of participation. An association is usually managed by executive committee. Its members who are more engaged in the activities of the association. For example, they organize workshops or conferences, publish newsletters, and try to attract new members. Other members participate in the conferences organized by the association and sometimes even help in organizing them. There are also members who read the newsletters or the proceedings of the conferences and participate sometimes in the workshops promoted by the association. In a distributed community there is no executive committee but members who participate more frequently and intensively, who form the *core group* of the community. Such a group is responsible for organizing events like chats and for animating the community in, say, suggesting new topics or new activities. The core members amount to generally 10 to 15 percent of the whole community [WMS02]. Other members, active members, of distributed communities participate in the activities, like the chats or the discussion forums, but without the same regularity and intensity as the core members. Active members of a community are 15 to 20 percent of the members of a community [WMS02]. Members of an association who read the newsletter could be compared with the peripheral members of a community. Such peripheral members observe the interactions among core and active members through the discussion forums and in their own way learn the practice of the community as the process goes by.

In an association, usually the members of the committee are elected for a term. So after some time, new elections are called and a new committee is appointed to manage the association for another term. In a community, the core group can be changing at any time. A core member could loose interest in the domain as it shifts and leave the community. Peripheral members could become more active as they start participating more regularly. As they get more involved in the activities of the community, they move towards the centre and can end up in the core group.

As they change their level of participation, members describe trajectories. Such trajectories can be in the direction of the core but they can also indicate that a member is disengaging from the community. As CoP elements change (the domain, the practice or the community) the members change their level of participation describing a trajectory that points towards the outside of the community. In an association, some members can also adopt a peripheral level of participation when a new executive committee is elected.

Monitoring individual trajectories could seem secondary to monitoring the whole community, but individual trajectories represent in some extent how a community is doing. For example, becoming a core member is an important process in a community because it indicates that the member has learnt the practice of the community. Trajectories towards the core of the CoP indicate that members are learning, which is a vital process for the entire community.

Given the importance of trajectories, we think that they must be explored in order to support CoPs effectively. We consider that following trajectories could contribute to the development of CoPs in several ways:

- Trajectories can indicate how well members of a given community are learning;
- Various members with trajectories in direction of the core are a signal of the vitality of the community.
- Remarkable trajectories could help newcomers to project their future participation [WMS02].
- Trajectories can help old-timers to analyze their past participation [WMS02].

Certainly, it is a challenge to determine which indicators can best represent a trajectory. Quantifiable indicators such the number of posts in a discussion list, the number of contributions in a *blog* and the number of documents posted in a repository could be useful. A process of peer assessment could be used to follow a trajectory too. But qualitative clues should be more representatives of the trajectories, like, the quality of the contributions or the impact of a document.

At this point, we can envisage some MAS applications for supporting CoPs. One of them is an agent that could survey some quantitative indicators of participation. This agent could monitor the number of contributions in the various forms of communication used by the community.

For example, if the community uses email, *blogs* and chats for communication, such an agent could count the number of emails posted by a member, the number of his interventions in the chat, the entries in his own *blogs* and the commentaries posted in other members' *blogs*. The agent could also verify in how many chat sessions each member participated and how often a given *blog* is accessed.

Such indicators cannot measure the participation of each member, but they could provide some clues on how a member is participating to the community coordinator. For example, if the participation is low, he could try to promote a face-to-face meeting to verify if there is a problem.

In a CoP, usually, peer recognition is highly valued. An agent can help to manage spontaneous demonstrations of recognition. For example, if a member of the core group recognizes that the contribution of a peripheral member was valuable, this fact should be saved and considered because it could mean that the degree of participation of such a peripheral member is changing.

In some circumstances, peer recognition can be induced. For example, an agent could start a process of assessment of a peripheral member's participation, triggered by a quantitative indicator as the number of posted emails. This agent could be used to synthesize the contributions of a member and send them to other members in order to get an evaluation.

In this way, quantitative indicators and qualitative assessments could be combined to represent a trajectory. Surely, it is not a complete representation, but we think it could help the coordinator and the core group to observe the dynamics of the community.

The MAS technology could help in this kind of task. Moreover it could use intelligence to perform the tasks. In this context, we think that the MAS technology can contribute significantly to supporting CoPs.

4.3 Some Practical Considerations

We are currently developing our agents using the OMAS (Open Multi-Agent System) platform. Such a platform allows us to develop two types of agents:

- Service Agents (SAs) that provide specific services like handling documents and performing web searches.
- Personal Assistants (PAs) that interface the users to the system [BT02][TB02] [TB03].

In the following, we assume that in the near future each user will be connected to the outside world through a Personal Assistant. At the moment we plan to have an additional specialized agent, called Trajectory Agent (TA), to manage the trajectory of a community member. Such an agent is an SA that will work mostly with the user's Personal Assistant, in other words, a Staff Agent for the Personal Assistant. It should save and present the information concerning a user's trajectory. We envisage the use of one Trajectory Agent for each community in which a given user participates. In this case, multi membership implies the use of various Trajectory Agents working for the user's Personal Agent.
Trajectory Agents can be used to indicate an affiliation to a community, e.g. whenever a user downloads such an agent to become a community member. Instead of paying a subscription, like in formal associations, candidates would download a Trajectory Agent to become member of a specific community.

All Trajectory Agents of a given user should be able to communicate and provide him, through his Personal Assistant, information about his participation in the various communities. This information would be obtained from other Service Agents.

The Service Agents should perform tasks like the analysis of emails, *blogs* and chats and the management of the peer recognition system. In this way, a Service Agent can monitor the number of messages and replies a user sends in a discussion forum. Another Service Agent could monitor how many times a *blog* is read and who the members that post comments in this blog are. A third Service Agent could monitor the participation in the community chat sessions, etc. All the Service Agents should be able to communicate with the user's appropriate Staff Agent. As OMAS is an open platform, other SAs can be added to provide different kinds of information characterizing a trajectory.

We expect that the coordinator of the community will need a Trajectory Agent for his own trajectory and an agent that allows him to follow the trajectories of other members. Such agents can be used to also monitor important changes in the participating patterns. For example, the coordinator should be able to ask his Personal Assistant information about the activities of a particular member during a given period of time. His Personal Assistant should contact the member's Staff Agent and ask for the information. The Personal Assistant should be able to ask another Service Agent to format and to present the information.

We envisage as a next desirable step to introduce Service Agents for analyzing the content of the contributions, allowing a more precise representation of a trajectory. We consider that although quantitative indicators could help community coordinator and core members to monitor the activity in community, other types of indicator are also desirables. For example, a question in the discussion board that becomes a FAQ in the community's home page represents an important contribution. Members that contribute in this way should be acknowledged and this should appear in some way in their trajectories.

5 Final Considerations

This paper presented a preliminary analysis of some possibilities to apply MAS for supporting CoPs. Participation in CoPs should not absorb too much time because CoP members are basically team members developing projects. Consequently the participation in CoPs should be facilitated. One way of doing this is to provide adequate technological tools. MAS with their flexibility and possibility of intelligent behavior seem to be a promising technology to support participation in CoPs. In particular, one of the aspects in which MAS could be employed is to monitor the TRAJECTORY of a member inside a community. Following this trajectory could help to assess the participation of a member and the vitality of a community. Because our prototype is not yet available, we cannot give concrete results. However, the preliminary analysis presented at this stage constitutes a theoretical framework to develop some ideas about using MAS technology.

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