Divergence Occurrences in Knowledge Sharing Communities

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Abstract. While knowledge-intensive communities are actively interacting, divergent knowledge positions appear as a natural consequence of the knowledge-sharing activity. Although this feature can look like an unfavorable situation, we argue that maintaining the coexistence with conflicts and following their evolution allows the community to understand how new knowledge emerges. In this paper, we discuss the knowledge sharing process where divergences occur and we propose a technological approach that allows communities to coexist with conflicts.

1 Introduction

This paper seeks to present an approach to supports divergent knowledge positions in the context of a knowledge intensive community that collaboratively develop it own memory.

Communities of practice have gained a particular interest in Knowledge Management due to their knowledge-intensive nature. Communities of Practice, as Wegner states in [9], are groups of people who share a concern, a set of problem, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis.

People find value in meeting this kind of communities because they become bound by the value they find in learning together. Because of their knowledge sharing activity, communities accumulate knowledge and develop a unique perspective on their topic as well as a body of common knowledge, practices, and approaches. However, before reaching a unique perspective, divergent positions appear as a natural consequence of the act of sharing knowledge. Divergence means the generation of alternatives, arguments and different point of views about a topic of interest. Divergences are generally considered as conflicts at the common understanding. The community can take different decisions to solve the conflict, but we are more interested in the situation where the community coexists with the conflict. In spite of this situation can be seen as unfavorable, it exactly describes how the agreed knowledge naturally emerges in the community by the simple act of sharing knowledge. Although the achievement of a consensus may or not happen, the main thing is the process that takes place while

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the community persists with a conflict. This process represents the discussion in which the participants are involved. It is an evolutionary process based on sharing knowledge.

From a general point of view, our approach centers on community technological supports that allow communities to accumulate knowledge at the same time they suitably share knowledge, and we specially focus the attention on allowing the community to deal and coexist with conflicts while it shares knowledge. In particular, we conceptualize this problem in a community that collaboratively develops its own knowledge repository. We also put forward a knowledge sharing workspace that allows: knowledge externalization through representing the shared knowledge by ontology formalism [6]; representing private and shared knowledge context, supporting publishing through bringing a contribution from the private to the shared workspace; and facilitates to express divergences and follow the discussion thread.

This paper is organized as follow. In section 2, we discuss the knowledge sharing activity paying special attention to the knowledge sharing process and identifying the nature of the shared knowledge. Next, in section 3, in the context of the knowledge sharing process, we introduce the problem of divergence appearance. Finally, in section 4, we will describe our approach for supporting knowledge divergences.

2 The Knowledge Sharing Activity

To achieve to a suitable support of divergence occurrences in a knowledge sharing community, first of all it is important to have a complete understanding of what is the knowledge that the community shares and a significant attention must be paid to the process that allows communities to share knowledge in a coherent manner. In the following, we will briefly describe the kind of knowledge the community share and we will analyze the features of the process throughout the community shares knowledge.

The Shared Knowledge. The shared knowledge is the knowledge that the community accumulates while the knowledge sharing process takes place and it represents the community's common understanding. The nature of the shared knowledge is varied. Communities do not only accumulate knowledge about a topic of interest, they also share knowledge about who are participating in the community, who knows what, who are interested in, level of expertise, perspectives, and more. All of them together are the shared knowledge. We classify the shared knowledge in:

Domain Knowledge. This is knowledge about the domain of interest or competence. It consists of conceptual elements and facts that conceptualize the domain. Community's domain knowledge also represents the consensual knowledge and the shared common language.

Social Knowledge. This is knowledge about members and their organization. Member's knowledge is knowledge about who is each member and their relationships. Members can be individuals or groups.

Members Profile. This knowledge describes interests, capabilities, and expertise of the community members. This knowledge is described in terms of the relationships that exist between the knowledge and people.

Community's knowledge could be seen as conceptual network that is made up of conceptual knowledge artifacts (domain and members knowledge) linked by associations between knowledge and people expressed by member profiles.

The Process. The knowledge sharing process is an iterative and incremental process, similar to the one described by Nonaka in [7], where knowledge goes emerging in each cycle. Knowledge sharing involves from the community point of view, individual and collaborative learning and from the knowledge point of view, knowledge evolution. This process begins when one member contribute with some knowledge, and continues when other members realize this, and begin to contribute with comments, and additional information that allows the community to have a more complete idea of the subject of the initial contribution.

The knowledge sharing process consists of four steps, externalization, submission, internalization and reaction.

Externalization means to make explicit some knowledge. Externalization is a private activity, which is carried out it in isolated manner at the individual knowledge context. Some knowledge representation system it is needed to make explicit the private knowledge. This knowledge representation can be informal or formal, going to informal systems (emails or document writing) to semi-formal systems that mixes a formal and a informal system classifying document in based on a ontology; or even to formal systems to develop a formal specification (using ontologies to design a knowledge conceptualization).

Submission/Publication is the act of making public some knowledge. Submission means to transfer some knowledge from the individual knowledge context to the community knowledge context. Publication has externalisation as pre-condition. The submitted element generally is called a contribution and the submitted knowledge is named the contribution subject. Communities can use different media for publishing their knowledge.

Internalization is an individual process, which takes place when someone realises and appropriates a new contribution - individual learning. At this moment, the contribution subject becomes part of the individual knowledge context. Internalization it is not easy to detect, but we can say that internalization took place if a reaction was manifested.

Reaction is the act of giving some kind of response to a contribution. Any reaction is an externalisation of an individual position in face of a new contribution. Reaction always gives an "augmented" version of the original knowledge subject because it is improved with new knowledge and even new point of view. Reactions are interesting to observe because they imply that internalization has taken place.

Although the four steps of the knowledge sharing process are interesting, we will pay a special attention to submission and reaction because they are the key to maintain the community learning together. Meanwhile the community is sharing knowledge; its knowledge context is constantly growing and evolving.

Each new contribution to the community knowledge is a step forward to a new community knowledge state.

3 Divergences in the Knowledge Sharing Process

While knowledge-intensive communities are actively interacting, divergent knowledge positions appear as a natural consequence of the knowledge-sharing act. In knowledge sharing communities, it is not so realistic to think that everybody is agree with everything that is told; whereas, it is very often to observe people that express different positions or argumentations in the context of the same knowledge subject. Therefore, to coexist with knowledge divergences is very natural in any knowledge intensive community.

Occurrences of divergence are consequence of reaction, where each contribution by reaction represents an "augmented" version of a initial contribution. Reactions always are tied to an initial contribution. A sequence of reactions corresponds to a sequence of contributions triggered by an initial contribution. This sequence begin with an initial contribution and follows by a set of contributions by reaction.

Adapting the Ibis model [3] to our needs, we define different kinds of contributions by reaction: complementary contribution, alternative contribution and argumentations.

- *Complementary contributions* always add more knowledge to the original one and do not imply any divergence.
- *Alternative contributions* are contributions created with the intention of replacing the original one. They introduce another point of view on the knowledge subject. An alternative contribution manifest always conflicts.
- *Argumentations* give a personal opinion that supports or object any given contribution. Argumentations are always attached to some contribution.

Contributions are organized in the *discussion thread*. A sequence of contributions, triggered by an initial contribution, represents the discussion thread at one particular moment in the knowledge sharing process. Discussion threads represent the history of the reactions tied to an initial contribution. Threads act as the continuous link of the discussion. As reaction can occur over any kind of contribution, we define the thread of discussion as an aggregation of complementary and/or alternative contributions. Alternative contributions correspond to different branches in the thread structure. Each branch can be seen as a sub-thread of the original contribution. The discussion thread also holds the argumentations that are attached to contributions. Therefore, a thread looks like a tree where the root represent the initial contribution an each branch represents an alternative in the knowledge discussion. Although given the thread definition allows one to imagine the thread structure as a deep tree it is not so realistic to think that in the real life the thread structure can grow in depth so much, because of going in depth in the tree means to follow the discussion on a subject that has not be reached by consensus.

4 Supporting Divergence in a Knowledge Sharing Workspace

There are many approaches to support knowledge sharing. Wenger enumerated in [9] many technologies already used by on-line communities like home pages, on-line discussion groups, collaborative-shared workspaces, document repositories. There are also many technologies for supporting community's knowledge sharing where the community develops it own group memory. However, there are not many systems explicitly oriented to communities of practice that support divergence. Existing ones only focus on one or more aspects of the whole picture. For example, systems based on Ibis model, like G-Ibis [2] and currently Questmap [3] or even, WebGuide [8] may be considered as an approximation to this problem, but they emphasized more in modeling the discussion, that in supporting suitably the occurrence and evolution of divergences.

In particular, we are interested in those that allow the community to develop its own community's memory with the capability of expressing divergences. The community memory is a knowledge repository where the shared knowledge is stored. For achieving this, the community needs a knowledge sharing workspace that supports the knowledge sharing process with following requirements:

- *Knowledge representation formalism.* For externalization, it is mandatory to define a mechanism that allows one to make explicit the knowledge. This formalism is embedded in the knowledge sharing workspace and define the type of the allowed actions.
- *Representation of private and shared knowledge context.* People need to differentiate between private and shared knowledge. Knowledge externalization is a private activity, whereas publication and community's memory development are public activities.
- *Knowledge discussion thread.* The discussion thread is the result of expressing conflicts. Conflicts are characterized depending on the knowledge representation formalism, therefore the knowledge sharing workspace needs mechanisms that facilities appropriately the expression of them.
- *Discussion awareness.* Internalization facilities are needed to have a suitable awareness about knowledge changes and discussion evolution.

In our approach, we focus in a community technological support that allows a community to share and make explicit its accumulated knowledge. In particular, we conceptualize this problem in a community that collaboratively develops its own memory through the design of the ontologies [6] that represent the shared knowledge. Following we will discuss this requirement in the context of a community that develop its memory where knowledge is represented by ontologies.

4.1 Supporting Divergence in a Collaborative Ontology Design

Currently, there are some approaches for design ontologies collaboratively, like Protege approach [5], but they lack of facilities to represent the private and public

knowledge context and to follow the knowledge discussion and its evolution. Here we will present our approach that take into account the requirement presented above.

Using Ontologies for Externalizing Knowledge. Although there are different systems to represent the knowledge, we had chosen ontology formalism, because ontologies allow developing a conceptualization of the domain of interest and describing common language among communities' members. Then, this knowledge can be browsed, queried and used to make deduction about the community shared knowledge.

When the community externalizes its knowledge with ontologies, it makes a conceptualization of its shared knowledge. This conceptualization is based on objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that are held among them [1]. A conceptualization is an abstract, simplified view of the world, which is be specified for some purpose.

Ontologies to represent any shared knowledge, but the community only focuses on the collaborative developing of the *domain knowledge ontology*, since it is the knowledge the community must to conceptualize. Whereas, other knowledge, like social or member profile, has already a predefined conceptual level. Therefore, the domain ontology is the result of the collaborative processes to build the community memory. This ontology is the core of the community's memory, and it is the shared objects among community's members while they share knowledge.

Therefore, a contribution, in the knowledge sharing workspace is a conceptualization of the knowledge subject externalized in terms of ontology primitives, that we will call ontological contributions.

Knowledge Sharing Workspace. Knowledge sharing workspace consists of two workspaces: a private knowledge workspace and a shared knowledge workspace, where participants can alternate between both of them.

The *private knowledge space* is a non-public space that is only accessible by its owner and is useful to represent the private knowledge context and allows participants to externalize any knowledge in a private fashion. Private knowledge is also articulated with personal view of the shared knowledge space. A private knowledge becomes public by publishing it from the private to the shared workspace.

The *shared knowledge workspace* is a public space that is accessible to any community member and is useful to represent the shared knowledge context. It holds the shared knowledge. It allows user to publish some private externalization as any contribution type, and beginning or following a discussion thread.

Knowledge Discussion Thread. As ontologies are use to externalize the knowledge, in the following, we discuss how the collaborative ontology development is carried out on the top of the shared knowledge workspace. In particular,

we explain how divergences are manifested in terms of ontologies and when they happen.

The collaborative ontology development occurs through the edition of ontologies at the private workspace (knowledge externalization), and their publication at the shared workspace. Edition of ontologies occurs at private level and is carried out through directly manipulation of ontology primitives; whereas, ontological contribution means to publish a piece of an ontological representation of the knowledge that is held at private knowledge context.

A new contribution has to be *compatible* with the shared version; otherwise, it may be a potential conflict. Conflict may appear when there are at least two versions of the same shared-knowledge, this means there is a private version that is not compatible with the shared version, and it would be published.

In order of detecting conflicts we have follow a conflict detection approach that categorizes the edition operations. This categorization is based on a set of conservation rules. These rules allows us to determine if an edition action can provoke a conflict, if it is the case, participants must publish it as an alternative contribution. Notice that this rules are dependent on the knowledge representation system, each knowledge representation system has its own set of rules.

Therefore, an ontological contribution, in the context of the discussion thread, can be a complementary conceptualization of an initial ontological contribution if it does not provoke any conflicts, or an alternative conceptualization to an existing one if it provokes conflicts. Arguments that support or object some previous ontological contribution are also part of the discussion thread.

Discussion Awareness. In short, we can say the activity on a community is summered to externalizations and contributions, but it is also important to maintain the context where they take place, since it defines if it is a reaction. To determine if a contribution is a reaction is very useful since it gives information to follow the discussion thread, because of identifying if a contribution follows or not discussion thread allows providing the users with awareness information about the flow of the discussion.

There are some cases where to identify if a contribution is a reaction is very easy because it is explicitly expressed (for example the user decides to submit them as an alternative contribution when the system detect the conflict). However, there are other cases where to determine the occurrence of reaction can be more complicated are not explicit like complementary contribution.

We propose the design of a thread manager component that allows users to act more free without managing the discussion thread but feeling it. To reach this goal is necessary to determine the contribution context, this means to understand if a contribution is a trigger of a new thread or not. For determining if a new contribution is a trigger or not, it is necessary to understand if it is related to a previous contribution in terms of: the involved knowledge element (it touches some of the more recent contributions, the performer (it was carried out by the same member), the type of contribution (argumentations are always attached to a previous contribution), or may also be the submission/publication time.

5 Conclusions and Future Works

In this paper, we have introduced the problem of sharing knowledge in a knowledge intensive on-line community, and in particular, we have centered on the problem of divergence occurrences. We have introduced technological requirements to support to develop the community memory that support conflict expression. In particular, we conceptualize this problem in a community that collaboratively develops its own knowledge repository through the collaborative design of the ontology. On the top of a collaborative workspace for developing a knowledge repository, we put forward a knowledge sharing workspace that allows knowledge externalization through representing the shared knowledge by ontology formalism; represents private and shared knowledge context; and where is able to alternate between them; supports publishing through bringing a contribution from the private to the shared workspace; and facilitates to follow the discussion thread.

At the moment of writing this paper we are implementing a prototype system on the top of Protege, that supports previous requirement. Next steps, it is evaluate the usability of the system.

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