

## **Supporting Knowledge Sharing in a Community with Divergence**

**Alicia Díaz**<sup>1,2</sup>

<sup>1</sup>Lifia, Fac. Informática- UNLP, CC 11, 1900 La Plata, Argentina  
alicia@sol.info.unlp.edu.ar

**Gérôme Canals**<sup>2</sup>

<sup>2</sup>Loria, Campus Scientifique, B.P. 239, 54506 Vandœuvre-lès-Nancy cedex, France  
canals@loria.fr

**Abstract:** In this paper, we propose a technological approach that allows communities to coexist with conflicts and leaves that agreed knowledge emerges naturally, by the simple act of sharing knowledge. On the top of a collaborative workspace for developing a shared knowledge repository, we put forward: a mechanism for maintaining the discussion threads, a knowledge awareness mechanism to be up-to-date about discussion threads and their evolution, and a user centred workspace to support personal view of the shared repository with the capability of adding private knowledge.

**Keywords:** Knowledge Sharing, Discussion Threads, Groupware, Knowledge Awareness  
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### **1 Introduction**

Currently, knowledge intensive communities, like communities of practice<sup>1</sup>, have gained a particular interest in Knowledge Management due to their knowledge-intensive nature. People find value in meeting this kind of communities because they typically share information, insight, and advice. They help each other to solve problems, they discuss and explore points of view and ideas or simply they develop a tacit and shared understanding. They become bound by the value they find in learning together.

As a consequence 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 [Brown, 95]. 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. Divergence is generally considered as a conflict at the common understanding. The community can take different decisions to solve the conflict. For example, it can delegate the decision to a knowledge manager, to vote or even to use an automatic mechanism. We are more interested in the situation where the community coexists with the conflict. In spite of

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<sup>1</sup> Communities of Practice 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 [Wenger, 02].

this situation can be seen as unfavourable, it exactly describes how the agreed knowledge emerges as consequence of the simple act of sharing knowledge. Although the achievement of a consensus may or not happen, the most important thing is the process that takes place while 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.

There are many community-oriented technologies for supporting community's knowledge sharing, like knowledge repositories [Abecker, 99] or version control systems for supporting some kind of divergence, but they only focus on one or more aspects of the whole picture. For example, systems based on Ibis model [Werner, 70], like G-Ibis [Conklin, 88] and currently Questmap [Conklin, 01] may be considered as an approximation to this problem, but they emphasized more in modelling the discussion, that in supporting the occurrence of divergence and its evolution.

In this paper we propose an approach that allows communities to coexist with conflicts and leaves that agreed knowledge emerges naturally, by the simple act of sharing knowledge. On the top of a collaborative workspace for developing a knowledge repository, we put forward: a mechanism for maintaining discussion threads, a knowledge awareness mechanism to be up-to-date about discussion threads and their evolution, and a user centred workspace to support personal view of the shared repository with the capability of adding private knowledge. In the following sections, we will present how these tools work altogether in order to facilitate knowledge sharing with the coexistence of divergences. In particular we conceptualise this problem in a community that collaborative designs an ontology [Gruber, 93] that conceptualises its shared knowledge.

First, we present in section 2, the knowledge sharing process to place the occurrences of divergence. Then in section 3, we will propose a framework that integrates the discussion thread management, knowledge awareness mechanism and user-centred workspace to allows community to share knowledge suitable and permits knowledge emerge naturally.

## 2 The Knowledge Sharing Process and Divergence Occurrence

The knowledge sharing process is an iterative and incremental process that is performed repeatedly and consists of four steps: externalisation, submission/publication, internalisation and reaction [Nonaka, 94]. These four steps are executed in this order and they eventually describe an iterative process.

**Externalisation** means to make explicit some knowledge that is at the individual knowledge context. This knowledge can be concrete knowledge, an idea, a point of view or an argument. In the future we will refer to all of them just only the "knowledge". Externalisation is a private activity, which is carried out in isolated manner. 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, like emails or document writing, to semi-formal systems like OntoShare [Davies, 03] 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 to develop a knowledge conceptualisation. In particular, we will use a formal system like ontologies.

**Submission/Publication** is the act of making public a new knowledge. Submission corresponds to the transfer of knowledge from the individual knowledge context to the community knowledge context. The act of submitting an externalised knowledge generally is called a *contribution* and the *subject* of the contribution is the involved knowledge. Communities can use different media for publishing their knowledge. For example, a scientific community formally writes papers and communicates them through conference, journals, etc, whereas on-line communities publish their ideas by forums, chatting sessions, list of interest, etc. In particular, we will use an ad-hoc publication mechanism that is native of our system that allows publishing knowledge, and even knowledge divergences.

**Internalisation** is an individual process, which takes place when someone realises and appropriates the subject of a new contribution - individual learning. At this moment, the new subject becomes part of the individual knowledge context. Internalisation it is not easy to detect, but if someone reacts (next paragraph) to a new contribution, then he/she has internalised this contribution.

**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 internalisation has previously taken place.

Reactions always are tied to an initial contribution. Reaction can be private, this means that it only produces some change at individual knowledge context; or it can be public when it affects community knowledge context. A private reaction corresponds to an externalisation, while a public reaction also involves publication.

Public reactions, by introducing a new externalisation followed by its respective publication, provoke iteration in the knowledge sharing process. In other words, a sequence of reactions corresponds to a sequence of contributions triggered by an initial contribution. This sequence begins with an initial contribution and follows by a set of contributions by reaction.

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 in evolution. Each new contribution to the community knowledge is a step forward to a new community knowledge state. Knowledge evolution occurs in long term as consequence of the knowledge sharing activity.

To conclude, knowledge sharing process is an iterative process where knowledge goes emerging in each cycle. Besides, knowledge sharing activity involves from the community point of view, individual and collaborative learning and from the knowledge point of view, knowledge evolution.

## 2.1 Divergence Occurrences at the Knowledge Sharing Process

Meanwhile communities are active, divergent knowledge positions appear as a natural consequence of the knowledge-sharing activity. 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 to the same knowledge subject. Therefore to coexist with knowledge divergence is very common in any knowledge intensive community.

In the context of CSCW, as it is stated in [Dourish, 95], the problem of divergence is considered more as a problem of synchronization and versioning. But in our approach it is a problem of coexisting with the conflict with the aim of leaving the community free for evolving in its knowledge domain.

Appearance of divergence occurs as consequence of reaction, where each contribution represents an “augmented” version of the initial contribution. Adapting the Ibis model [Werner, 70] 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 and they introduce another point of view about the knowledge subject. An alternative contribution manifests always a conflict.
- *Argumentations* give a personal opinion that supports or object any given contribution. Argumentations are always attached to some contribution.

A sequence of contributions, triggered by an initial contribution, represents a 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; this means that once a thread has been triggered by an initial contribution, it will be augmented by more contributions. 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 and 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 been reached by consensus.

### 3 Supporting Knowledge Sharing with Divergence

As we have already mentioned at the introduction [Section 1], we are interested in an approach to support knowledge sharing that allows the community to develop its own community’s memory. We focus in a community technological support where the community can share and make explicit its accumulated knowledge; and where it also can deal and coexist with conflicts meanwhile it share knowledge. In particular, we conceptualise this problem in a community that collaboratively develops its own knowledge repository through the design of ontology [Gruber 93]. In this context, we propose a collaborative workspace that allows participants to:

- to contribute with new knowledge and point of views. The community needs a shared workspace where it can build collaboratively its own knowledge repository by externalising and publishing knowledge.
- to represent private and public knowledge space. Public knowledge space represents the shared knowledge context, but private knowledge space

represents the individual knowledge context and is a user-centred workspace where individual can express himself privately.

- to manage knowledge contribution threads automatically. A contribution thread has a nested structure that should be easily navigable in order to get different alternatives, point of views, and arguments without hard cognitive efforts. Any new contribution should be set in context according to its discussion thread.
- to be aware about what is going on with the contribution thread. A knowledge awareness mechanism facilitates knowledge internalisation, because members are aware about new knowledge occurrences. But here in particular, knowledge awareness gives information about what is going on with contribution threads. Knowledge awareness must be according to personal interest and the context of the contribution.
- to know member's profile (interest) and its evolution.

In following sections, we present our approach to deal with these functional requirements to shares knowledge with diverges.

### 3.1 Knowledge Sharing Workspace

Communities use a shared workspace where they can build collaboratively their own knowledge repository by externalising and publishing knowledge. We use ontologies to externalise the knowledge, in consequence the knowledge sharing activity consists only on the collaborative design of the ontologies that represent the accumulated knowledge. Ontologies are used not only for representing knowledge about the domain of interest, but also about community's members, community organization (groups, roles) and even members' interest and skills.

A contribution, in the context of the shared ontological knowledge repository, means to give an ontological conceptualisation. Ontological contribution means to publish a piece of an ontological representation of the knowledge that is held at private knowledge context. An ontological contribution, in the context of the discussion thread, can be a complementary conceptualisation of an initial ontological contribution, or an alternative conceptualisation to an existing one. Argumentations are also contributions but they are not expressed by ontologies.

Edition of ontologies is carried out through directly manipulation of ontology primitives. We use a workspace that is an adaptation of Protégé [Grosso, 00] environment for detecting conflicts and also for supporting the visualization of private and public knowledge.

### 3.2 Individual and Shared Knowledge Space Management

Knowledge sharing workspace consists of two workspaces: a private knowledge workspace and a shared knowledge workspace. This workspace allows alternating between the both workspaces, in order to support the alternateness between the shared and private knowledge context. The collaborative ontology development occurs through the edition of ontologies at the private level, and their publication at the shared level.

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. Each community member can have a private knowledge space and it allows users to externalise any

knowledge in a private fashion. Private knowledge space contains private knowledge: personal knowledge, point of view, and alternatives. Private knowledge is also articulated with personal view of the shared knowledge space. Private knowledge is not part of public knowledge; however shared knowledge can be part of private knowledge. We also name private knowledge as private knowledge version. A private knowledge becomes public by publishing it from private workspace to the shared one.

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 or public knowledge version. It allows user to publish any private knowledge as a contributions. Contributions to the shared space come from private spaces and represent knowledge that was externalised in the private spaces. Any contribution to the shared space can be a spontaneous contribution (initial contribution that's triggers a new discussion thread) or a contribution related with a previous one (that follows the discussion thread); in the last case, they can be complementary or alternative contributions or arguments.

### 3.3 Facilities to maintain thread of knowledge contributions

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 an alternative contribution to an existing one), but there are other cases where to determine the concurrency of reaction can be more complicated are not explicit like complementary contribution.

Thread management allows users to act more free, without managing the threads but feeling them. 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.

Thread manager works in collaboration with the awareness mechanism we will introduce in [Section 3.4].

### 3.4 Being Aware of Knowledge Sharing Activity and Contribution Thread

In the context of the knowledge sharing process, we define *knowledge awareness* as the needed awareness for knowledge-intensive communities to keep it up-to-date about the shared knowledge [Diaz, 03], whereas traditional awareness gives information about the collaborative activity [Dourish, 92]. Knowledge awareness:

- allows a better understanding of the shared knowledge; it gives information about new knowledge contributions;

- induces participants curiosity; it is well known as the key for learning process takes place, and it becomes the seed of knowledge internalisation;
- promotes that knowledge emerges. It is a natural consequence of curiosity induction. Members are constantly articulating received awareness information with her/his private knowledge and it is the source for the generation of new individual knowledge; and finally,
- helps knowledge evolution understanding; members are kept up-to-date about knowledge progresses through the knowledge sharing activity.

Knowledge awareness must pay a special attention to the *relevance* of a contribution (knowledge quality, contributor, activity quantity) and *contributor's profile*. Understanding contribution relevance means to deduce the intention of a contribution in the context of the discussion thread. In order to achieve this, knowledge awareness mechanism works as follow: first, it captures the *activity context*, then, it generates the *contribution context* and finally it is delivered to the community. For determining activity context, knowledge awareness mechanism collects information about what was the performed *action*<sup>2</sup>, *who* has performed it, and *what* knowledge is involved.

The contribution context is deduced in terms of *what* was the knowledge sharing action, *who* has carried out it and in collaboration with whom; *where*, at what knowledge level and what other knowledge is involved; *when* the contribution takes place; *how*: what tools were used; and finally *why*, the intention of this contribution. In particular, to determine the *why* component is very useful, because it helps to put the contribution in the context of the discussion thread. We use an adaptation of aggregation model that was described in [Bouthier, 04], where we have added the notion of thread. Although, in our approach, aggregation mechanism is used to deduce activity context, here it allows us to deduce contribution context.

Finally, awareness information delivering is made according each member interest. Delivering mechanism pays attention to the receiver context; this means it filters awareness information according to members' profiles and their interest in the discussion thread.

### 3.5 Members' Profiles

Member profiles represent members' interest, skills and responsibilities at community organization. Member profiles are used to maintain their private views and also by the knowledge awareness mechanism. Although, each member can define member profile explicitly, we use a profile manager that can follow member evolution based on member action.

The profile manager is the component responsible to maintain members' profiles. It uses the contribution context to learn about members' activity, intention, interest, abilities and to maintain members' profiles and follows their evolution in the knowledge sharing activity.

This mechanism is the responsible of interpreting member action in order to deduce member interest and abilities. For example, if a user contributes with, comments or selects a piece of knowledge, it can deduce member interest at this piece

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<sup>2</sup> Actions are those available functionalities in the shared knowledge workspace.

of knowledge. Beside, paying attention to the level of participation of the member in the discussion thread, profile manager determines his/her interest on the thread.

## 4 Conclusions

In this paper we propose an approach that allows communities to coexist with conflicts and leaves that agreed knowledge emerges naturally by the simple act of sharing knowledge. In particular, we conceptualise this problem in a community that collaboratively design an ontology that conceptualises its shared knowledge.

On the top of a collaborative workspace for developing a knowledge repository, we have proposed: a mechanism for maintain the threads discussions, a knowledge awareness mechanism to be up-to-date about discussion threads and its evolution, and a user centred workspace to support personal view of the shared repository with the capability of adding private knowledge. Although, in this paper we could not give much more details of the different issues, we have attempted to present how these tools work altogether in order to facilitate knowledge sharing and divergence occurrences.

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