Facilitating Experience Sharing in Groups
Collaborative Trace Reuse and Exploitation

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Abstract: In the context of a web-based collaborative working environment, any interactive activity among the actors themselves or between the actor and the system in the collaborative workspace produces a set of Collaborative Traces (CT). A collaborative trace reflects the group's working experience from past actions. Indeed, systematical experience reuse in organizations can sustain the complex project completion and problem solving by exploiting collaborative traces. This paper proposes a method and fundamental principles to enhance the exploitation of collaborative traces. Grounded on our previous work that defined a collaborative trace and proposed a corresponding model, we define a model of complex filter and discuss its possible functionalities according to the real needs and constrained by technical restrictions. The filter is the primary way for facilitating collaborative trace reuse. Using a collaborative platform E-MEMORAe2.0, we apply our model and validate several complex filters in two practical situations.

1 INTRODUCTION

Due to the rapid changes in information technology, people can work together using new and faster web-based collaborative working environment (CWE) with less restrictions due to time or geographic position, and even to language or culture. Such environments can strongly promote and enhance different aspects of computer-supported cooperative/collaborative work, e.g. the process of organizational knowledge management, group communication or decision making. In a typical collaborative workspace, users can send email, edit wikis, share documents or have a video conference, and all such interactions with the systems or with other members of the group leave collaborative traces that contain information about the collaborative activities (Li et al., 2012a), (Li et al., 2012b). Indeed, research issues concerning traces is at the intersection of the three fields of study: Knowledge Management(KM), Information Sharing(IS) and Experience Management(EM).

In this article, we do not intend to discuss the three important concepts in the IT literature, but accept the common definitions: information is "process data" (Zins, 2007), knowledge is "authenticated information" (Dretske, 1981), (Machlup, 1980) and experience is "a special case or a refined form of knowledge in a higher level" (see (Sun and Finnie, 2005) and (Schneider, 2009)). According to Clauzel and his colleagues, traces can be considered as a kind of "knowledge sources" to represent users' experiences in synchronous collaborative learning activities (Clauzel et al., 2011). Moreover, Mille and his team claim that the knowledge of both individual and group can be captured from the modeled traces (Champin et al., 2004). Later, they explain that interaction traces reflect experience more than simple knowledge for complex task support in computer-mediated environment. Meanwhile, they propose a framework to assist Trace-Based Systems creation (Laflaquière et al., 2006). Further, Laflaquière et al. state that the type of trace from the past interactions can be applied to measure the personal experience (Laflaquière et al., 2010).

In the domain of personal experience management, the above research works greatly enrich the trace theory and also provide rich directions for the practical applications. However, not enough attention is given to the issue of experience sharing and reuse for *group* in *collaborative working environment*. In the context of CWE, this issue concerns three aspects

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of group experience management: (i) defining different kinds of trace in group; (ii) modeling these traces with a view to support collaborative work; (iii) exploiting the defined traces in line with the group and personal needs. Although the interactive activities in CWE are numerous and intricate, the main one is collaboration. Thus, the trace from collaborative activities is named "Collaborative Trace (CT)" and defined as follows: "A Collaborative Trace is a set of traces that are produced by a user belonging to a group and aimed at that group" (Li et al., 2012b). This article is based on our previous research results (the CT definition and the CT model, refer to (Li et al., 2012a) and (Li et al., 2012b)), and concentrated in some possible methods to exploit and reuse the collaborative trace.

This paper is structured as follows: Section 2 describes some remarkable definitions and projects of Trace in the literature, and the definition of collaborative trace is reviewed; Section 3 explains the collaborative activities in shared workspace and recall the principals and some basic notations of our proposed collaborative trace model; Section 4 analyzes the various possibilities for exploiting collaborative traces in group spaces and introduces several practical examples; Section 5 cover the evaluation of our model and the exploitation process in the collaborative platform: E-MEMORAe 2.0; Finally, we conclude with a summary and discuss future work in Section 6.

2 DEFINITION OF A TRACE

In the world of nature, usually, a trace is a mark, an indication or an object denoting the existence or passing of activities, e.g. a series of animal footprints in the wood. It strongly relies on the effective "actions" and the surrounding "environment". As a stretch of the original meaning, in the domain of computer science, a trace always comes from the observation of the interactive activities between the user and the system. Almost a decade ago, Mille and his colleagues proposed an approach named Musette (Modeling USEs and Tasks for Tracing Experience, see more details in (Champin et al., 2003), (Champin et al., 2004)). The objective of Musette is to "capture a user trace according to a general use model describing the objects and relations handled by the user of the computer system". In this case, primitive trace is collected and analyzed as a "task-neural knowledge base" for the experience reusing to support user's reflexivity. What's more, a generic framework for experience modeling and experience management are mentioned and discussed in details (Champin et al., 2003), (Champin et al., 2004). Indeed, trace[1] is considered as a variable or a tool to measure the user's experience for the past interactions.

On the basis of their results, Laflaquière and his colleagues found that the trace can be used to solve some of the important issues in experience management, e.g. "the activity reflexivity and the experience reuse". They defined a trace as "temporal sequences of observed items". Besides, a framework was introduced to support the Trace Based Systems (TBS) that focused on the processing of trace exploitation (Laflaquière et al., 2006). With minor variance, Clauzel and his colleagues defining an interaction trace as: "histories of users' actions collected in real time from their interactions with the software" (Clauzel et al., 2009). Zarka et al. defined a trace of interaction as " a record of the actions performed by a user on a system, in other words, a trace is a story of the user's actions, step by step" (Zarka et al., 2011). In the TRAIS project (Personalized and Collaborative Trails of Digital and Non-Digital Learning Objects)[2], the researchers analyze a trace that can be considered as a sequence of actions in an hypermedia environment to identify the users' overall objective. From another perspective, Settouti et al. defined a numerical trace as a "trace of the activity of a user who uses a tool to carry out this activity saved on a numerical medium" (Settouti et al., 2009). They applied the framework of trace-based system in Technology-Enhanced Learning (TEL) Systems that can meet the needs of personal services.

From the definition of interaction trace, we introduced the new concept of Collaborative Trace (CT) and recall its definition: "A Collaborative Trace is a set of traces that are produced by a user belonging to a group and aimed at that group" (Li et al., 2012b). In the following section, a brief summary of our collaborative trace model (Li et al., 2012a) (Li et al., 2012b) is provided with some basic notations.

3 COLLABORATIVE ACTIONS IN GROUP SHARED SPACE

3.1 Collaborative Activities

A collaborative working environment (CWE) represents a kind of computer-supported working environment that "consists of a network of spatially dispersed actors (either humans or not) that play different roles

[1] In this article, we do not make a difference between trace, interaction trace and trace of interaction unless explained in particular.

[2] http://www.noe-kaleidoscope.org/telearc/

and cooperate to achieve a common goal"(Angelaccio and D'Ambrogio, 2007). It stems from the concept of "virtual workspaces" (see (Schaffers et al., 2006)) and can be used to assist both the individual work and the cooperative work, e.g., e-work and e-professional (Prinz et al., 2006b). With various information and communication technologies and tools, group users could conduct their collaborative work through the CWE (Prinz et al., 2006a). Actually, very basic factors found in CWE facilitate knowledge and information sharing in group (Patel et al., 2012).

In software engineering principally, collaborative activities can be divided into four types: "Mandatory, Called, Ad hoc, and Individual" (Robillard and Robillard, 2000), e.g. the scheduled video conference, sending e-mail, or document management. For a typically CWE, most of these activities happen in the collaborative workspace (shared workspace) (Martinez-Carreras et al., 2007). With the popularity of Internet and the development of wireless technology, there are less limitations due to time or space for participants, therefore, CWE inherits and extends this idea from the design theory of groupware. In the early research stages, a shared workspace is designed as "a form of an electronic white-board" that helps collaborators draw or write (Whittaker et al., 1993). Without a doubt, communication (e.g. video and audio conference) and information sharing (e.g. exchanges of messages or files) are one of the elementary parts of shared workspace functions. In addition to this, during the past decade, knowledge management (e.g. document management, group wikis and task management) and application sharing (work in the same application in real-time) have expanded the functionality of CWE and added new features to the shared workspace.

All interactions or actions that concern diverse functionalities of CWE in the shared workspace can be recorded by traces. Thus, a trace model is necessary and strongly required in the process of experience management. It is not only the historical list that shows the user's past actions, but also the previous "experiences" to help perceive and interpret clearly his interactions with systems. The trace model that was proposed by Clauzel and his colleagues (Clauzel et al., 2009) for the project ITHACA represents and visualizes traces in the context of synchronous collaborative learning platforms. To address similar issues, Lafifi (Lafifi et al., 2010) and his colleagues introduced a trace model for the project SYCATA that they concentrated on the whole architecture of the collaborative learning system. In a different approach, the trace model was proposed by Sehaba (Sehaba, 2011) and deals with the transformation process for the adaptation of the shared trace in accordance with the user's profile. For CWE, a collaborative trace model could facilitate analyze and reuse knowledge and experience in group. It focuses on the activities that involve or engage the collaborators in group shared workspace.

3.2 Collaborative Trace Model

Before explaining our model, a simple example is introduced. Suppose that in an established CWE, some engineers collaborate within a project. John finds a crucial problem that may be helpful for all the group members. So, first of all, he sends a mail to the group (every member in this group), then creates a new entry on this issue in group's wikis, and finally shares his solution (a pdf document) in the group workspace. In the meantime, Tom and Peter, whose views are similar but different from John's on this problem, both request a video conference with John in the reply email. John receives the emails and agrees on a video conference with Tom and Peter. At last, they obtain a satisfactory answer for this problem in the subgroup meeting.

Thinking back the meaning of an interaction trace, apparently, there exist three basic factors concerning the trace: (i) "Emitter" who produces the trace; (ii) "Receiver" who obtains the trace (the target of the trace); (iii) "A property and a corresponding values", that are the elements of the active environment where the trace is generated and utilized. In practical web-based CWE, the definition of "Emitter" and "Receiver" depends on the structure of the collaboration group. A collaboration group is generally defined as *a set of some users with a same collaborative objective*:

$$g_j = \{u_i, u_k, ..., u_m\}$$

and may contain several subgroups and independent users. Moreover, a single user can be considered as a special type of collaborative group (a group of one person): $g_i^0 = \{u_i\}$.

Therefore, a trace is formally defined as:

$$t_{i,j}^k = < E_i, D_j, Q_k >$$

where $t_{i,j}^k$ is the kth trace sent by the ith Emitters E_i (a set of users), and received by the jth Receivers D_j (a set of users), and Q_k is a subset of pairs of the set Q, each element including a property and a value. Different situations of Emitters and Receivers lead to identify three types of traces (Li et al., 2012a).

3.2.1 Collaborative Trace

A collaborative trace can be regarded as a type of trace that satisfies the conditions:

$$E_i = g_i^0 = \{u_i\}$$

and

$$D_j \neq g_i^0$$

This means the trace is the result or the effect of an operation that has been done by a "Emitter" and then flows to another user or to a group. In particular, we can classify different types of collaborative traces based on the relations between "Emitter" and "Receiver":

i) The trace is produced and transferred within a group:

$$u_i \in g_k, D_j \subset g_k$$

That is to say, the emitter is belonging to the receivers group. However, the relations between D_j and g_k indicate that there exist two types of sub-situations:

- (a) The trace is between the subgroups:

  $$u_i \in g_k, D_j \subseteq g_k$$

  For instance: a member sends an email to several group members that constitute a subgroup. This type of trace records the collaborative activities in subgroups.

- (b) The trace is inside the whole group:

  $$u_i \in g_k, D_j = g_k$$

  For example: a member announces the details of the project schedule in group (that a message is sent to all the group members). All the group's activities are recorded by this type of trace.

ii) The trace is between two groups:

$$\exists g_k, u_i \notin g_k$$

and

$$D_j \subseteq g_k$$

For instance: some groups work together for a project, and documents or messages are shared between groups. In Figure 1, we can clearly see the differences between such traces.

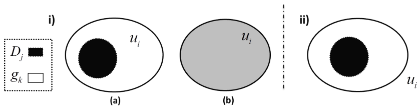

Figure 1: Example of two types of collaborative trace.

In order to analyze and reuse collaborative traces, a *filter* is applied as a tool or a pattern in the CT model. The basic component of a filter is the extractor (operators to access some part of the trace), then the elementary filters, and last, the complex filter (a combination of elementary filters) (Li et al., 2012b). As a matter of fact, the most important part is the design of elementary filters. It can be considered as a predicate testing the value associated with a specific property. There may be many elementary filters associated with a single property. Formally, an elementary filter is defined as:

$$\xi : V \times V \rightarrow B, \; where \; B = \{true, false\}$$

With the elementary filters, we can analyze a set of particular traces according to our needs: $\{t \mid \xi_j^k(\alpha(t, p_j), v_m)\}$, where α is the value extractor, and ξ_j^k is one of the operators associated with property p_j. v_m is a reference value. For example: we'd like to find the traces that mention female members in the group. We apply

$$\xi_{sex}^{member} \equiv female - member(\alpha(t, sex), female)$$

Concisely, a collaborative trace model is a triple structure: (G, Q, Ξ), where G is the set of users: $G = \{g_j\}$, that for $\forall E_i \subset G, \forall D_j \subset G$, they meet the conditions: $E_i = g_i^0 = \{u_i\}$ and $D_j \neq g_i^0$. Q is a set in which each element includes a property and a value: $Q = P \times V = \{< p_l, v_m >\}$. P is a set of properties (attributes of environment) and V is a set of values : $p_l \in P$ and $v_m \in V$. Z is a set of elementary filters: $\Xi = \{\xi\}$. Indeed, the processes of programming can be greatly simplified by the formulaic model of collaborative trace.

4 EXPLOITATION OF COLLABORATIVE TRACES

Continuing the example above: (i) Naturally, the email that is sent to the group by John is stored in the group shared workspace, but has it been read by all the members in group or just by a single person? Same question for the shared pdf document: did they open and view it or not? (ii) If Tom or Peter were absent, it would affect the results of the video conference with John? In other words: do Tom and Peter have the same competence on this problem and any one of them could be substituted for the other? (iii) Actually, John, Tom and Peter collaborate together and can be regarded as a subgroup. Were the others in the group satisfied by their answers to the problem? Is the new added entry in the group wikis really helpful for their project? In CWE, such questions are common but difficult to answer. They are directly relevant to the issue of CT exploitation.

As we explained in Section 3, collaborative traces record past interactive activities in a group shared workspace and can be used as tools to enhance an application, to generate adaptive scenarios and to assist members in their collaborative tasks. In general, the collaborative activities produce more information and knowledge than personal states. Therefore it may create a large number of CTs in the group space. Elementary filters are limited, when screening and analyzing a large amount of CTs against actual demands. A complex filter is thus proposed and designed to help addressing this issue. It is defined as a logical combination of elements of Ξ (Ξ is the set of elementary filters, $\Xi = \{\xi\}$).

Thus,

$$\zeta : T \times \Xi \times P \times V \rightarrow B$$

An example of group collaborative trace would be

$$\{t \mid t \in CT_{i,l} \wedge \xi_j^k(\alpha(t, p_j), v_l) \wedge \ldots \wedge \xi_m^n(\alpha(t, p_m), v_s)\}$$

This allows selecting for example traces emitted by a user, mentioning the concept of "culture", or traces sent to a particular group during a specific week, or traces of messages sent by a specific user to a specific group, etc.

Three foundational parts constitute a primary framework of trace-based systems ((Laflaquière et al., 2006) and (Laflaquière et al., 2010)): (i) Collection; (ii) Transformation; and (iii) Presentation. One can clearly see this architecture Figure 2:

- **Collection:** this process uses diverse sensors and collectors, in a web-based CWE, the main data consists of text documents, hypertext documents, linked structures, server logs, browser logs and so on. The level of capture determines the diversity of the values. Collecting can be done on-line or off-line;
- **Transformation:** this part includes three functions: filtration, calculation and analysis. The output (CT) from the first process can be classified, analyzed, merged and edited automatically or manually. The programming language and practical system environment (e.g. the number of users, the hardware support, etc.) directly affect the efficiency and accuracy;
- **Presentation:** the last process utilizes the outcomes from the transformation procedure. The object is to explain the users' finished "interactive activities" and assist them in their future work. To make the modeled traces easier to understand and reuse, the interface design and the mode of presentation (for instance: visualization, audio or video) require serious consideration.

In CWE, the exploitation of collaborative traces is principally focused on the transformation and the presentation process. Since CT signifies the collaborative experience, it is an important issue concerning experience reuse in EM theory (for the general experience reuse, refer to (Bergmann, 2002) and (Tautz, 2001)).

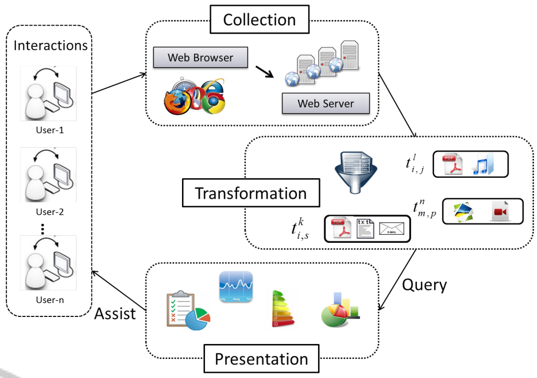

Figure 2: A primary framework of trace-based system.

CWE, like other application scenarios, e.g. electronic commerce, diagnosis of complex technical equipment or electronics design, has the following characteristics:

- **Knowledge Intensive:** Collaborative knowledge, e.g., about group project (e.g., project description and budgeting, task management, human resources, re-set target), group member (e.g., background, competence and character etc.) and group management (e.g., leadership and hierarchical relationships) directly influences every phrase and is enriched with group needs;
- **Vague Collaboration Description:** the goal of group collaboration are often vague, incompletely specified or even fickle. To clarify the problem and the objective, regular meetings are recommended for all the group members.
- **Large Collaboration/Solution Space:** the more possible collaborations and solutions there are, the larger the space would be in CWE and a single collaboration or solution is not enough for a complex project. Normally, these solutions depend on the quantity of tasks and involved people;
- **Group Size:** different kinds of people (e.g., engineers, experts or manager) are needed in every process of problem solving and act in a collaborative task. However, for the this issue, most of the research works examine small size (Steiner, 1972) and (Ellis et al., 1991). A great challenge for CWE is the large size of collaborative groups;
- **Highly Dynamic:** the rapid change and development of technology has a great effect on the renewal of knowledge, the people involved, the potential collaboration, the working style and so on.

Like the sketched situations above, a complex project is heavily based on collaborative experience. Collaborative traces sharing and reuse enable helping individuals and groups to avoid making same mistakes over again. To understand the process of exploiting collaborative traces, four basic scenarios are introduced as follows:

- **Record and Analyze the Finished Collaborative Activities:** this scenario can be characterized as "a dictionary of group collaborative activities in accordance with the chronological order". All the members in a group could distinctly see their interactions and the corresponding results in the group shared space, e.g. the usage status of shared documents or the sent email may be opened by the others;
- **Assist Group Future Work:** in this case, the filtered CTs can be distinguished as "a guide" for the future collaborations in groups. For example, if a task that failed in several ways, we can avoid doing the same mistake in the future. Besides, some potential collaborations may be found by their similar CTs, e.g. the comparable preference of shared documents or entries in group wikis;
- **Support Group Decision Making:** in this situation, collaborators can review all their past decisions with their consequences and the project progress in the group. They can make a better decision with such classified CTs. For instance: during Tendering, the analysis of customer RFP (Request For Proposal) within collaborators;
- **Enrich Group Knowledge:** in this circumstance, CTs reflect the needs and preferences of groups, with recommendation strategies, new knowledge is gained and shared in the collaborative workspace. For example: from the preferred books, links or videos, it is easy to recommend more with similar topics.

In CWE, the benefits of CT exploitation in the mentioned scenarios are beyond our expectations. The major advantages can be summarized as below:

- **Shorter Project Completion Time/Cycle:** e.g. the cost of time or group work efficiency;
- **Improve Project Quality:** e.g. from the reuse of CTs, we would make less mistakes but have more potent collaborations.
- **Reduce Project Expenditure:** e.g. from the analysis of CTs, it is not difficult to identify collaborators' contributions and attitudes.

5 APPLICATION

In this section, we evaluate our CT model and several complex filters in a web-based collaborative platform E-MEMORAe2.0 (Leblanc and Abel, 2008). Within the MEMORAe approach (Abel and Leblanc, 2008), E-MEMORAe2.0 (Figure 3) is combined with: (i) Models stem from knowledge engineering to support Knowledge Management; (ii) Semantic Web technologies to facilitate sharing and interoperability; (iii) Web 2.0 technologies to promote the social processes. Via this platform, both the fields of organizational collaboration and expertise can be enhanced by means of ontologies that define knowledge in organization (Abel and Leblanc, 2009). In a shared workspace, the users can exchange messages, edit and annotate shared documents, write wikis, share calendar and so on. For the personal use, the user can navigate through the shared ontologies; moreover he can also organize and capitalize the resources (e.g. documents, links and etc.). Up to now, within the range of this platform, only two kinds of personal interactions are recorded: (i) the access to concepts; (ii) the access to resources; then presented in the "Navigation history." In order to facilitate collaborative activities, apparently, the personal traces are limited and weak. The application of the CT model and of complex filters directly meet this issue and are easy to use.

In our application, firstly, the CTs are stored in accordance with the CT model conditions; then the queries are done through the designed complex filters; lastly, the results are presented in a chart or graph. Summarizing our case: the collaborative group is formed by four members: Qiang, Étienne, Marie-Hélène and Jean-Paul, formally, $g_1 = \{u_1, u_2, u_3, u_4\}$. They cooperate in a project called "Trace". As shown Figure 4, the group has four members and two subgroups. Recall the general framework of trace-based systems, the proposed model and filters are mainly in the transformation and presentation parts. Three factors of CT are collected and stored in a MySQL database: the list "per_id" from the table "mem_personne" is used to identify the members (e.g. the E_i and D_j); the values and properties are decided by the needs of practical scenarios (refer to different methods of CT exploitation), but the "time" and "date" of past interactions is determined as the "Index" of CT (geographical position could be another choice). We discuss respectively the two cases ("Concepts" and "Resources") in the following part:

- **For the Case:** "Concepts," the three components of collaborative trace are written as: (i) E_i ="The administrator (one of the members who is in charge of building the ontology, e.g. creation, connection of concepts etc.)"; (ii) D_j ="All the group members" (g_1), e.g. every member can view and check the shared ontology in the group workspace; (iii) Apart from "time" and

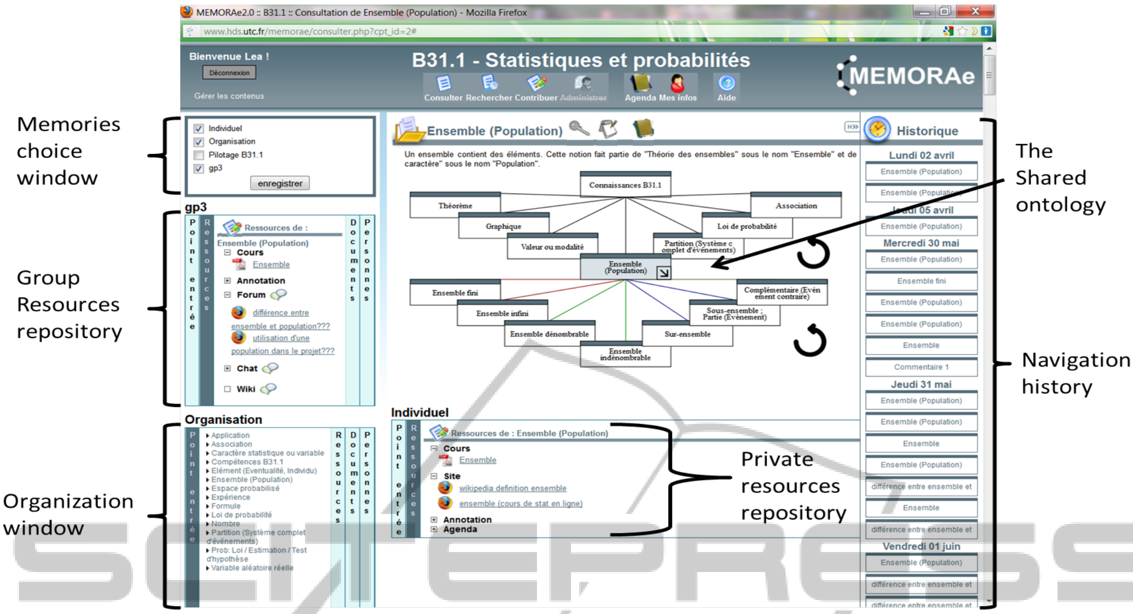

Figure 3: The collaborative platform E-MEMORAe2.0 (in French).

"date" (formally, which can be written as v_1), the frequency/times (that can be considered their preferences) is intended as another value (v_2) for the property (p_1) "the concerned concepts in the group shared ontology"; the upper part of Figure 5 shows the three most consulted concepts: "Collaborative Trace Definition", "Experience Management", "Collaborative Trace Model" during one month (from 01/12/2012 to 02/12/2012).

The most relevant concept is "Experience Management" and the least is "Collaborative Trace Model". The lower chart presents the trail of the most consulted concept in time. In 06/Feb, the group examined this concept three times, but only once in 12/Jan. Therefore, we can clearly obtain their preference and attention within this ontology. The group's attention for this concept changes and is reduced after a period of time. This phenomenon may imply that the group has an extensive understanding and shares common conclusions about this concept. Here, the complex filter (ζ_1) is designed to analyze the frequency and the change of consulted concepts with time variation;

- **For the Case:** "Resources", (i) the "Emitter" (E_i) and "Receiver" ($D_j = g_1$) are the same as in the above situation, but the traced object is the shared file (two categories: one involving pdf and doc documents, the other concluding video and images) that concerns the three concepts in the ontology. (ii) The property (p_2) is "the shared files for the most checked concept in the group shared ontology". Besides, for the values, one (v_3) is the situation of shared files (file types and quantity) and

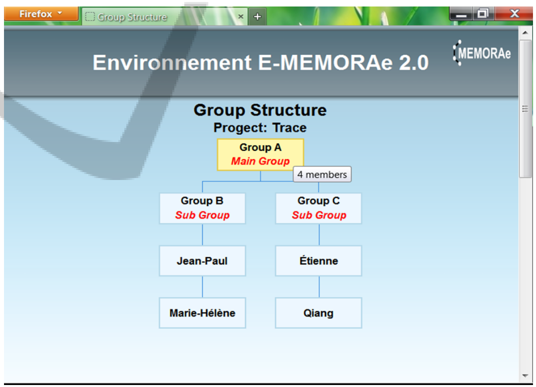

Figure 4: The Group Structure.

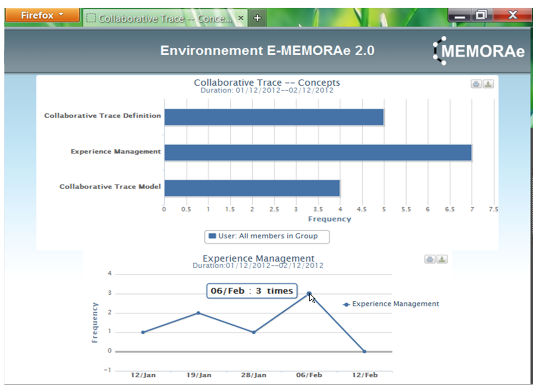

Figure 5: An example of the case "Concepts".

another (v_4) is the frequency/times of the service situation for each type of the file. As shown in Figure 6, the upper chart demonstrates the quantity of each type file that has been shared in group workspace during one month (same as the case "Concepts": from 01/12/2012 to 02/12/2012).

We can see that the most frequently consulted concept (from the first case), Experience Management (EM), is connected with several files: three pdf, three doc, one video and two images in this period. And the least interesting concept, "Collaborative Trace Model," has the most connected files: four pdf, four doc, two videos and three images. The lower figure presents the state of service for the three shared pdf documents that is associated with the concept EM. The "frequency" signifies the number of times the file has been opened ("open this file"). For the "PDF2" ("Note I of EM"), it is obvious to see that Étienne (u_2) had a lack of interest and has never opened this file. However, it was certainly read several times by Qiang (u_1) and Jean-Paul (u_4). Moreover, Marie-Hélène (u_3) is more interested in "PDF3" ("EM vs. KM") than in other documents ("Note I of EM" or "Trace and EM"). In this case, the complex filter (ζ_2) is used to help observe, compare and analyze the group's preference and members' contributions in collaborative workspace.

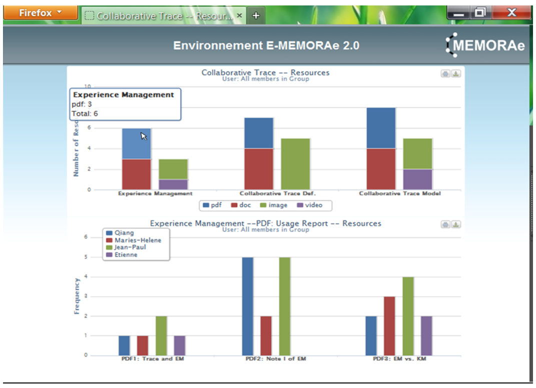

Figure 6: An example of the case "Resources".

As a consequence of the filtered CTs, some potential collaborative relations that tightly rely on their "preferences" and "contributions" will be recommended within group members, for example: Qiang (u_1) and Jean-Paul (u_4) collaborate with the subject of "PDF2". Furthermore, the competence or knowledge background within group members can be identified with more complex filter, e.g. from the similarity of the shared files. It is helpful to allocate the tasks or replace a member in some particular situation. For instance if we are missing an expert in a group, we could propose another expert for this task. Without a doubt, the group's knowledge is enriched by these shared files and the ontology in the group workspace. Using the filtered CTs, we could understand the service state of the shared knowledge, e.g. the level of knowledge usage and the type of knowledge requested in the group.

In the E-MEMORAe2.0 platform, the group collaborative working experiences are modeled and reused by the application of collaborative traces. CTs model and the complex filters can also be applied to other ends, like in supporting the Tendering process (in railway applications) (Penciuc et al., 2010) and the organizational Content Management (Deparis et al., 2011). Moreover, our model can be expanded to different collaborative platforms, e.g. in an agent-based CWE, or collaborative learning systems.

6 CONCLUSIONS

In this paper, we proposed using a complex filter approach to facilitate group experience management and support collaborative works in the context of web-based CWE (Section IV). This approach has been developed from the results of our previous work: Collaborative Trace Definition and Model. A literature review of traces and some basic notations of our CT model were introduced and discussed in Section II and Section III. Furthermore, to validate this method and some principles of exploitation of CTs, two typically use cases based on the collaborative platform E-MEMORAe2.0 were compared and explained in Section V. Exploiting collaborative traces concerns several critical issues in the different fields of EM study, which can be summarized into three principal points: (i) Experience reuse in collaborative groups, not only for personal usage; (ii) Analysis and modeling of the finished/past collaborative activities and interactions; (iii) Enriching organizational knowledge and supporting the Knowledge Management process in CWE. Using the CT model and the complex filters are also interesting in other fields, such as: multi-agent systems, or social systems.

Actually, there exists many other collaborative interactions in the platform E-MEMORAe 2.0, for example: in a group shared work space, that adds concepts or resources, creates comments in wikis, etc. We are interested to test our model and filter for more types of collaborative interactions. Besides, in the coming autumn semester, we will apply our application to the collaborative learning scenarios via platform E-MEORAe 2.0 in the University of Technology of Compiègne. It will be used to support the students' collaborative activities that can be traced and analyzed by our application.

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