

AUGMENTING AWARENESS IN DATA-INTENSIVE WEB-BASED COLLABORATION

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ABSTRACT

Much research has been performed on how computer-based technologies might facilitate awareness among cooperating actors. However, existing approaches in providing awareness services prove to be inadequate in data-intensive situations. Moreover, they fail to address the needs of dynamic, web-based communities. In this context, this paper presents a list of awareness mechanisms that have been integrated in an innovative web-based collaboration support tool, the ultimate aim being to satisfy the requirements associated to the above remarks. The proposed mechanisms are described and elaborated with respect to various awareness types reported in the literature.

KEY WORDS

Web technologies, awareness, computer-supported collaborative work, visualization.

1. Introduction

The concept of awareness has been extensively elaborated in the field of computer-supported collaborative work (CSCW) [1, 2]. In this context, awareness can be defined as an understanding of the activities of others, which provides a context for one's own activity [3].

Much research has been performed on how computer-based technologies might facilitate awareness among cooperating actors (i.e. members of a community). An important body of this work attempts to develop computational environments based on event propagation mechanisms for collecting, disseminating, and integrating information concerning collaborative activities [1]. Generally speaking, awareness of past and current actions in such shared environments and over shared artefacts influences and guides the actors' decisions and course of actions. It allows them to have a general perception of the community's activities, progress, and problems, as well as to have a perception about their progress compared to the others. Some awareness-related services, offered by these environments, could also aid actors to find potential collaborators for exchanging diverse types of artefacts

(which can serve as an instrument to generate and sustain awareness themselves) or asking for help.

However, existing approaches in providing awareness services prove to be inadequate in data-intensive situations [2]. Collaboration settings are often associated with huge, ever-increasing amounts of multiple types of data, obtained from diverse sources that often have a low signal-to-noise ratio for addressing the problem at hand. In turn, these data may vary in terms of subjectivity, ranging from individual opinions and estimations to broadly accepted practices and indisputable measurements and scientific results. Their types can be of diverse level as far as human understanding and machine interpretation are concerned. They can be put forward by people having diverse or even conflicting interests. At the same time, the associated data are in most cases interconnected, in a vague or explicit way. Data and their interconnections often reveal social networks and social interactions of different patterns.

The above bring up the need for innovative software tools that offer the appropriate awareness services in order to make it easier for actors and communities to capture, represent and process big and complex volumes of data and knowledge. Such services should shift in focus from the collection and representation of information to its meaningful assessment and utilization, the ultimate aim being to facilitate and augment collaborative sense-making. This can be seen as a special type of social computing where various computations concerning the associated context and group's behaviour need to be supported.

In line with the above, this paper presents a list of awareness mechanisms that have been integrated in a web-based tool, namely CoPe_it! (<http://copeit.cti.gr>), that supports data-intensive collaboration. In the following sections, we sketch our overall approach and motivation, make a distinction of various awareness types, describe the proposed mechanisms and services in detail, and conclude with some preliminary evaluation results and future work directions.

2. Motivation and overall approach

Awareness mechanisms are essential in cooperative and collaborative environments where people interact through task sharing and assets exchange [4]. However, and as previous research has proven, not all notifications are welcomed by users and they might end up having an adverse effect. As a matter of fact, many studies have shown that excessive unnecessary notifications might lead to undesirable effects such as a decrease in productivity [5, 6]. For instance, in a learning community that includes educators, teaching assistants and a considerable number of students, if every time that a student comments on a document or an educator decides to change the rights assigned to a role in a specific activity everyone is notified, information overload is unavoidable. Consequently, community members will tend to ignore all received notifications, some of which might be relatively important and require an immediate action.

A way to avoid these adverse effects and successfully sustain collaboration is to provide context-sensitive, user-centred awareness services. In order to appropriately develop such services, three basic issues have to be addressed: (i) what information should be delivered? (ii) when should it be delivered? and (iii) how should it be rendered? [7]. In other words, the relevancy and importance of a notification to a specific user, its delivery and display means, and its time of delivery are the three intrinsic notification parameters that should be adapted based on the interests and notification preferences of the target user.

At the same time, the notion of community in the context under consideration refers to a highly dynamic entity that evolves and changes during collaboration sessions and its lifetime; new actors can be added to a community or abandon it, some actors may be online and others not, different actor roles can be assigned (which might even change during a collaboration session), while the status of individual actors evolves in terms of their participation and expertise. In addition, actors may be members of different communities or work on multiple workspaces, where they may have different roles, be assigned to different tasks and pursue different goals.

Although expressive, such a highly dynamic environment may lead users in blurring or even losing the mental image they have of their community (e.g. what goals are to be achieved, what task they are supposed to do, how do others contribute to the community) and the knowledge items of a collaborative workspace. This compromises the ability of individual actors to align their actions during a collaboration session with the actions of their peers and hence threatens the group's cohesiveness. Absence of such cohesiveness results in harming the ability of the community to solve problems efficiently. This situation is exactly the opposite of what the awareness mechanisms should try to achieve.

To avoid the aforementioned problems, our attempts focus on controlling the consequences of such a highly dynamic and data-intensive environment. Hence, the proposed mechanisms provide features and functionalities with which the various events during a collaboration session can be timely captured, analyzed and made visible to end users.

Another important issue during the shaping of our approach concerned the awareness types to be supported. Related work from the CSCW field reveals that various sets of awareness types have been already proposed [8-11]. These sets attempt to address different concerns in a collaboration setting. However, in the context of our approach, no single set of awareness types was able to address the abovementioned collaboration aspects and requirements. Instead, a synthesis of relevant awareness types found in the literature has been adopted. This set of awareness types permits addressing awareness issues at both the individual and the community levels, something that is critical for collaboration support services. The proposed list of awareness types to be offered in a data-intensive collaboration setting includes:

- **Informal awareness:** This form of awareness of a work community is the general knowledge of who is around and what he/she is doing. It has been pointed out as an enabler of spontaneous interaction [12].
- **Presence awareness:** It involves information about the status of users. This information indicates each user's availability, aptitude and willingness to collaborate with others.
- **Task awareness:** It involves information about the aim of a task, its requirements and how it fits within a bigger plan.
- **Social awareness:** It concerns the information that a community's member maintains about his/her peers in a social or conversational level. It includes issues like the degree of attention and the level of interest of a member.
- **Group-structural awareness:** It involves information about the members' roles and responsibilities, their positions on an issue and the overall community's processes.
- **Historical awareness:** It concerns knowledge about how artefacts resulting from collaboration have evolved in the course of their development.
- **Workspace awareness:** It concerns the up-to-the-minute knowledge about others' interaction within a shared workspace [7]. This includes knowledge about the collaborative workspace in general, information about other actors' interactions with the shared workspace and the artefacts it contains. Its difference compared to the informal awareness is that the workspace awareness is relevant only within the context of particular, shared collaboration environments. Informal awareness does not make such an assumption and considers a broader, system-wide context. Several elements are relevant to this

type of awareness: presence (is anyone in the workspace?), identity (who is participating?), authorship (who is doing what?), action (what are the actors doing?), action history (how did that operation happen?), artefact history (how did this artefact reach this state?), etc. (for a complete list see [12]).

It is important to notice that the adopted awareness types are not considered as independent; rather, they overlap in a collaborative environment [7]. Hence, some awareness functionalities may be related to more than one awareness types.

3. Awareness mechanisms in CoPe_it!

In this section, we present the mechanisms that CoPe_it! offers in order to deliver awareness information to a community's members. For each mechanism, we discuss issues related to what information is available, how it is conveyed to users, how preferences with respect to desired awareness information can be expressed and what cues are used to facilitate transparent delivery of this information. Before that, we briefly introduce some key concepts of CoPe_it! in order to sketch the overall computer-supported environment in which the proposed awareness services function and better explain their purpose and role.

3.1. Short Description of CoPe_it!

CoPe_it! is a web based tool supporting argumentative collaboration within communities [13]. The tool's workspaces provide the ground where collaborative activities take place. Communities may have one or more workspaces where their members can upload diverse types of knowledge items such as notes, ideas and comments as well as other artefacts such as files, images and videos. Within workspaces, users can associate all knowledge types in arbitrary ways that suit their understanding of the domain. Moreover, they can freely change the type of the knowledge items (e.g. changing a note to an idea and vice versa) at any point during the collaboration. Workspaces can be either public (shared by a group of people) or private. In CoPe_it!, the emphasis is on the place rather than on the time dimension.

To support the evolution of collaboration in communities, CoPe_it! builds upon an incremental formalisation approach, through which the emergent transformation of loosely coupled, informal and unstructured workspaces to highly structured, formal workspaces is achieved. Alternative formalisations of a particular workspace are possible; these are supported by appropriate visualisations schemas.

The collaboration environment of CoPe_it! brings in a new way of interacting with knowledge items in shared workspaces. This is attained by introducing a new set of operations that go beyond traditional operations found in contemporary collaboration environments, such as web-based forums. These operations include amongst others changing the spatial position of knowledge items on the workspace, relating knowledge items using explicit relationships, aggregating knowledge items, changing the visual appearance of knowledge items or relationships, and changing the view of a workspace. Being a natural extension of the collaboration space, they do not make the tool more complicated; rather, they turn it to be a much more dynamic environment compared to traditional solutions.

Within CoPe_it!, the notion of a community exists explicitly. Users may belong to one or more communities. Distinct roles within a community can be assigned; these determine and control the access of users to resources. In terms of user privileges, a hierarchical organisation scheme is assumed. Every community has one or more administrators (moderators).

3.2. User Bar

An integral part of the user's main interface is the information that indicates the presence or not of a community's members within CoPe_it!. The bottom-left pane in Figure 1 (entitled Quick Contacts) shows which users that belong to the same community are currently online. Special visual cues (called presence indicators) convey this status. A green bullet indicates a user that is currently online, while a gray bullet indicates a user not currently online.

By hovering over a user in the presence pane, a window displays information on the user profile. This is the information that the users have decided to share. It gives the currently logged on user the ability to get in touch with his/her peers by either email or chat. Hence, spontaneous and ad-hoc interactions can be possible.

A special visual cue indicates users that have a particular role in the communities of which the current user is a member. For example, special icons will indicate users that are administrators/moderators of a community or a particular workspace. It is noted that the list of users visible on the quick contacts pane are those that belong to the same community as the current user and not those who are working on the same workspace as the current user. This case is described in the context of another awareness mechanism.

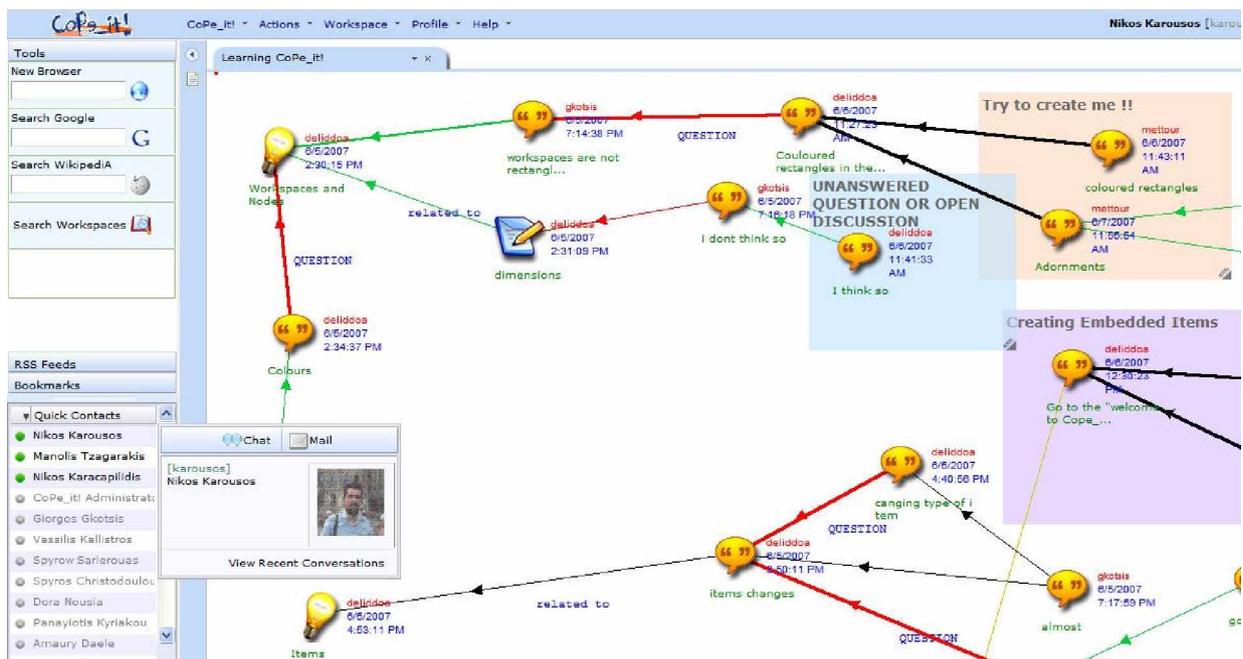


Figure 1: Information on the status of individual users that belong to a community.

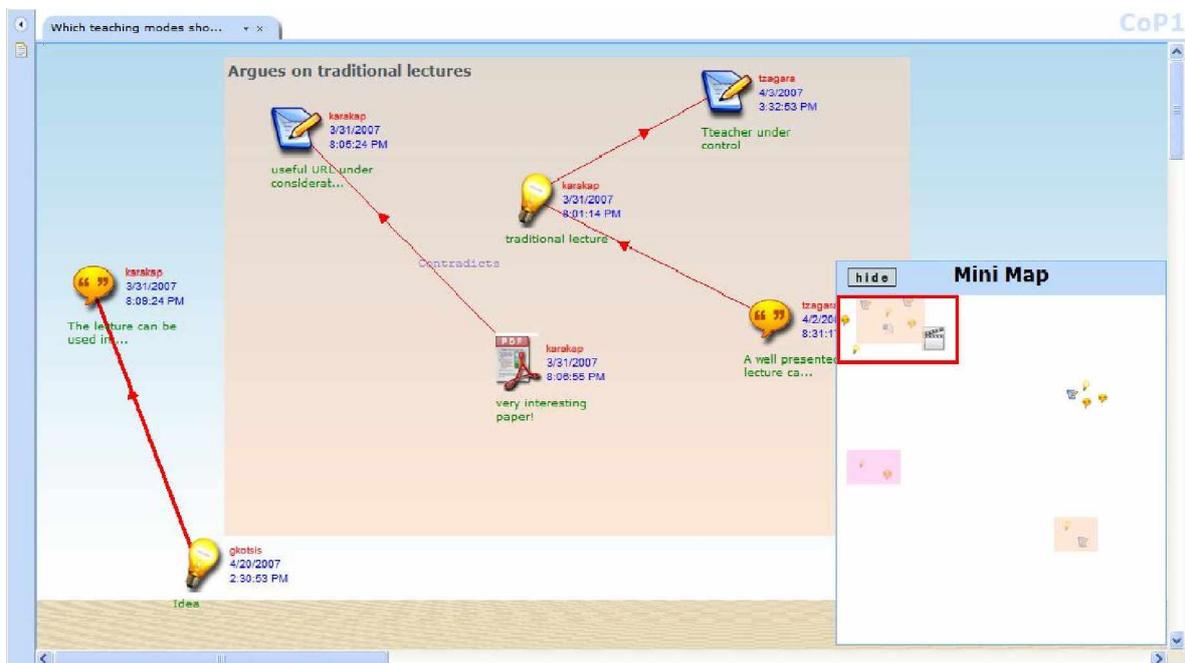


Figure 2: Mini map giving an overview of the entire workspace.

3.3. Mini Map

Every workspace in CoPe_it! is equipped with the ability to get an overview of the workspace in which a user is currently collaborating (Figure 2). Through the mini map space, the user is able to see areas of activity of that

workspace that indicate which issues are being discussed by other community members. Due to the synchronous nature of the CoPe_it! workspaces, the mini map may also enable users to see where the most collaborative activity is happening. While the main display permits a user to focus on his/her own tasks, the mini map lets the same

user glimpse on which issues other members of the workspace are currently engaged. In different situations, this may also provide valuable insights that facilitate the coordination of collaborative actions within a workspace.

3.4. Workspace Head-Up Display (WHUD)

Every workspace also provides a transparent area at the bottom of the display that will present and report information about current events in which the user is currently working (Figure 3). This area is called the workspace head up display (WHUD). This is the main mechanism through which events of the synchronous collaboration in a workspace will be perceivable by the user. In particular the WHUD will allow a user to: (i) get information about the users that are currently working in that workspace; (ii) get notification on the actions other participants carry out in the workspace and on events related to individual artefacts, e.g. artefact creation, deletion, update etc. As with the online community users presented in previous section, services for initiating spontaneous interactions are provided via email or chat.

3.5. Workspace and Resource History

At the workspace level, users are able to query what events happened in the past. Various filtering options are available so that they can see changes within a workspace. Changes may concern users, resources or operations (e.g. what relationships have been added, what deletions and insertions occurred, etc.). As an alternative modal interface, such chronological information can also be obtained by examining individual artefacts on the workspace.

In addition to chronological information, visual cues indicating the access intensity of individual resources are supported. Figure 4 illustrates how 'access intensity' is rendered visible to users. A usage bar is shown next to each resource that can take colours from white to red. A darker colour indicates more frequent access by a larger number of users (than a lighter one). This aims at making visible which resources of a workspace are accessed the most (and which are not). This may give useful insights on which resources have not been taken into consideration.

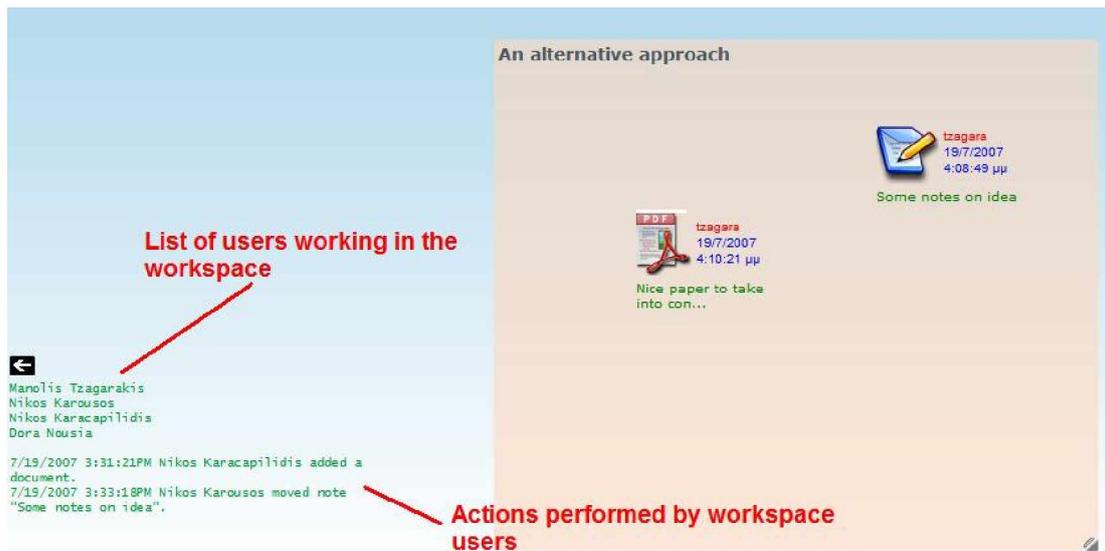


Figure 3: Workspace Head Up Display.



Figure 4: Information about the usage of various artefacts in a workspaces (the red bar on the left indicates the access intensity; from left to right the figure shows artefacts in increasing usage intensity).

3.6. Workspace Teleporting

CoPe_it! enables users to peek at other workspaces that may or may not be in their community and see what activities happen there without being noticed by the users that are currently working on that workspace. According to similar mechanisms that are available in CSCW [10], this is referred to as 'workspace teleporting'. This functionality is achieved by assigning a special role to individual users and in particular the role of a 'lurker'. Not all users have this role by default and assignment of this role to community members that in general do not have access to a workspace is controlled by the communities and workspaces administrator.

4. Conclusions

The overall approach followed in the development of CoPe_it! is the result of action research studies [14] concerning the improvement of practices, strategies and knowledge in diverse data-intensive collaborative environments. Moreover, the research method adopted follows the design science paradigm [15].

CoPe_it! has been already introduced in multiple collaborative settings (both in industry and academia) for a series of pilot applications. Preliminary results referring to the awareness services provided show that they fully cover the user requirements associated to the data-intensive nature of a collaboration setting, as well as to the dynamic nature of web-based communities. In particular, users have admitted that these services stimulate interaction, makes them more accountable for their contributions, while they aid them to conceive, document and analyze the overall collaboration context in a holistic manner.

Future work directions include the extensive evaluation of CoPe_it! in diverse collaboration paradigms, which is expected to shape our mind towards the development of additional awareness services required. Another direction concerns the high exploitation of a user's profile in order to provide user-specific awareness indicators, as far as the indicators' type, volume and content are concerned.

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