From 'Collecting' to 'Deciding': Facilitating the Emergence of Decisions in Argumentative Collaboration

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Abstract. Current tools aiming at supporting argumentative collaboration either provide means to successfully tame wicked problems or offer advanced reasoning mechanisms to support decision making. When CoPs need both kinds of functionalities for addressing issues this gap perplexes the process. We argue that a key factor in enabling the bridging of this gap is viewing argumentative collaboration as an *emergent phenomenon*. Addressing emergent aspects of argumentative collaboration would benefit the respective systems as that would permit them to support the evolution of the entire collaboration. We outline this approach by presenting CoPe_it! a prototype argumentative collaboration system. In CoPe_it!, an incremental formalization approach facilitates the emergence of individual and loosely coupled resources into coherent knowledge structures and finally decisions.

Introduction

Argumentative collaboration can augment learning in formal as well as in informal group settings in many ways such as in explicating and sharing individual representations of the problem, maintaining consistency and focus on the overall process, thus increasing plausibility and accuracy, as well as to enhance the group's collective knowledge [1][2]. Over the years, a variety of tools supporting argumentative collaboration have appeared; they usually facilitate argumentative discussions among members of a group and range from simple ones such as e-mail, chat and Web based forums to dialogue mapping and argumentative collaboration tools, reaching even into the realm of sophisticated conferencing and formal argumentation systems [3][4][5][6].

Tools that facilitate argumentative discussion are of particular importance to Communities of Practice (CoPs); many CoPs have already integrated them into their processes. CoPs deal heavily with *wicked problems*, i.e. problems which are difficult to express, have no "correct solution" and exhibit a high degree of complexity [7]. A well known approach to address these kinds of problems is through discussing them

among the group members aiming at collecting available alternatives, elaborating them further and finally deciding on the proper solution. Given the many different technologies for assisting the process of discussing and decision making, the selection of the proper one that fulfills a CoP's collaboration needs and successfully matches its processes is in general a critical success factor [8].

However, in many cases, the basic building blocks for decision making, namely ideas and prospective alternative solutions do not exist beforehand and cannot be simply 'collected'. Ideas and prospective solutions usually do not arise spontaneously or instantly with clear conceptual boundaries. They are harvested as they gradually grow out of existing resources that may even at first bear no indication of their potential. This lack of clearly identifiable alternatives and ideas may hinder groups in using sophisticated decision support systems that would fit their purposes well such as [4]. These tools – which can play an active role during argumentative collaborations - require that alternative solutions have been already crystallized and are able to be clearly represented in an unambiguous way within the system.

In general, systems for argumentative collaboration support well either the "taming" of a wicked problem in an attempt to harvest and justify alternatives or they attempt to support actively the decision making process. The consequence of this gap for groups is rather severe: the group has to employ different tools during the same collaboration session, something that introduces problems and technical obstacles that harms ultimately the group's ability to solve problems.

In this paper, we present how CoPe_it! – a Web-based tool to support argumentative collaboration (http://copeit.cti.gr) – attempts to bridge the aforementioned gap. In particular, CoPe_it! builds on the assumption that argumentative collaboration environments are environments where ***understanding occurs*** through the emergence of the collaboration space. This emergence is characterized by small and incremental changes of the available items in the collaboration space that - although local in nature - when accumulated lead to global transformation of the collaboration space into something that is useful for the task at hand. In particular, CoPe_it! attempts to provide the framework to support the emergence of decisions in online collaborations. Within the CoPe_it! approach, the notion of emergence is conceived on two levels: ***emergence within a shared collaboration space*** where individual items are transformed into prospective solutions and ***emergence between shared collaboration spaces*** where the collaboration is transformed into a decision. In CoPe_it! these two forms of emergence are considered as related as ***emergence between shared collaboration spaces is based on emergence within shared collaboration spaces***. To implement this framework, CoPe_it! introduces the notion of incremental formalization into argumentative collaboration research drawing upon approaches that have been well established in other related areas of research, such as hypertext [9][10] and knowledge management CSCW [11]. The rest of the paper is organized as follows: first we discuss the notion of emergence in argumentative collaboration and review existing systems with respect to their ability to support emergent structures and decision making. We then present the mechanisms provided by CoPe_it! to address the main concerns. The last section concludes the paper and identifies issues for future work.

Emergence in argumentative collaboration.

Ideas do not arise well formed [12]. In many cases of argumentative collaboration, they emerge as the discussion proceeds. This is mainly due to the nature of the related resources and how they are brought in into the collaboration space.

Resources may include explicit claims or questions that capture precisely the problem. Or, resources that constitute entire scientific articles (e.g. papers or books), where only a part of them is in some way relevant to the issue being discussed may be introduced. Alternatively, a set or such resources – as the result of a Web search - may be brought into the ongoing discussion. Even raw fragments of texts – of unrestricted size ranging from a single sentence summarizing an opinion to lengthy essays that reference additional problems and solutions – may appear. Any of the above kinds may be brought in into the discussion at any time. In addition, due to the collaborative nature of the medium, every resource made available is based on the subjective judgment of the user who admitted it into the discussion. This means that resources may at a later point be obsolete or characterized as unimportant by the group. The sheer diversity of the resource types requires from individual members of the group to engage into the process of information triage [9] i.e. sorting the available material, interact with the resources on the space in an attempt to interpret and recast them as well as organize them into larger structures. Some resources may even have to be filtered out or signified as unimportant. While individual interactions are small in nature (with local consequences), they have a global impact on the understanding of the collaboration space as they accumulated over time. This results in transforming individual resources to something that is consequential for the task at hand and is referred to as sense-making [11]. Hence, in argumentative collaboration sense-making does not happen automatically but rather *emerges naturally* as a consequence of the anticipated users interactions and modifications of the items available in the collaborative space. Research in CSCW has already outlined criteria with which collaborative environments can be characterized with respect to their ability to support emergence. These include [13]: (a) arranging and spatial reasoning, (b) implicit structuring and (c) sketching.

As the shared collaboration space emerges towards sense-making, the entire collaboration emerges towards the decision to be made. Hence, a second level of emergence is in action. This form of emergence occurs only if the collaboration activity reached a state where sense-making has been achieved. The recognition of this kind of emergence gives the ability to reconsider the outcomes of the sense-making process in new contexts, such as the formal exploitation of collaboration items patterns, and the deployment of appropriate formal argumentation and reasoning mechanisms.

Background work

All existing approaches supporting argumentative collaboration systems provide the means to support emergence within a collaborative activity. Yet, they differ to what degree they support emergence and in particular whether they succeed in

making the emergent knowledge items of the collaboration explicitly within the system (and thus system understandable) or not.

E-mail, chat and Web based forums are representatives of the most basic argumentative collaboration environments as they support only a limited form of emergent structures. In those systems, emergence of sense-making occurs mostly in the head of the user rather than within the system. This form of emergence is characterized as implicit. These systems allow only trivial discourse moves that include uploading of resources and their (implicit) association. Even in cases where explicit relationships between items are possible (e.g. by quoting a post), the semantic of this association is implicit (i.e. understandable only by humans). Nevertheless, Web-based forums may exhibit a slightly higher degree of explicit emergence, as they can deploy visualization techniques; these techniques can to some degree express spatial placement and relationships between posts (e.g. threaded view). Implicit emergence is also exhibited by the majority of formal argumentative systems that attempt to provide advanced functionalities to actively support decision making such as Hermes. (see Fig. 1).

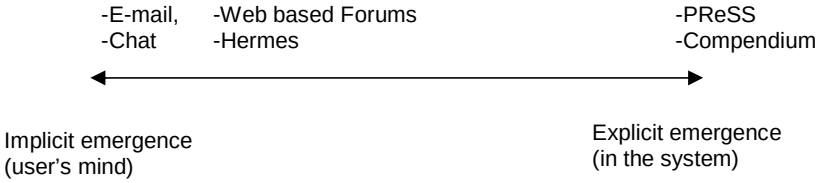

Figure 1: Levels of emergence supported by different argumentative collaboration systems.

On the other hand, systems like Compendium [6] and PReSS [11] facilitate explicit emergence i.e. allow the explicit representation of emergent knowledge structures within the system that can be shared between users. These systems provide a wide range of mechanisms facilitating emergence that include arbitrary relationships between items with their semantics clearly articulated, spatial arrangement of items to express tacit knowledge, changing the types of resources to convey their meaning, and mechanisms to build new abstractions such as specialization and generalization.

When considering the aspect of how well they support decision making another picture can be drawn. In these situations, systems that exhibit a high degree of support for emergence provide very little or no support for decision making. On the contrary, some systems with low degree of supporting emergence exhibit advanced support for decision making (see Figure 2).

Figure 2: Levels of supporting decision making in different argumentative collaboration systems.

Both pictures above indicate a gap that exists in today's argumentative collaborative environments. Although they acknowledge the need to support emergence of individual resources into structures facilitating sense-making they fail to take the next step and in general neglect to support the emergence of the process towards making the decision. When groups need both functionalities, only burdensome solutions can be provided. In these cases, technology proves to be an obstacle rather than a solution. CoPs, in general, face many times such situations; hence, in this context, bridging this gap will immensely benefit their ability to address problems.

Argumentative Collaboration with CoPe_it!

CoPe_it! is a Web-based tool that facilitates argumentative collaboration emphasizing supporting emergent collaboration and in particular attempts to actively prolong the entire life-cycle of collaboration from gathering to decision. CoPe_it! permits semi-synchronous collaboration among group members. The term semi-synchronous denotes that synchronous as well as asynchronous collaboration is possible; hence, the emphasis of the collaboration is not on time bur primarily on the space.

The approach of CoPe_it! builds upon the observation that environments aiming at the emergence of sense-making provide more flexible means to build knowledge structures than environments aiming at decision making. In particular, they exhibit completely different levels of formality. By the term formality, we refer to the rules enforced by the system, to which all user actions must comply. In CoPe_it!, formality is not considered as a predefined and rigid property of the system, but rather as adaptable aspects that can be modified to meet the needs of the tasks at hand. Figure 3 illustrates the different objectives that can be supported by adjusting the level of formality. Decreasing the systems formality facilitates sense-making while increasing the system's formality facilitates decision making. Allowing formality to vary within the collaboration space, *incremental formalization*, i.e. a stepwise and controlled evolution from a mere collection of individual ideas and resources to the production of highly contextualized and interrelated knowledge artefacts, can be achieved [10]. In general, this emerging into a new collaboration level is associated with a set of functionalities.

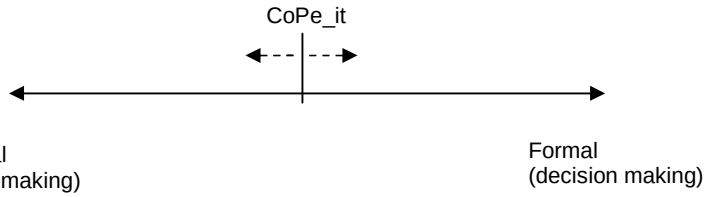

Figure 3: By adjusting the formality of CoPe_it! different intentions of the argumentative collaboration can be supported.

Currently, CoPe_it! supports three stages of evolution of collaboration spaces with more stages planned in future versions. Each stage resembles a *projection* of the collaboration space.

The collection and sharing stage. This is the most informal setting supported by CoPe_it! where it functions simply as a Web-based forum. The emphasis here is simply to express, gather and share knowledge items that the group may posses making others aware of their existence. No advanced structuring is at this point necessary. Structuring of the collaboration space cannot be made explicit, hence no constraints exist on what and how a resource is related to another in the collaboration space. Relationships can only be established by quoting posts or by referencing them in the content of a post.

The synthesis stage. While previous one emphasizes on collecting and initial feedback on the collected items this stage is primarily concerned with providing support for synthesizing existing items and support the emergence towards coherent knowledge structures that can act as building blocks for decision making purposes. The key aspect in this stage is that the emergent structures can be represented explicitly within the system. In this stage, gathering and collecting resources is also possible but do not constitute the main activities. The emphasis is how they relate to other resources and how they can be aggregated into larger structure. At this stage, sense-making means achieving the crystallization of the alternative solutions and explicitly represent them within the system.

The decision stage. This is the most formal setting supported by CoPe_it! as at this stage the alternative solutions of the synthesis stage can be further elaborated with active support of the system. It is at this stage where decision making needs are fully supported. Sense-making here means transforming the resources into a decision.

How an argumentative collaboration emerges in the collection and decision stages has already been documented in previous work [4]. In the next paragraphs we outline the mechanisms with which CoPe_it! supports emergence in the synthesis stage and describe how the entire collaboration space emerges from one stage to another. The later is also referred to as switching projections.

Emergence within the synthesis stage.

Since in this stage emergence of the resources has to be supported in order to achieve synthesis of individual resources into larger structures, such projection of the collaboration space has been build to enable the following:

Spatial interaction with the items on the collaboration space and spatial reasoning. The ability to arrange spatially has already been pointed out as a key factor for emergence [13]. This is in particular important for hatching tacit knowledge that resides latently in a collaboration space.

Arbitrary relationships between resources and the creation of new abstractions. Explicit articulation of relationships between resources facilitates the creation of semantics and the transformation of individual resources into larger knowledge structures. Furthermore, the ability to treat these larger structures as a single entity or even as templates aids the evolution of the collaboration space.

An instance of such a synthesis stage is shown in Figure 4. The figure shows the issue of "alternative teaching modes" being discussed. The argumentation has evolved to a stage where alternatives solutions have started to emerge. Alternatives to the issue at hand are indicated by the rectangles that enclose the structured items that have been jointly authored by the community members. Items that are placed within rectangles –without relationship to other items – imply indicate that they are relevant to the particular alternative.

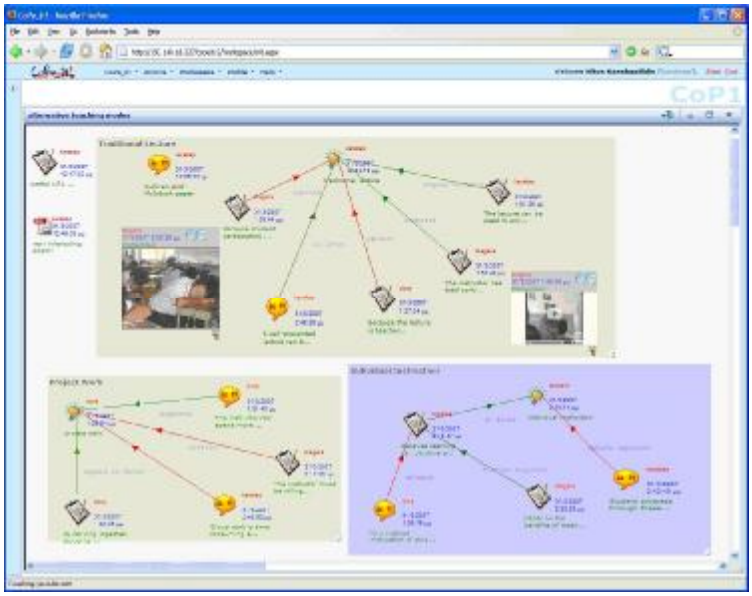

Figure 4: Instance of the collaboration stage at the synthesis stage.

Abstractions

A set of abstractions provided at this stage aids the emergence of the space. These include (a) notes, that are used to represent simple information content, the value of which has not yet been assessed by the community (the content of notes can be anything from text, images or video - a short title acts as the summary of the content), (b) comments that are used to characterize content that comments on an existing resource or comment in the collaboration space and (c) ideas that constitute the main abstraction to explicate individual solutions. Any abstraction can receive arbitrary attribute-value pairs.

Instances of the aforementioned abstractions can not only be spatially arranged but also explicitly associated with relationships. Relationship captions help conveying their semantics to other members. In addition, the visual attribute of every item on the space can be modified. For example, a relationship can be colored red or green to indicate that one resource is standing critically or favorably with respect to another. The thickness of the line representing the relationship may be used to indicate how strong a resource opposes or supports another.

Abstraction mechanisms

CoPe_it! includes means with which resources can be conceived at a higher level of abstraction enabling their transformation into artifacts useful for decision making tasks. These means constitute the main mechanisms with which emergence is supported in the collaboration space as they permit the piecemeal transformation of the available resources. Within CoPe_it! the mechanisms include:

Explicit transformation of resources. Individual resources can be transformed from one type to another without any constraint at any point in time.

Aggregation. Individual resources can be aggregated into larger structures that nevertheless can be treated as single entity and can take part in any structuring activity e.g. relating an aggregated entity with a note or another idea. For example, a set of aggregated resources can be cast into an idea, comment or note. Undoing of an aggregation is also possible. In these situations, the aggregation is dissolved and the constituent 'parts' appear as separate entities on the collaboration space.

Specialization. Specialization permits the creation of finer grained abstractions i.e. more detailed knowledge items out of coarser grained ones. Specialization tasks generate new resources of type 'note' that inherit all attributes and values of the specialized resource. In essence CoPe_it! maintains an explicit relationship of type "is-a" with within the system between these two resources i.e. the system is aware of the type of relationship.

Patterns of knowledge structures: the ability to specify instances of interconnected knowledge items - of any type - as templates. These templates can then be used during the collaboration to create new instances of knowledge items. This allows the definition and use of user-defined abstractions during the collaboration.

Emergence across collaboration stages.

Once the collaboration space has been structured to the point where the semantics of individual items has been assessed and individual alternative solutions have taken shape advancing the entire collaboration to the decision phase is possible. This permits the community to elaborate the generated knowledge structures in new contexts including the formal exploitation of collaboration items patterns, and the deployment of appropriate formal argumentation and reasoning mechanisms. The decision stage of CoPe_it! supports such activities employing an IBIS like formalism [14] and builds on the functionalities of previously developed argumentation system [4]. The emphasis here is not on supporting emergence hence mechanisms such as mentioned in the previous paragraph are not available.

In CoPe_it!, the knowledge structures of the analysis stage are transformed into the IBIS like structures of the decision stage according to transformation rules that capture how the transformation will take place. Transformation rules can take into consideration the type of knowledge items as well as their visual attributes. They can be modified so as to reflect the needs of a particular community. The following table summarizes the current set of transformation rules:

Analysis stage	**Decision stage**
Collaboration space	Issue
Idea	Alternative
Relationship between comment/note and idea colored red	Position against the alternative
Relationship between comment/note and idea colored green	Position in-favor of the alternative
Thickness of the relationships	Weight of the position

Some resources present in the analysis stage are simply ignored by the transformation mechanism. After completing this procedure the collaboration can continue at the decision stage where advanced functionalities can be provided.

Conclusions

In this paper we have presented how CoPe_it! attempts to address the evolution of argumentative collaboration for decision making in CoPs. When CoPs get engaged in such activities argumentation systems must support both the emergence of the shared collaboration space towards sense-making and the emergence of the entire collaboration towards the decision. Current argumentative systems exhibit with respect to this a gap: they either support well emergence of a space for sense-making or emergence of the collaboration towards decision making. They lack a unifying framework that integrates both aspects. CoPe_it! attempts to bridge this gap by providing a framework that enables incremental formalization of the argumentative collaboration. Future work includes evaluating extensively the proposed framework in environments of real CoPs and investigating additional mechanisms to facilitate the stepwise evolution of argumentation collaboration.

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