Proposals for adaptive and interoperable IA systems

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Abstract: This paper outlines the experience and current proposals of our research group in the support to the analysis of interaction in CSCL blended scenarios. We adopted a participatory approach that led us to use Social Network Analysis to support the study of these settings. Two of our main concerns during this year have been to provide an extensible solution based on the interoperability of the tools, and to adapt the results obtained by the IA process to different types of users. We present our proposals related to these two topics, as well as several reflections related to our experience in trying to develop them further.

Introduction

The application of Computer-Supported Interaction Analysis IA methods and tools (IA methods and tools for short) can contribute very positively to CSCL research (Dimitracopoulou, 2005; Soller, Martínez, Jermann, & Muehlenbrock, 2005). However, IA has not yet been incorporated into mainstream CSCL practice, partially because research in this area has not produced enough number of stable and generic solutions that practitioners can adopt (Martínez-Monés, Dimitriadis, & Harrer, 2008). As a response to this problem, the authors' work in this field during the last years has focused on providing IA tools able to *adapt* to the needs to different users, such as teachers and students. These tools are based on *open architectures* that aim at being extensible so that the IA tools can be applied to new scenarios with little or none programming effort, thus increasing their potential impact.

Our first proposals regarding IA methods and tools aimed at supporting teachers in the evaluation of classroom-based CSCL experiences. We adopted a situated perspective, focusing on the analysis of participatory aspects of learning. With this approach, and taking into account the specific requirements and opportunities provided by CSCL systems**,** we proposed the so-called ``Mixed evaluation method" (Martínez, Dimitriadis, Rubia, Gómez, & de la Fuente, 2003) that defines how data sources and analysis methods can be combined with the goal of achieving a deep understanding of participatory aspects of the learning processes. This method is supported by computer tools. For example, in order to integrate SNA in the process, and make it feasible for teachers and non-experts, we developed SAMSA (*System for Adjacency Matrix and Sociogram-based Analysis*) (Martínez, Dimitriadis, et al., 2003), a tool that takes data conforming to a generic protocol defined in (Martínez, de la Fuente, & Dimitriadis, 2003) and automates part of the SNA processes. SAMSA allows to configure the analysis, specially regarding how are the social networks being defined for each case. With this information and the data, SAMSA produces several SNA indexes (degree, closeness, density, etc.), and enables the visualization of the resulting networks as sociograms. The sociograms are enriched with additional properties (color, shapes, line width) to add meaning to them and help the user in their interpretation. SAMSA was validated in the evaluation of several CSCL experiences where BSCW and Synergeia were used as the collaborative learning supporting tools (Martínez, et al., 2006).

These and other experiences helped us to get conscious of some of the problems that hinder a wider adoption of IA tools in CSCL (Martínez-Monés, et al., 2008). In order to advance towards a more generalized application of these IA systems, our current efforts are focused in the areas of *adaptivity* and *interoperability*. Regarding the former, we are working in an extension of SAMSA, called RoleAdaptIA (Marcos-García, Martínez-Monés, Dimitriadis, & Rodríguez-Triana, 2008), which adapts its output to the needs of the different roles participating in a CSCL experience. With respect to interoperability, we have been involved in several initiatives that try to increase it in the IA field. Both aspects will be discussed in this paper with references to our work related to them.

The rest of the paper is structured as follows: First, we describe our recent experience in the provision of adaptivity and interoperability in IA systems. After it, we outline on-going work related to these issues. All this work has helped us to identify some open questions related to the integration of IA in CSCL practices, which are summarized in the last section of the paper.

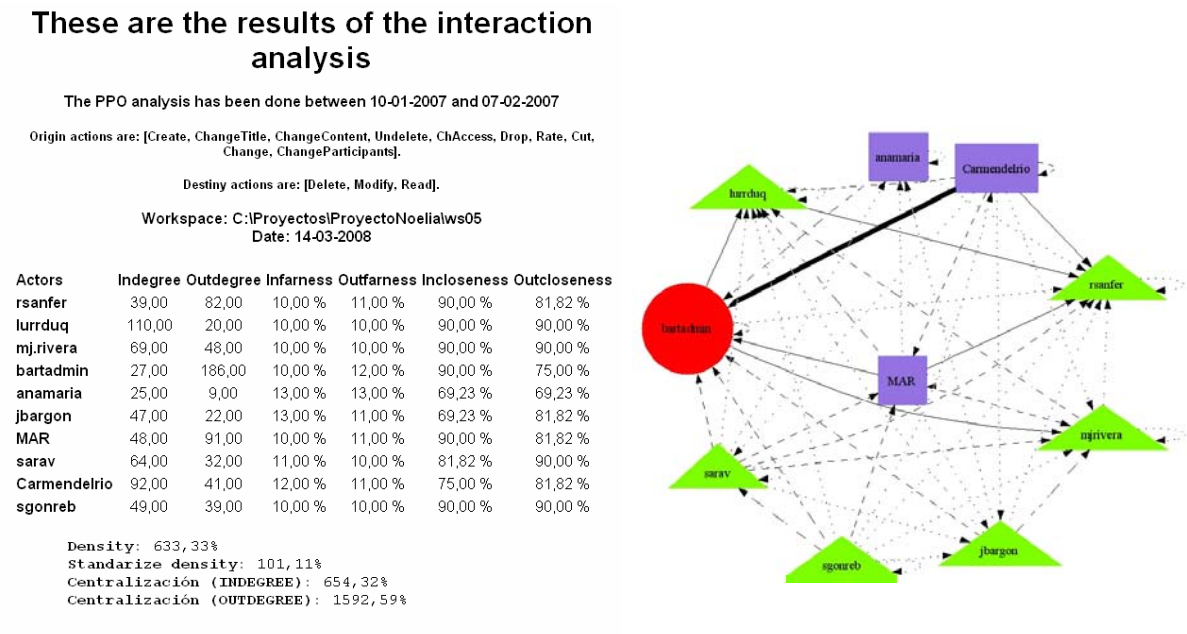
Adapting the feedback of the IA tool to the needs of different users

As mentioned in the previous section, SAMSA was designed to support evaluation processes. However, it was clear from the outset that its output could be used by other actors, like students. In general, IA can serve different functions (evaluation, monitoring, reflection), which themselves correspond to different users' needs within the collaborative processes. In fact, we state that in order to be more efficient in our proposals as IA

researchers, we should design and develop adaptive AI tools, able to provide the information needed by the different actors implied in a CSCL scenario.

Our approach to achieve this goal is based on roles. In educational systems, the concept of "role" refers to the characteristics of an actor participating in the process, and can be refined to distinguish different functions among these actors. However, there is no universal classification of roles, as it depends among other things on the context of the educational experience. For this reason, we have proposed a *framework for the description of roles* (Marcos-García, Martínez-Monés, Dimitriadis, & Anguita-Martínez, 2007) that enables the definition of the roles of interest in a given situation, the parameters that define them, and their information needs. Both the parameters and the needs are defined in terms of the indicators provided by the IA tool being used. This way, this IA tool will be able to detect if a concrete actor starts to behave according to the characteristics of a role defined with the framework. After identifying this fact, the IA tool will also be able to adapt its output to the needs of that role, as defined in the framework. At this moment, the framework is supported by a tool named RoleAdaptIA (Marcos-García, et al., 2008).

The framework has been defined and evaluated during a iterative design process, based on several case studies, documented in (Marcos, Martínez, & Dimitriadis, 2006; Marcos, Martínez, Dimitriadis, & Anguita, 2006). In them, several SNA indicators where used to define the roles with respect to their participation in the collaborative activity (e.g., *teacher-guide*, *teacher-collaborator*, *student-isolated*, *student-coordinator*. The output offered by SAMSA was adapted to these roles to make it closer to the needs and capacities of each one of them. Figure 1 shows an example of the report sent by e-mail to the participants that hold the *"student-coordinator"* role, with elementary graphical and numerical information, according to the IA needs specified previously. The graphical information is a sociogram representing the collaboration of the participants by means of a social network. The numerical information shows some SNA indexes related to the individual and group collaboration of the participants during a period of the collaborative activity.



These are the results of the interaction analysis

The PPO analysis has been done between 10-01-2007 and 07-02-2007

Origin actions are: [Create, ChangeTitle, ChangeContent, Undelete, ChAccess, Drop, Rate, Cut, Change, ChangeParticipants].

Destiny actions are: [Delete, Modify, Read].

Workspace: C:\Proyectos\ProyectoNoelia\ws05
Date: 14-03-2008

Actors	Indegree	Outdegree	Infarness	Outfarness	Incloseness	Outcloseness
rsanfer	39,00	82,00	10,00 %	11,00 %	90,00 %	81,82 %
lurrduq	110,00	20,00	10,00 %	10,00 %	90,00 %	90,00 %
mj.rivera	69,00	48,00	10,00 %	10,00 %	90,00 %	90,00 %
bartadmin	27,00	186,00	10,00 %	12,00 %	90,00 %	75,00 %
anamaria	25,00	9,00	13,00 %	13,00 %	69,23 %	69,23 %
jbargon	47,00	22,00	13,00 %	11,00 %	69,23 %	81,82 %
MAR	48,00	91,00	10,00 %	11,00 %	90,00 %	81,82 %
sarav	64,00	32,00	11,00 %	10,00 %	81,82 %	90,00 %
Carmendelrio	92,00	41,00	12,00 %	11,00 %	75,00 %	81,82 %
sgonreb	49,00	39,00	10,00 %	10,00 %	90,00 %	90,00 %

Density: 633,33%
Standarize density: 101,11%
Centralización (INDEGREE): 654,32%
Centralización (OUTDEGREE): 1592,59%

Figure 1. Example of the output provided to teachers by Role-AdaptIA

In order to evaluate these experiences, we adopted a qualitative approach, triangulating the information collected from different sources of data, including observations, group interviews and questionnaires. The participants of them assessed it positively. They stated that the information provided was easy to understand, reliable and useful for the self-regulation of their work. However, further and deeper evaluation methods should be used to be able to analyze the impact of the feedback given to the participants in their activities.

Interoperability based on a standardized data protocol to represent interaction

In the previous section we have mentioned *adaptivity* as a desired property of IA tools. Another important concern in this field is *interoperability*, i.e., the search for *open architectures* that allow to share tools, so that the different IA systems can be used with different collaborative environments and vice versa. This would be a

first step towards a library of IA tools and methods, which in turn would increase the number of studies carried out in collaborative experiences, and then, contribute to leveraging CSCL as a research area.

We started with an XML-based proposal to represent interaction that was flexible, generic and interoperable (Martínez, de la Fuente, et al., 2003). However, the objective of achieving a common proposal, shared with the rest of the community made it necessary to discuss these ideas with other groups that were working in this same area. Following this principle, we got involved in several projects within the European Excellence Network Kaleidoscope, more concretely IA and CAViCoLA (Kaleidoscope, 2007). In the former we worked in a shared library of interaction analysis tools, which made it necessary to define a set of dimensions and characteristics to describe such tools. This served to initiate the effort to define a common-format to represent interaction (Harrer, Martínez-Monés, & Dimitracopoulou). This work was continued in CAViCoLA, where several cross-site studies were carried out, and we could test different approaches to use the common format. As it can be seen in Figure 2, the most appropriate approach to this problem is that both the collaboration supporting and the analysis tools work in this format, facilitating the integration and making it more efficient. However, this solution will only be generalised when a common understanding and representation of collaborative interactions is well established and shared by a critical mass of researchers.

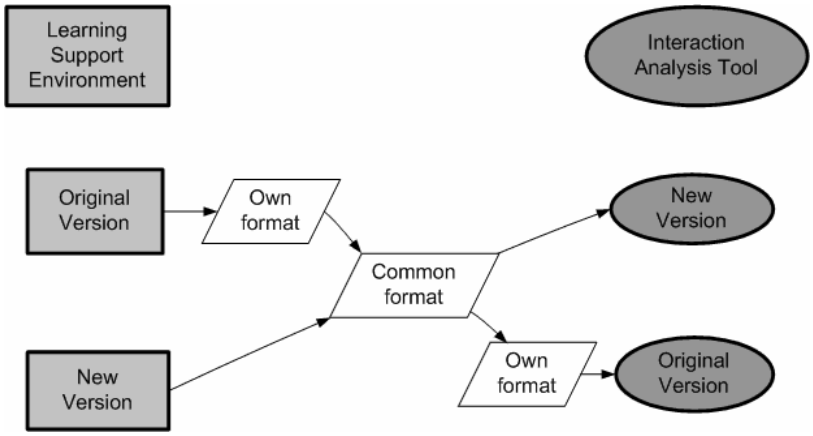


Figure 2. Different modes of using the common format with learning environments and analysis tools

Until the community reaches this common understanding and representation for collaborative interactions, a practical approach, depicted in Figure 2, is to develop translators between the specific formats to the proposed common one. This solution is also valid for the existing tools that cannot be modified. The mentioned CAViCoLA experiences were supported by XSL transformations. However, this solution is quite rigid and leads to several problems of information loss between transformations. Looking for more flexible techniques to translate the files, we have developed a new translator (*GCTranslator*) based in JAXB (Java Architecture for XML Binding) (Ort & Mehta, 2003). This Java API allows to represent the information contained in an XML file as (Java) objects, and therefore, use all the possibilities of a programming language to manipulate and convert the information from one format to another. This way, it is possible to convert different formats to and from the common format, provided the respective DTDs are compatible, i.e., the compulsory elements appear in the source files. Additionally, *GCtranslator* is able to validate the original documents and avoid working with badly formatted documents. The integration of different tools has been facilitated by the use of this translator. Currently, experiences with data from observations captured with Iloca and from wikis have been carried out with success, as described in the next section.

Current work: Integration of new data sources and learning environments

The aforementioned mixed method for the evaluation of CSCL experiences stated the convenience of using different data sources, such as observations, questionnaires, interviews, and automatic data-logs recorded by the collaboration supporting tools, in order to complement the information provided by each one of them and reaching a better understanding of the collaboration processes being modeled. In response to this, we are currently working in extending the input accepted by SAMSA to two new data sources, i.e., observations of face to face interaction in the classroom, and the data logs provided by a wiki-based learning environment.

The capture of observations from face to face interaction data is supported by Iloca (Interactive Learning Observer for Computer Analysis). Iloca helps observers to manage observations in a graphical and intuitive way. It can be pre-configured for a set of observations in a given scenario, by describing the scenario physical setup, its participants, as well as an initial set of interaction categories. This configuration is then used by observers as a template, on which they can annotate the face to face interactions occurring among

participants in one or more sessions. These interactions are stored in common format files, which can be translated using GCTranslator to the format accepted by SAMSA for its analysis.

From a technical point of view, the mentioned decoupled architecture together with GCTranslator allowed for a smooth integration of Iloca with SAMSA. This enabled us to set up a pilot study (still on-going at the moment of writing this paper). We are analyzing a classroom of about 24 students working in groups of two and four people, following an Inquiry-Based Learning approach. An observer annotated the face to face interactions between teachers and students, and between students of different groups. While the evaluation of this experience is still ongoing, several open issues have emerged, related to the preparation and interpretation of the data. For example, the definition of the initial Iloca categories made by the external observer was not directly mapped to the types of interaction identified by the common format, and thus, by SAMSA. This mismatch meant that not all the possibilities of the analysis could be exploited. It has been solved by modifying the categories and adding new types of interactions to the common format structure (which is a possibility considered in its definition). A second issue are the difficulties met by the observer to capture interactions at a sufficient level of detail so as to be able to analyze the dynamics of the classroom. An issue raised by the experience, thus, is the need to define efficient procedures to use Iloca in order to exploit the analysis capabilities provided by SAMSA (or any other IA tool able to use Iloca's output).

Besides face to face interactions, we are also interested in augmenting the number of learning environments analyzed by SAMSA, such as those based on wikis. Many implementations of wikis provide a public register of modifications to their pages, which makes them good candidates for its use as data sources for IA. However, this information is not always enough for a complete analysis. For example, it does not normally include *reading actions*. In response to this problem and other demands, we are currently working in an extension to MediaWiki that takes the data on all the actions performed by the users (including reading actions) from the database and translates it to the common data format. In order to avoid the potential danger of considering any access to a page as a reading action, the tool allows the user to specify a minimal time threshold below which a visit is not stored as a reading action.

In the initial analysis carried out to the data provided by this tool, we have met new challenges, which are not necessarily connected to wikis but to the way the teachers set up the environment. More concretely, we found that if we allow the user to specify a concrete time-frame for the analysis, (as it happens in SAMSA), it might not be possible to identify who created some pages. This is specially so if the course designers reuse them at the beginning of each course, instead of creating them from scratch, as it happens in the experience being analyzed. If this creation action is lacking, some meaningful relationships for the analysis are not possible to reproduce, such as the ones established between an actor that creates and object and the one(s) that read it. We are currently trying to sort out this problem without having to ask the users to change the way they carry out the setup of the learning environment.

Final remarks

IA tools and methods are still more a promise than a reality in CSCL. A wider adoption of these tools requires that the systems provide flexible and interoperable solutions, able to adapt to the needs of different users, and to be applicable to different learning supporting environments. In this paper we have analyzed two proposals that try to advance in these two directions.

Our first proposal is based on the framework for the definition of roles, that allows to define the needs and characteristics of the users of a CSCL environment. It has been successfully tested in the analysis of several learning situations, all of them based on the use of sociograms and SNA indexes. It would be interesting to extend this approach to other types of analysis. This would allow to test how the framework can support the adaptation of the output of IA tools different from SAMSA to their users' needs.

Regarding interoperability, the decoupled data-driven architecture based on a common data format and adapters has been shown as a successful solution for integrating new sources of data with existing tools, such as the mentioned Iloca observations and wiki-based interactions with SAMSA. Interestingly, the first experiences with these tools show that once the technical integration is solved, new problems appear, due to the different nature of interactions coming from each data source or to the distinct characteristics of the learning environments being considered. The positive point is that by facing these problems the community will be able to understand better the field and to provide more practical solutions for its end-users.

The long-term goal for the community is to define common models and representations of interaction data (the input of the IA tools) and of the indicators provided by them (their output). This would allow developers to combine different CSCL and IA tools to adapt them to the needs of their users in the different and changing contexts that characterize CSCL. Other initiatives in this direction are the MULCE project, that aims to define a learning data corpora for sharing purposes (Chanier, Reffay, Lamy, & Ganascia, 2009), and the Centralised Research Data Repository, another Kaleidoscope initiative, which aimed to define a common ontology to share learning materials among researchers ("Centralized Research Data Repository," 2007).

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