Role-AdaptIA: A role-based adaptive tool for interaction analysis

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Abstract

Interaction analysis (IA) is a basic instrument for computer-supported collaborative learning (CSCL), as it facilitates important educational functions such as monitoring, evaluation and reflection. However, IA tools and processes are still not adopted in mainstream CSCL practices, mostly due to the fact that the current proposals are research prototypes, which do not provide generic and usable solutions for practitioners. To face this weakness, researchers in the IA field should strive to provide *adaptive* and *interoperable* tools. This paper presents *Role-AdaptIA*, a tool based on the concept of role, which supports the adaptivity of IA tools, by enabling the definition of the needs and characteristics of different types of users (roles) in terms of IA indicators. This tool uses a *generic data format* to represent interactions, proposed by our group as part of our attempts to increase the interoperability of IA tools. This format is discussed in the context of other initiatives in which the authors have participated with other members of the IA research community in order to define a common format to represent interaction data.

1 Introduction

Interaction Analysis (IA) supports different functions, such as monitoring and evaluation, which are basic elements in any educational process. In Computer Supported Collaborative Learning (CSCL) systems, IA can contribute to understand collaboration, and computer support can be provided to enhance IA processes and make them more efficient (Soller, Martínez, Jermann, & Muehlenbrock, 2005). During the last years, a number of proposals of different nature (research- or practice-oriented, based on dialogue, action, products; etc) have been proposed, but IA is still rare in mainstream CSCL practices (Dimitracopoulou, 2005). Two approaches to face this problem are to design and develop *adaptable* AI tools, able to provide the different users of the CSCL systems with the information they need, and therefore, make these tools more flexible and usable in different contexts; and to provide for *interoperability* between CSCL and IA tools (or modules), so that it is possible to reuse them in different contexts and for different objectives.

With regard to *interoperability*, we have been involved in the proposal of generic, flexible and interoperable data formats to represent interactions, so that the CSCL community can share tools (both for supporting and analysing collaboration), and thus make their work more efficient. As this is not only a conceptual effort, but also requires agreements among the implied actors (mainly, the CSCL community), it is still ongoing research in the area, as this workshop reflects. Our tools are based on one of these generic data formats, so that they are able to understand data from different sources (ethnographic, automatic, etc.) and different types of interaction (dialogue-, action-, object- based, etc.). However, as there is still no unified representation for interaction data, in the meanwhile we need practical solutions to be able to share data and tools. In this line of work, we have been also working on translators to bridge different systems so that they can communicate between each other, even if their native data formats are different.

In order to achieve *adaptive* IA tools, we have defined a *framework for the description of roles* (Marcos-García, Martínez-Monés, Dimitriadis, & Anguita-Martínez, 2007) that enables the definition of the needs

and characteristics of the users of a CSCL situation in terms of the roles they can play in a specific context. Both the characteristics and the needs are defined in terms of the indicators provided by the IA tool being used. The framework is supported by a tole, called Role-AdaptIA (Role-Based Adaptive Tool for Interaction Analysis), that will be described in this paper.

The next section describes our work related to the representation of interoperable interaction data, while section 3 describes Role-AdaptIA research principles and use. The paper finishes with some reflections and remarks on the problems faced in this workshop.

2 Towards interoperable IA tools: Common and specific formats to represent interaction data

As discussed previously, an important concern in the CSCL field is *interoperability* among tools, i.e., the search for *open architectures* that allow to share tools. In the IA field, interoperability would enable that the different IA systems can be used with different collaborative environments and vice versa. This would allow to increase the number of studies carried out on collaborative experiences, and then, contribute to leveraging CSCL as a research area. Moreover, drawing on this basis, we could strive for development processes using *interaction-aware design and architectures*(Martínez-Monés, Dimitriadis, & Harrer, 2008), this is, a comprehensive vision to the development of CSCL systems that could take into account the need to analyse interactions from the beginning.

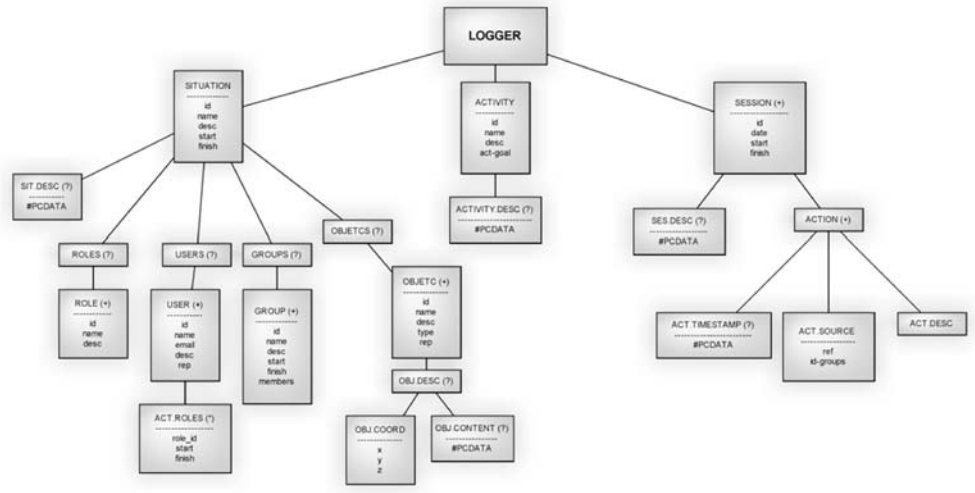


Figure 1: Main elements from the GSIC format

Our first contribution to *interoperability* in CSCL was the definition of a *data format* (which we will call *GSIC format*), to represent interactions (Martínez, de la Fuente, & Dimitriadis, 2003a). This format is *generic* in the sense that it can be used to represent different types of interactions (dialogue-, action-, object-based, one-to-one, one-to-many, etc.); *flexible*, as it has configurable elements, and *interoperable*, as it is described by means of the XML standard. This format has evolved, according to our current research objectives, in order to provide also for the adaptability of tools to the roles played by the actors implied in a CSCL situation (see next section). Figure 1 shows the main elements that constitute this format. The DTD proposes the element SITUATION as the one that represents the context of the learning activities. A situation is constituted by a set of sub-elements: ROLES, USERS, GROUPS and OBJECTS. ROLES is a basic element, as it supports our approach to adaptability, which will be described in the next section. The second aspect we face in our proposal is to provide an operational taxonomy for the representation of interactions. We aim at integrating dialog and action, as well as data collected manually as well as automatically

in a common structure, by means of a classification that focuses on the agents that take part in interactions. This way, the proposal distinguishes between direct interactions with a source and one or more receivers (ACT.DIR), indirect interactions, mediated by a shared object (ACT.IND) and finally, participation-oriented interactions, that allow to annotate participations of an actor in situations where no receptor has been identified (ACT.PART). These elements are further defined by sub-elements and attributes, not shown in the figure. The main advantage of this bottom-up approach is that it easily accommodates to the data collected by the (CSCL) system for each type of interaction.

The properties of the GSIC-format have been validated by its use for representing different types of interaction in different contexts (Martínez et al., 2006). However, the objective of achieving a common format proposal, globally accepted by the IA community, made it necessary to discuss these ideas with other groups that were working in this same area, to advance towards this joint proposal. Following this principle, we have been involved in several projects within the European Excellence Network Kaleidoscope (Kaleidoscope, 2007). In the IA (Interaction Analysis' supporting Teachers & Students' Self-regulation) project we worked in a *shared library of interaction analysis tools*, for which it was necessary to define a set of dimensions and characteristics to describe such tools (Martínez, Harrer, Barros, & Vélez, 2005). This served to initiate the effort to define a first version of the so-called *common-format* to represent interaction data (Harrer, Martínez Monés, & Dimitracopoulou, 2008). This work was continued in CAViCoLA (Computer-based Analysis and Visualization of Collaborative Learning Activities), also within Kaleidoscope NoE. In this project, several cross-site studies were carried out, where our interaction data was applied to the tools developed by the different participant teams. In these studies 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.

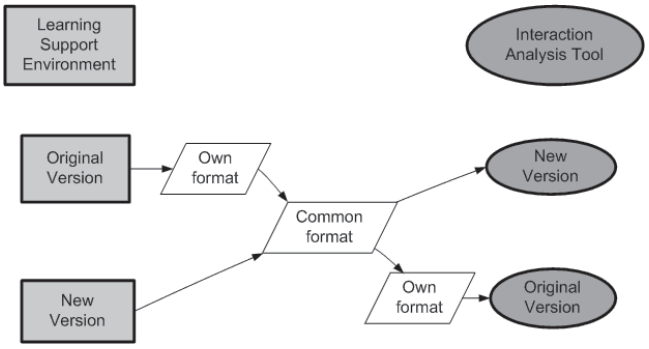


Figure 2: Different modes of using the common format with learning environments and analysis tools

Until the community reaches this common understanding and representation for collaborative interactions, a practical approach, as seen 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 (W3C, 1999). 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 are developing a new translator 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, this JAXB-based translator is able to validate the original documents and avoid working with badly formatted documents.

3 Role-AdaptIA: ROLE-Based ADAPtive Tool for Interaction Analysis

This section provides a basic description of Role-AdaptIA, a tool based on the structured description of roles, which main objective is to be able to adapt the output of IA tools to the needs of the actors involved in CSCL environments.

3.1 Role-AdaptIA approach and principles

As mentioned beforehand, our approach to achieve adaptivity 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 (ISO/IEC JTC1 SC36, 2001). 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 et al., 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.

The framework is supported by Role-AdaptIA, that enables its users (normally teachers) to use the framework to define the *roles* to take into account in a given situation, and to specify their *characteristics* and *needs*, in terms of IA indicators. Currently, Role-AdaptIA draws on SAMSA (Martínez, Dimitriadis, Tardajos, Velloso, & Villacorta, 2003), an IA tool that builds social networks representing the interaction among the users of a CSCL environment and computes a set of social network analysis indexes that measure individuals' participation and groups' collaboration structures.

The framework has been defined following an iterative design process, based on several case studies, documented in Marcos, Martínez, and Dimitriadis (2006), Marcos, Martínez, Dimitriadis, and Anguita (2006). In these case studies, several SNA indicators were 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. These experiences were validated using the *mixed evaluation method*, which allowed us to positively assess the adaptiveness achieved by the new tool, and also pointed to further improvements to both the tool and the framework. More details about this validation are given in the referred papers.

3.2 Role-AdaptIA in use. Some examples

In this section, a brief introduction to Role-AdaptIA basic functionality is presented, including how to define the needs of a role in terms of IA, the actual information provided to this role, and finally, how to define its characteristics in terms of IA indicators.

Figure 3 shows the menu displayed by Role-AdaptIA to define the IA needs of a role,, in this case, the "student-coordinator". The information provided on IA needs specifies the IA information required for a role in a particular context. These requirements include the *purpose* pursued with the provided information (i.e., social-awareness, regulation, evaluation), the *information content* (e.g., individual intra-group collaboration or inter-groups collaboration during a time period) and *type*, that specifies the *output format* (e.g., numerical or graphical) and the *presentation* way and complexity of this information (e.g. elementary sociogram, advanced list of specific SNA indexes), as well as the *frequency* and type of *communication medium* which will be used to communicate the information to the user.

Figure 4 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

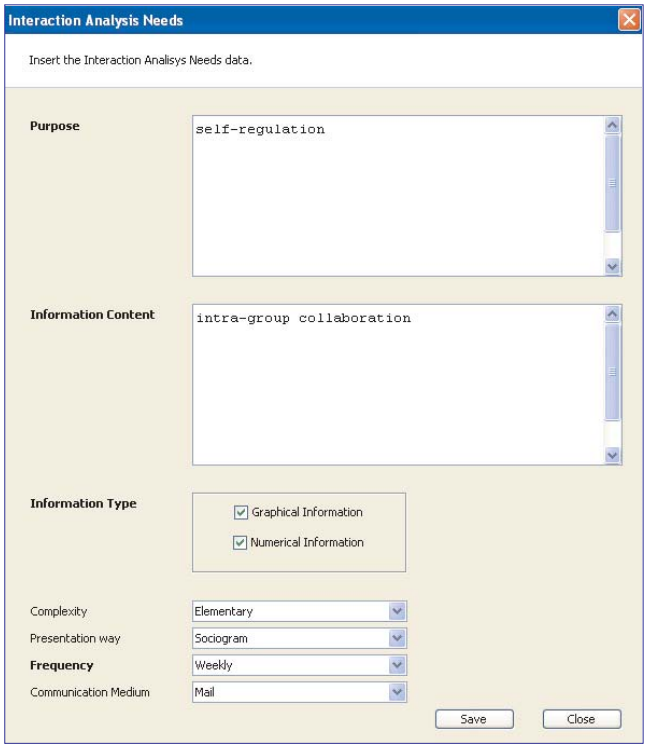
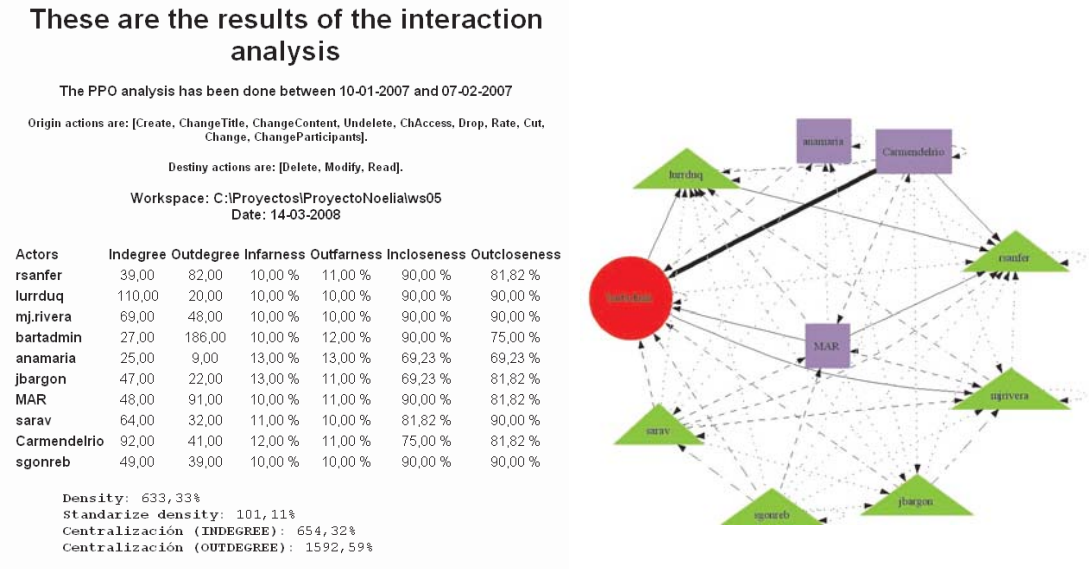


Figure 3: Specification of IA needs for the role "student-coordinator" in Role-AdaptIA



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 4: Example of the output provided by Role-AdaptIA to a student-coordinator. It includes numerical (SNA indexes) and graphical (sociogram) information of the group to which the student belongs

above (see figure 3). 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.

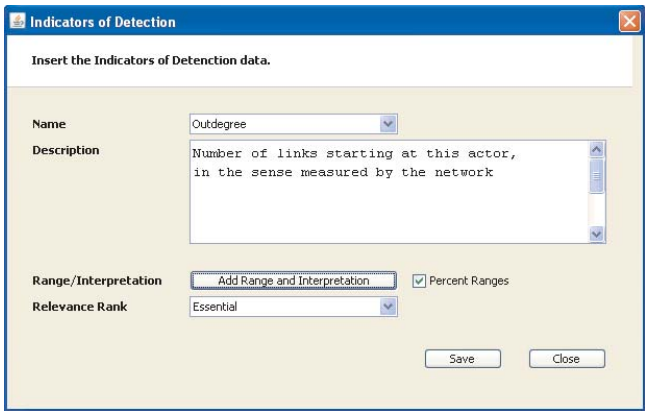


Figure 5: Definition of indicators that characterize a role for its detection

The dynamic adaptation of the output provided by Role-AdaptIA to the roles' needs requires that the IA tool can detect the dynamic role transitions between roles that usually occur in authentic learning settings during the development of a collaborative activity. To achieve this aim, Role-AdaptIA checks automatically the different participants' roles during the activities, and detects role changes using a list of indicators and values defined previously that characterize each role for this collaborative experience. When the tool detects a role change (i.e., a student starts to behave as a "coordinator"), the teacher receives a warning. With this information, the teacher can modify the role assigned to this participant, and Role-AdaptIA adapts dynamically the information provided to this participant according to the needs required by the new assigned role. Figure 5 shows the menu to define the indicators and values that characterize a role for its detection. The specification of each indicator related to the detection of a role includes five aspects: the name of indicator, its description, the rank of values to detect by the analysis and the relevance rank of the indicator for detecting this role, specified as some proportion or as a priority rank.

Role-AdaptIA is still under refinement. Our short-term objectives include to enable finer-grained choices for the specification of the indicators to be provided to the users. On a medium-term, we plan to redesign its architecture, in order to introduce indicators provided by other IA tools different from SAMSA. This will require decoupled architectures, were the IA tools are able to expose their outputs in standard formats, so that other tools (like Role-AdaptIA) can use them at convenience. Service-oriented architectures are promising to achieve this goal, but again, the research community should commit itself to produce a critical mass of IA tools usable by third parties following these principles.

4 Conclusions and further remarks

This paper has presented and discussed our proposals for interoperability and adaptivity of IA tools in the CSCL field. These two properties are necesary in order to achieve more usable and efficient IA processes, and thus, facilitate their adoption by the broader community of CSCL practitioners.

This paper has introduced the initiatives we have been involved in to define generic and common formats to represent interactions, which, once adopted, may allow CSCL practitioners to analyse their interactions with a choice of IA tools offered by third parties, thus opening new possibilities to enrich the CSCL practices they are involved in. This common format that would enable communication among tools may live together with specific ones, adapted to the needs of each tool. For this reason, appropriate solutions to translate data between these formats, such as the one we are currently developing, are also needed. It is to be noted that the current proposal of a common format, although it has already been used and tested by different research teams, is still in early stages of adoption. It is a minimalist syntax proposal, that has tried to avoid details,

in order to increase generalizability. Therefore, there is still work to be done in this line, including more comprehensive views to the conceptualization of collaborative interaction, and possibly including semantics in their description.

This shared conceptualization of collaborative interactions should take into account the requirements posed by the different tools and analysis processes being proposed by the community. For example, the tool presented in this paper, *Role-AdaptIT*, draws on the concept of role to adapt the output of IA tools to the needs of their users. According to this perspective, the roles and their characteristics should be an important element in the conceptualization of interactions taking place in CSCL environments.

Related to this discussion is the need to define and implement decoupled architectures based on these common conceptualizations. 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 characterise CSCL.

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