Towards a Flexible Intelligent Tutoring System for Argumentation

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Abstract

Supporting students in the acquisition of argumentation skills is an important goal of educational technology. However, there has not been much work done towards developing generic and reusable software architectures for collaborative argumentation that could reduce the development time for distributed argumentation learning systems. Based on a survey of more than 50 different argumentation systems, this paper presents a requirements analysis for a generic collaborative intelligent tutoring system for argumentation.

1. Introduction

Argumentation skills are critical for humans in many aspects of life. Consequently, teaching argumentation skills is a central goal of education. The classical way of teaching these skills is the provision of instructions on argumentation through face-to-face dialog and direct interaction between teacher and students. However, this approach does not "scale up" well hence it is not possible to teach large numbers of students effectively using this approach due to limitations in teacher time and availability.

Educational technology such as computer-supported collaborative learning (CSCL) systems and intelligent tutoring systems (ITS) can help realize instruction on argumentation at a larger scale. Indeed, there has been considerable effort in developing and assessing educational technology to support argumentation (e.g., [1], [2]). Many of these efforts have been shown to be educationally effective for specific argumentation domains. Yet, there has not been the same amount of research aimed at generic, flexible, and reusable software architectures for building educational collaborative argumentation systems. Building upon a well-designed software architecture has the potential to reduce the development time for constructing collaborative argumentation learning systems as compared to a "from scratch" development approach.

But what are the essential design features and requirements for a flexible software architecture that facilitates the implementation of a rich variety of potentially differently targeted educational argumentation systems for research purposes and practical classroom usage? Based on an extensive systematic literature review of more than 50 argumentation systems covering both general-purpose and educationally targeted tools, e.g., *Digalo* [3], *LARGO* [4], and *Belvedere* [5], this paper summarizes the key requirements resulting from our investigations.

2. System and Architecture Requirements

In the literature review, we compared and classified the existing systems with respect to a number of criteria, including general information (e.g., system purpose/intended usage), argumentation related criteria (e.g., domain and ontology), main system functions, degrees of system flexibility, collaboration options, intelligent argument analysis and system feedback, user-interface design and interaction techniques, technological criteria (e.g., used programming languages, adopted technology standards, software architecture) as well as evaluation related criteria. This comparison led to a list of requirements that a general CSCL argumentation system should fulfill. These requirements are presented in this paper, classified by type (functional and non-functional features). A first proposal of an architecture based on the requirements can be found in [6] and [7].

2.1. Functional Requirements

By nature, a flexible CSCL argumentation system should support different forms of *collaboration*

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(including different *awareness* mechanisms and *roles* such as moderator or student): While synchronous collaboration is beneficial for early brain-storming phases of argumentation, some typical school scenarios (e.g., discussion of arguments as homework) require asynchronous collaboration. These different collaboration manners can be supported by collaboration scripts (defined e.g. in IMS-LD), i.e. process definitions that serve as scaffolds for the collaboration processes [8].

To enable collaboration, it is essential to provide facilities for *communication* like chats (textual, audio or even video). These communication channels can be used by the students as well as by *intelligent software agents* to analyze and give feedback to arguments or to coordinate the further procedure among the students.

Another important aspect is the support for *different visualizations*, i.e. graphical or textual representations of arguments which fit domain and context specific needs ([5]). These different visualizations may include different *pre-defined ontologies* (e.g. Toulmin [9] or Wigmore [10]) or even *self-defined ontologies* such as available in *Digalo* [3].

A possibility to support needs of specific argumentation domains is the integration of *external resources* (e.g., texts, interactive web pages, or videos) to back up parts of the argument. Here, *micro-references*, i.e. references to parts of external resources (such as a paragraph in a given text) are required for some forms of argumentation (such as in *LARGO* [4]).

Especially for research purposes, a sophisticated *action-based logging* mechanism would be helpful, because this makes it possible to reconstruct each step of the argumentation process. Thus it would be easy to create a replay-client as used in Digalo [3], which could be used for discussions of the argumentation process.

2.2. Non-Functional Requirements

While most of the functional requirements are directly connected to argumentation systems, the non-functional requirements are more general, i.e. they are common to most collaborative learning systems and well established in the software engineering domain:

First, the system must be *flexible* to be used in different domains with requirements that are manifold. Thus, *configurability* and *extensibility* are key features. Second, a *loose coupling* of system parts would be beneficial for the *maintainability*. Third, the system must scale up well to support also larger groups of students in their argumentation (both through intelligent support and collaboration). Fourth, the system should be *open* for interaction with other systems, which could be achieved via a *standardized data exchange and communication format*. Finally, the system should be able to handle the data in a *persistent* and *consistent* manner, avoiding data loss and handling concurrency.

3. References

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