From Argumentation Theory to Real Life Debating - Building Social Web Applications

Abstract. With the World Wide Web firmly in place as the prime source of human knowledge, its contents and structures feature more and more prominently as sources for Argumentation research. Being no exception to this, we present a number of applications of Argumentation that build upon the online debating platform *Quaestio-it*. As a website, Quaestio-it provides an intuitive user interface through which users can debate any topic of interest. These debates are then evaluated automatically, assigning strength values to arguments and establishing winning arguments in a debate. As a more generic platform, Quaestio-it offers a variety of ways to be integrated within other, more specialised settings. With this paper we present three such settings, each of which illustrating the real life applicability of Argumentation research. We (I) describe the integration of Quaestio-it in a decision support system for the injection molding industry; (II) present developments towards using Quaestio-it as an e-learning tool and (III) describe how we use Quaestio-it as a crowd sourcing tool to support an serve as a test-bed for Argument Mining applications.

1 Introduction

Since its inception the Internet has been an ever-growing web, with every hyperlink spinning a new thread from one place to another. Today, many Argumentation researchers see the proliferation of debates and arguments within this web as a call to action and have adopted the Internet and its contents as one of the main sources for their research. Formalisms such as the Web Ontology Language (OWL) [13] propose ways to adorn any content on the web with metadata. This allows us to connect contents on the web, not only via hyperlinks, but through semantic relations, as well. Introducing such relations between contents on the web may offer us whole new ways of gathering information and is thus an appealing concept. The issue we face, however, is the size of the web that already exists. Having grown organically from hyperlinks, very little data has been annotated with metadata, and retrofitting seems out of the question.

Today, fora, customer reviews, discussion threads on social networks and many other sources of discussion produce more and more content. A growing body of work deals with ways of facilitating debates and introducing meta data, which can then be used to process this data more intelligently. A thorough review of Argumentation on the web is presented in [15].

With this paper we focus on Quaestio-it, a debating platform we have developed in [8], which uses algorithms to compute the strength of arguments in a certain context, as well as an innovative user interface. Instead of a grand scheme

to annotate the web, or the part of it that comes in the shape of arguments, we introduce an application that builds webs, or rather trees, of arguments within a closed world, offering concrete solutions for both research problems and industrial settings. We have used Quaestio-it to (I) develop a decision support tool for the Injection Molding Industry, (II) for e-learning applications and to (III) collect data to support Argument Mining research, as well as to serve as a test-bed for Argument Mining applications.

We present these three use cases for Argumentation applications, alongside lessons learned from taking Argumentation to the World Wide Web. The remainder of this paper is organised as follows: We review argumentation frameworks that for the basis of Quaestio-it in section 2. We then discuss the functionalities of Quaestio-it in section 3. Based on this we introduce the three applications for which we are using and have adapted Quaestio-it; (I) the engineering use case in section 4, (II) the e-learning use case in section 5 and (III) Argument Mining solutions in section 6. We conclude our paper with a discussion of the applications presented, as well as an outlook towards future developments, in section 7.

2 Background

Several argumentation frameworks exist that offer ways of modelling arguments and the relations between them. These frameworks can be divided into two sub-categories: (I) Abstract Argumentation frameworks where arguments and their attacking relations are formalised without focusing on the internal form of the arguments [6] and (II) Structured Argumentation frameworks where a more complex logical structure of the arguments is defined (see [1] for recent developments). This paper focuses on recent advances of Abstract Argumentation Frameworks in order to facilitate and support online debating.

An Abstract Argumentation Framework is a pair of: (I) a set of arguments and (II) a binary relation representing the attacks between them [6]. In Abstract Argumentation, semantics can provide a way to identify the strength of the arguments. Argumentation semantics, however, only provide a binary distinction between the arguments (e.g admissible or non-admissible [6]) which is not suitable for human debates. In such settings a more expressive mechanism is needed to assign individual values to the arguments that reflect their "strength" within a framework. Weighted Argumentation Frameworks [12] include a mechanism for asserting an argument's strength on a continuous scale (i.e non-binary classification). Each argument within the framework is evaluated and assigned a (predefined-range) value representing its strength (typically [0,1]). The strongest or weakest arguments within a framework can be identified simply by ordering the arguments according to their calculated strength.

Another extension of Abstract Argumentation frameworks is the inclusion of the relation of "support" between the arguments. Bipolarity in Argumentation Frameworks refers to the introduction of not only negative interactions between arguments (attacks) but also positive ones [2]. Supporting relations be-

tween arguments could be associated with counter-attacks in standard abstract Argumentation Frameworks. The concept of support can be helpful in modelling human debates where arguments can also support each other.

Other frameworks, such as the (Extended) Social Abstract Argumentation Framework [8] not only include supporting and attacking comments but also a voting mechanism where each argument is mapped to a number of positive and negative votes. This gives additional information about an argument's initial strength and through the use of various algorithms and models this can be aggregated to identify the strongest arguments.

3 Quaestio-it: Using Argumentation for Questions and Answers

Quaestio-it (www.quaestio-it.com) is a web-based Q&A debating platform that allows user to open topics, ask their own questions, post answers, comment and vote. It provides an interactive way for engaging into conversations regarding any question within the platform. Through an evaluation algorithm based on the Extended Social Abstract Argumentation Framework [8], the best answers and comments are highlighted. The strength is also visible through the visualisations in which stronger answers and comments are visibly larger. This section identifies the most relevant features of the platform.

Within the platform, each answer is open for discussion and users can post their comments, as supporting or attacking arguments, expressing their agreement or disagreement to the answer respectively. Subsequent levels of comments are regarded as attacks or supports to the parent comment/argument. This creates a debate that can be modelled as an Extended Social Abstract Argumentation Framework. In order to obtain the relations between arguments within a debate, each user, when posting an argument, has to explicitly state the nature of the comment (i.e. attacking or supporting argument). Answers and comments are then evaluated and the best answer for each question is highlighted. The rest of this section reviews the most relevant features and capabilities of the platform.

3.1 Browsing

Quaestio-it offers an interactive way for browsing through topics. Figure 1 shows a screen-shot of the visual map of the website where all topics are represented as bubbles and their respective size indicates their participation rate in terms of active contributors (i.e. the number of users that have either posted a question, an answer, a comment or voted). Therefore, the most active topics stand out in terms of their size.

3.2 Debating

In Quaestio-it, debates are represented as trees where: (I) the root node corresponds to the initial question, (II) its immediate children correspond to the

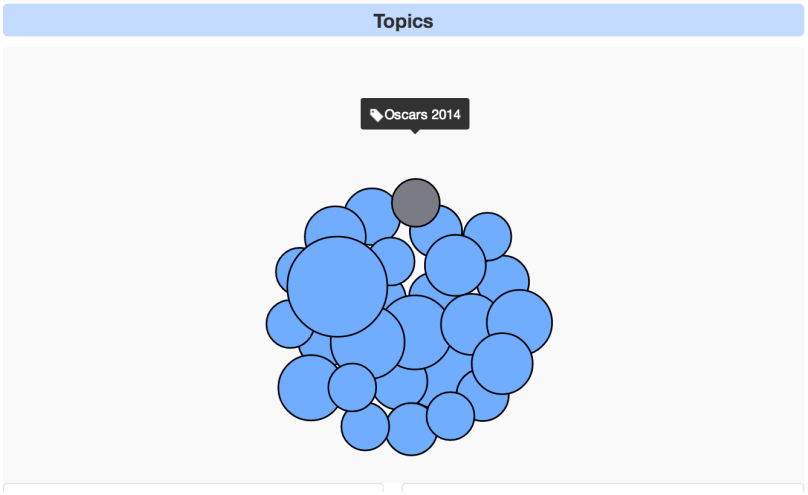

Fig. 1. A screen shot of the prototype application showing the topics user interface

answers and (III) all other subsequent level nodes are comments (i.e. supporting or attacking arguments on the answers). One such debate is shown in figure 2. The edges connecting the nodes indicate the relations between question, answers and arguments. Dashed edges indicate direct answers to the question, while straight, red (-) or green (+), edges show attacking or supporting arguments on the answers or on other arguments (as posted by the users).

Figure 3 shows several screen-shots of the development of a debate about whether or not the Matthew McConaughey deserved the best actor in a leading role oscar. Figure 3 (a) shows the initial question posted by the user while Figures 3 (b) and 3 (c) show the two first answers. At this point, both answers have identical strength since none of them has accumulated any votes or arguments. In Figures 3 (d) and (e), two supporting arguments are posted to one of the answers. This increases the answer's strength, making it the best answer for the question. In Figure 3 (f) an attacking argument is posted to the second answer, lowering therefore its strength. Finally, after both answers and arguments have accumulated a number of positive and negative votes, the final state of the debate is shown in Figures 2 and 4 where the best answer is highlighted with a strength of 0.684. This is due to the number of positive votes it has accumulated and the two supportive arguments posted by other users. Nodes vary in size depending on the strength evaluation. This provides a quick insight about the dominant (strongest) answers and comments for a particular question. Hovering over each node displays additional information for each comment or answer including its text and calculated strength.

Each debate can also be viewed in a more conventional form, which is shown in figure 4. This textual view of the debate includes the positive/negative votes ratio, strength evaluations and all available actions to the user. The available

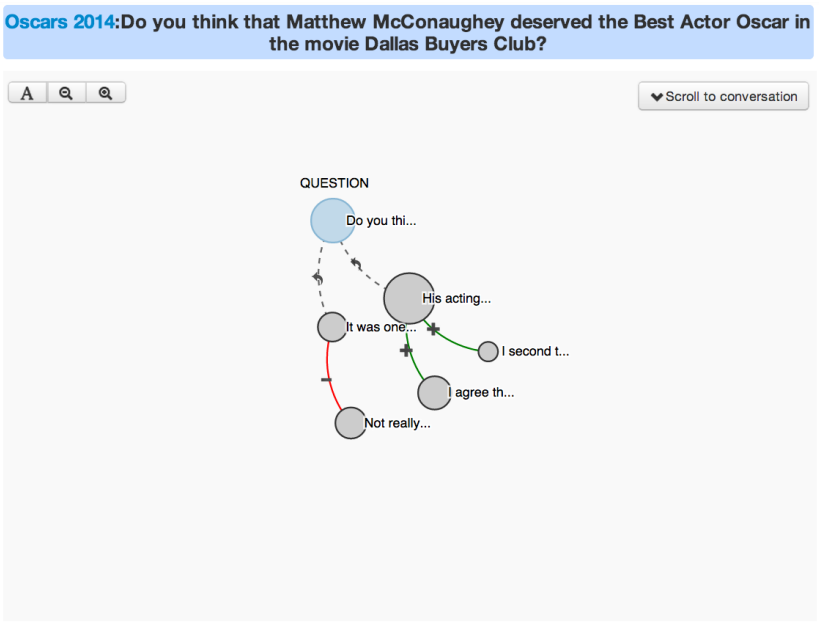

Fig. 2. A screen shot of the application showing the graphical representation of the final state of the debate

actions to the user from either view of the debate are (I) posting a reply and (II) voting positively, negatively or indicating that a comment is irrelevant, malicious or spam. After a predefined number of *spam* votes on an argument or an answer are disregarded alongside their sub-tree of comments.

3.3 Private Rooms

Private discussions within the platform can be initiated through the use of *private rooms* where a user, when creating a topic, can select to make it private and send invites to selected users to participate. Each user can create or be invited to multiple private rooms. This was found to be important in order for the platform to be used within organisations and companies wanting to discuss confidential or sensitive information. The next section descirbes such a scenario where the platform is being used by companies within the injection molding industry to discuss various design decisions and issues.

4 DesMold: Argumentation in Engineering

Computational Argumentation has been proven to be beneficial in a number of Engineering applications, e.g. [3]. Expert knowledge can be modelled through

Fig. 3. A screen shot of the application showing the development of the debate

Argumentation Frameworks and then analysed, extracting therefore useful conclusions that can aid engineers throughout the decision making process. The *Desmold* project [4] (www.desmold.eu) is a collaboration between industry experts in injection molding and Argumentation for building a knowledge-based system to aid injection molding design and prototyping. Within the system experts can share their experiences and opinions, through the debating platform, regarding each design and collaborate throughout the decision-making process. Additional information is provided by a Case Base Reasoner (CBR), where past debates and designs are stored and retrieved depending on their similarity to the current design being debated.

The platform is mainly composed of the following processes: (I) a decomposition process to convert complex geometries into simplified geometries, (II) a debate

Fig. 4. A screen shot of the application showing the text representation of the final state of the debate

process supporting argumentation and ontology interoperability to ensure designers' mutual understandings and (III) automatic recommendations based on debates, past experience and rules (see [4] for details).

To support the debating process, a separate instantiation of Quaestio-it is used for the debating process. Each debate is created by the users of the system to initiate a conversation about certain design choices and/or problems. All partners involved in the debate can contribute by providing their opinion in the form of arguments. Supportive material such as documents, images and an ontological representation of the concepts of each design provide additional information to the users to aid them in understanding the given problem and express their agreement or disagreement. Additionally, arguments are constructed from past cases, as provided by the CBR, and incorporated within the debate. Finally, after the debated has finished, the winning answer of each debate is highlighted

by taking into account all the available information, in the same manner as in the standard version of Quaestio-it.

5 E-learning

E-learning platforms have grown increasingly popular over the past years, with much research devoted to it; see, for example, [**?**,**?**] for recent overviews. Knowledge and education resources are accessible to a wide audience. However, conventional e-learning platforms do not materialise the true essence of a class environment where students and lectures communicate, exchange ideas and provide feedback. They are only focused on providing and consuming course material and assesing coursework.

Using a debating platform such as Quaestio-it, we can create an interactive environment between students and lecturers allowing students to express their opinion and teachers to collect valuable feedback and discuss upon teaching material, teaching methods, difficulty levels, etc. It can be used to support a friendly, interactive atmosphere amongst lecturers and students so that each side can benefit: (I) students benefit by expressing and discussing their ideas, concerns or complaints in a structured but intuitive user friendly environment and getting feedback at run-time, and (II) lecturers benefit by collecting valuable feedback on course material and teaching methods therefore understanding the overall sentiment towards courses and assessments.

As a pilot test of this idea, we created a separate topic within Quaestio-it for use in the tutorials of the "Argumentation and Multi-Agent Systems" course at Imperial College London. Students can login and post their questions about the course and the coursework and everyone can contribute in the answers including the lecturer and the tutorial helpers.

6 Argument Mining

Throughout the previous sections we have introduced applications that use the Quaestio-it architecture to provide functionalities for users that debate a certain topic. In this section we describe a project for which we are using Quaestio-it as a crowd-sourcing tool. Argument Mining research aims to automate, or at least facilitate, the process of building Argument Frameworks from text, where an AF is comprised of a set of Arguments, as well as attack and support relations between arguments, as described in section 2.

We are currently developing a prototype of an Argument Mining tool to classify relations between statements [5]. Our system takes as input two pieces of text and determines whether statement Child attacks or supports statement Parent. To achieve this we are exploring a number of classification techniques. On the one hand we have developed a scoring algorithm that weights an *attack score* and a *support score*. These scores are calculated based on similarity measures

[14], as well as sentiment scores [7] and keyword lists [11]. On the other hand we have trained a number of classifiers on the data extracted from Quaestio-it. To do so we take the measures used for the scoring algorithms and treat them as features; this allows us to build feature vectors and train classifiers. For this we use the *Weka Data Mining* software [9, 10].

We use Quaestio-it to extract pairs of statements of which we know that one either supports or attacks the other. We are thus provided with a set of related pairs that is constantly growing through the use of the Quaestio-it web application. We then use these pairs to test our prototype. Testing our current prototype on Quaestio-it data we achieve a classification with an F1-score of 0.684. While developing this prototype we are also investigating further potential uses of how Quaestio-it might serve as a test-bed for Argument Mining applications, in general.

7 Conclusion

With this paper we have demonstrated the value of practical Argumentation and how it may find application in users' everyday life. To achieve this we have described *Quaestio-it*, an online debating platform, as well as three use cases in which we have been using this platform. We are (I) integrating *Quaestio-it* functionalities in the decision support tool Desmold, (II) we have experimented with it as an e-learning tool and (III) we are using it as a data source for the NLP task of Argument Mining. Each of the use cases is in currently under further development. Nonetheless, all three have shown promise during our first development phases. While the e-learning use case is still in its early phase, both the injection molding and the Argument Mining tool developments are roughly half way into the development process and we aim to produce usable tools at the end of both projects.

All use cases presented in this paper are under development and offer to be useful not only on their own, but in combination with other uses, as well. The data we extract to develop our Argument Mining tool, for example, will help us develop solutions that can then be integrated to automate some of the Argumentation process. Once we are able to determine attack and support relations automatically in a sufficiently reliable manner, we can use this feature in a setting such as Desmold. Obviating the need for the user to label their arguments as supports or attacks will allow debating in a manner that is more akin to actual human discussion.

Other settings in which we envisage *Quaestio-it* to have applicability include, but are not limited to, engineering disciplines other than Injection Molding, participatory journalism and medicine. An issue that arises in many engineering disciplines is that of making *concessions*. When developing a product, a solution, etc., one may reach a point where a current design does not uphold some pre-defined measure of quality. In many situations such shortcomings will not be acceptable and will need addressing. There are cases, however, in which *concessions* to the original quality standard may be made, accepting a lesser result

in order to save time, expenses, etc. To establish whether such *concessions* are viable and to what degree, a process of weighing arguments for and against needs to be conducted. A platform such as *Quaestio-it* may prove to greatly simplify this process, which may involve many parties providing input.

Bringing multiple parties together in such a manner is equally applicable to modern forms of journalism. *Quaestio-it* may facilitate the involvement of not only professional journalists, but amateurs, witnesses and other important sources of information, collaborating to provide insights on the same story.

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