A Social Collaboration Argumentation System for Generating Multi-Faceted Answers in Question and Answer Communities

Ricky J. Sethi
University of California, Los Angeles
Los Angeles, CA USA
rickys@sethi.org

Yolanda Gil
University of Southern California,Information Sciences Institute
Marina del Rey, CA USA
gil@isi.edu

Abstract

In this paper, we propose an innovative approach for the development of social collaboration argumentation systems. These systems enable a community to collaboratively create answers to questions where many possible answers, or nuanced perspectives on a single answer, can be posited. We examine the emergence of critical reasoning via crowdsourced structured discussions, which are built upon a graph-theoretic framework populated by atomic argumentation components. Finally, we address the design of the online community to best facilitate this interaction. Our main contribution is the rationale and design of the system, which can easily be extended to build a general eLearning framework.

Introduction

The diverse landscape of Question & Answer (Q&A) sites on the Web reflects the different needs, approaches, and communities for eLearning about new topics of interest. In general, Q&A websites fall into three categories: Digital Reference Services (DRS), Ask-An-Expert (AAE) Services, and Community Q&A Sites (CQA) (Harper, Raban, Rafaeli, & Konstan, 2008). For example, an AAE service like The Madsci Network (http://www.madsci.org) fields questions from laypeople that are answered by expert scientists in various disciplines. In contrast, a DRS like New York Public Library's "Ask Librarians Online" (http://www.nypl.org/questions/) utilizes expert researchers to help people find useful information. Yahoo Answers (http://answers.yahoo.com) is an example of a CQA site, where a user poses a question and others give their own self-contained answers to the question. The popularity of Q&A sites attests to the need for Web users to learn about new topics, whether for work, school, or personal interest (Baram-Tsabari, Sethi, Bry, & Yarden, 2009).

However, all Q&A sites are inherently limited when dealing with complex topics where users want to understand the issues and form their own opinions rather than be given a particular answer. Questions that concern science and health represent notable areas where this is especially the case. A recent study conducted by *Scientific American* and *Nature* (Scientific American, 2010) shows that people place different levels of trust on scientists, governments, and companies when it comes to matters of science and health in topics as diverse as climate change, flu pandemics, and food safety. In some cases, many different sides can be presented as answers, while in other cases there is not a clear answer that can be presented as a final authoritative and settled response.

The nature of the answers provided by Q&A sites limits their utility in these cases. For example, DRS services are, by definition, limited to a single answer whereas AAE and CQA sites allow for either a single answer, possible aggregation of responses from multiple experts, or for many dispersed answers that are inter-related but difficult to conceptualize as a single, unified, complex argument. Thus, for complex queries, most users only see an incomplete or simple, non-nuanced answer.

In addition, since answers are not consistently backed by sources, users have to make uninformed trust judgments to gauge the quality of an answer. This situation is far less than ideal as users are left unsure of which sites contain high quality, complete answers (Harper, Raban, Rafaeli, & Konstan, 2008).

We believe that, in many situations, users in fact seek ways to understand a complex topic by examining alternative views on it, not just by being told a single, "right" answer. They have different beliefs about what sources are biased and which ones are trustworthy to them in specific topics. They are interested in learning all the facts and in making their own judgments about the answer, thus learning about a topic while exercising and developing critical thinking skills.

This paper presents a novel approach to Q&A sites that focuses on the development of social collaboration argumentation systems. These systems enable a community to collaboratively create answers to questions where many possible answers, or nuanced perspectives on a single answer, can be posited. We use a minimalistic argument structure to facilitate contributions and synthesis. We design the online community to best facilitate this interaction: we define the nature of the community, clarify the contribution process, and then design the system itself. We examine the emergence of critical reasoning and eLearning via crowdsourced structured arguments populated by atomic argumentation components. We envision a graph-theoretic framework to analyze arguments, which will enable the system to proactively relate viewpoints and derive source ratings.

Motivation

The Madsci Network (Baram-Tsabari, Sethi, Bry, & Yarden, 2006; Baram-Tsabari, Sethi, Bry, & Yarden, 2009) is one of the oldest and most popular Ask-A-Scientist (AAS) websites, a niche subset of AAE services. It is a human-mediated Q&A service that answers questions in 32 different scientific fields and receives 90-150 questions a day, which are answered by nearly 800 scientists and 25 moderators (http://www.madsci.org/info/intro.html).

An AAS website like The Madsci Network is indispensible since it allows for the direct flow of legitimate scientific information from scientists to laypeople, particularly to students (Baram-Tsabari, Sethi, Bry, & Yarden, 2006). In fact, finding reliable scientific information is not easy on the web; harder still is to discern legitimate science from pseudo-science. This is especially significant for children who are fast becoming consumers of science online.

A typical workflow for incoming questions to The Madsci Network is shown in Figure 1. Incoming questions are initially routed to a Moderator who assesses the suitability of each question before forwarding it to an expert Scientist. The Scientist prepares a response which is then reviewed by the Moderator before posting in the archives. Figure 2 shows the current user interface for displaying questions and answers from the archives to visitors.

Consider a student who comes across an advertisement showcasing a product that proclaims to release the 90% hidden potential of the human brain. Intrigued but skeptical, our enterprising student turns to The Madsci Network to get to the bottom of this extraordinary claim. Getting an authoritative answer from an expert would normally settle

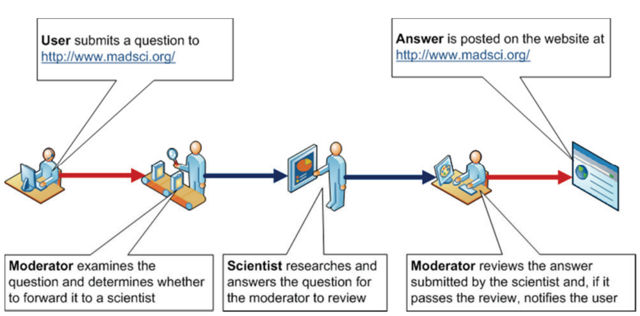

Figure 1: Overview of The Madsci Network Workflow

the question; but if the source that prompted the query was one which the student normally trusts, s/he would truly benefit from an understanding of why a seemingly trustworthy source might make such a claim.

For these kinds of questions, we envision a different kind of interaction with the site. Instead of a traditional one-way transmission of information, we imagine that such questions will be re-routed to an experimental portion of the site where more complex questions can be dealt with in a social collaborative argumentation system.

The workflow will also change slightly from that seen in Figure 1. The student still submits their question to The Madsci Network; however, unlike a traditional query, the student provides not just the question but also the citation for the advertisement that made the initial claim.

At this point, the Moderator examines the question and forwards it to an expert Scientist, also noting this complex question will be fielded under the new approach. The Scientist can thus start to seed the Structured Discussion, which is the heart of our new social collaborative argumentation system.

The Moderator would then open the argumentation to all contributors to the site. Some may elaborate specific points or add claims relevant to this topic. Others may add sources that corroborate a certain view, thereby showing how popular those views are on the web. The Moderator and the Scientist can steer the contributions in certain directions and restructure the contributions when appropriate. Finally, the Scientist can weigh in on why a certain side of the argument was chosen as the expert answer.

In looking at the final answer and the associated structured discussion, any visitor to the site would have a good idea of the various sides of the argument and why some sites may support certain claims. This will support critical thinking, as: 1) many contributors provided alternative views on the answer, 2) the alternative views were organized and sources were provided, and 3) the final answer was provided by an expert.

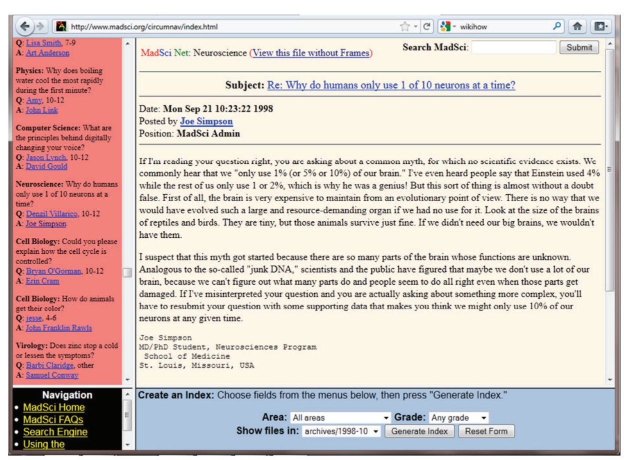

Figure 2: Traditional Interface of The Madsci Network

Approach

We take a comprehensive approach for social collaborative argumentation: we design a community to support this emergent critical thinking, build a framework for the ensuing Structured Discussion (SD), and develop a novel graph-theoretic infrastructure to support this framework.

The Community Design

We design multiple community roles to support our collaborative argumentation system. Our community allows for a generalized five-pronged constituency:

1. Questioners: These users will pose a question, perhaps providing sources that prompted them to ask the question and that should be referenced in the argument. We view the question as a "proto-discussion."
2. Question Moderators: They fulfill the traditional Moderator role on The Madsci Network of fielding questions and managing the workflow involved in producing the Expert Answer.
3. Experts/Scientists: Can seed the initial discussion based on the question, and can also steer the discussion by elaborating selected aspects of it.
4. Contributors: any registered user of the site can elaborate the argument or add sources to support certain aspects of the argument.
5. Answer Moderators: Their role is to guide and give structure to the Structured Discussions. They could be Question Moderators or Experts. We also believe this role could be played by the Questioners, by steering discussions in directions relevant to them, and Contributors with a sufficient authority to manage the crowd and can help guide and give structure to the SD. We plan to explore different options for this role.

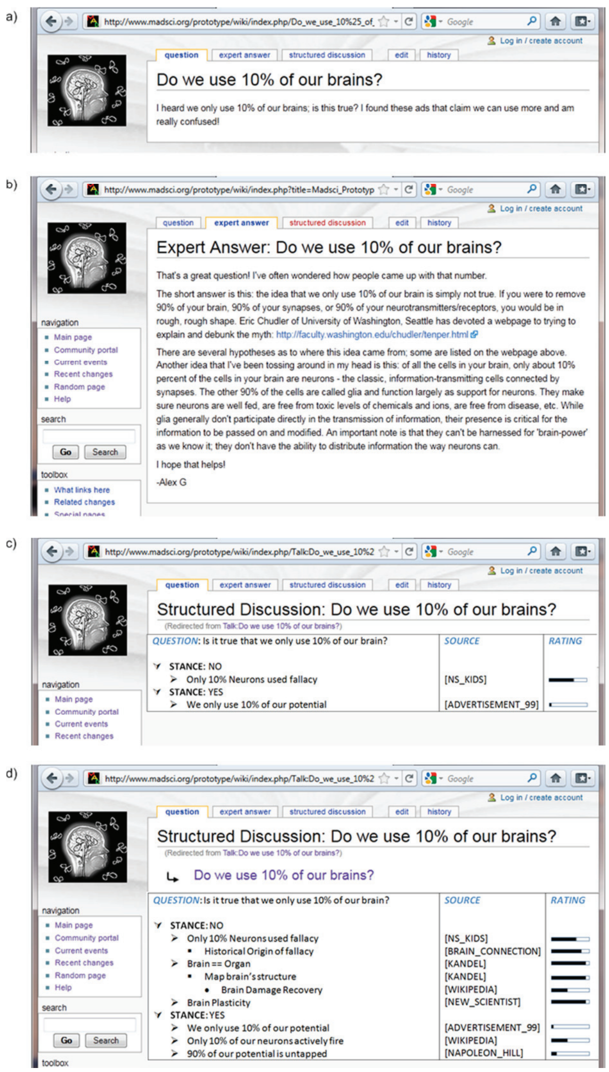

Figure 3: MediaWiki-based Prototype Interface for The Madsci Network customized with: a) Question Tab; b) Expert Answer Tab; c) Structured Discussion Tab: the initial structured discussion setup by the Moderator; d) Structured Discussion Tab: the final, emergent structured discussion constructed by users of the site.

In addition, we allow for Visitors, who are users that simply browse the argument to learn more about the question that was posed.

The Argument Structure

We provide the simplest possible argument structure that will enable understanding and participation. In our prior work on the Trellis system, we found this to be an effective representation to enable volunteer contributors to create collaborative arguments (Chklovski, Ratnakar, & Gil, 2005). We define an argument as being composed of Stances, Claims, and Premises, where both Claims and Premises are supported by Sources, typically web documents. A Claim is either an inference or a conclusion while a Premise provides the evidence for that Claim. A Stance is the final conclusion composed of Claims and Premises, and their associated Sources. Stances are fundamental stands on a topic and can be mutually exclusive, should have cohesive sub-structures, and are composed of *atomic argumentation components* (Claims, Premises, and Sources).

A Source could be fully described, for example using the Dublin Core metadata (http://dublincore.org). We envision giving the sources themselves their own properties. In this way, users could query the system for assertions from certain sources or from sources with specified properties (e.g., government institutions).

Our methodology also incorporates Ratings for each Source and user in the system. Different trust, authority, and other attribute dimensions are amalgamated and weighted in a Summary Rating, as seen in Figure 3c and Figure 3d; these compound ratings reveal their constituent components (SourceRating, ContentRating, QuestionRating, etc.) on a MouseOver event, displaying details of Users' Ratings, Source Ratings, Expert Ratings, etc.

User Interface Design

The user interface of our system is an extension of the MediaWiki interface. In addition to presenting an intuitive editor for end users, we believe that this will broaden the impact of our work.

A user of this experimental portion of The Madsci Network will see an interface built upon MediaWiki, the prototype shown in Figure 3a, instead of the traditional interface in Figure 2. The more familiar Wiki framework is customized in this prototype with three tabs: the Question tab (Figure 3a), the Expert Answer tab (Figure 3b), and the Structured Discussion tab (Figure 3c).

Upon approving the Scientist's response, the Moderator posts the Question and the Expert Answer (Figure 3a and Figure 3b) and also activates the Structured Discussion tab (Figure 3c). The newly-created Structured Discussion (SD) seeds the initial framework for the emerging argument, where any contributor can engage in this Structured Discussion, as shown in Figure 3c. After an extended social collaboration, the resulting argument evolves to a form similar to Figure 3d.

Collaborative Critical Reasoning & eLearning

Our proposed framework will not just be a system for argumentation structure; instead, we will organize the community and system to work together synergistically to support learning via critical thinking. Given its generality, it is designed to support critical reasoning in an eLearning environment as well as more traditional consensus building.

There are two approaches to building a Structured Discussion (SD): either a Top-Down (TD), generative model which builds the SD monotonically or a Bottom-Up (BU), discriminative model which builds the SD non-monotonically, as shown in Figure 5. In the TD approach, the Expert Answer (EA) is posted on the website first and then the outline of the SD is generated based on the EA, as shown in Figure 3c. Alternatively, the SD can be seeded first, as shown in Figure 5; the EA will then be an emergent property of the ensuing discussion in a BU manner.

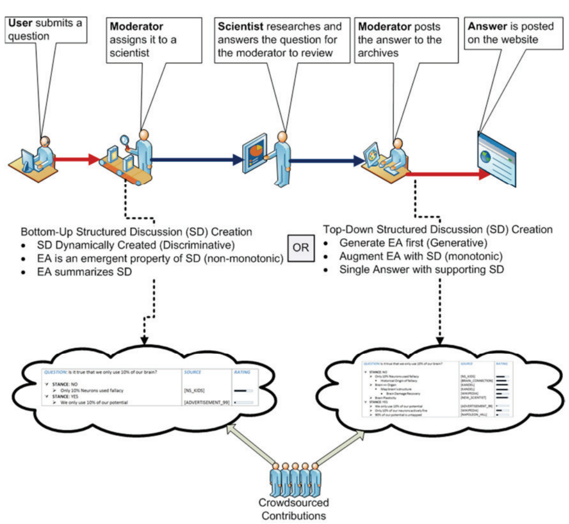

Figure 5: Structured Discussion (SD) formulation with respect to the Expert Answer (EA)

In both the TD and BU approaches, learning can be considered an emergent property of the critical thinking involved in constructing the SD. In fact, as the SD evolves, its structure dynamically emerges, helped in part by the Answer Moderators. Consequently, the argument content becomes an emergent property of the dynamic rearrangement of the SD.

Graph-Theoretic Infrastructure

Underlying the SD and essential to its dynamic arrangement is the representation of the argument via atomic argumentation components embedded within a graph, as shown in Figure 4. Our novel graph-theoretic approach abstracts and generalizes the SD.

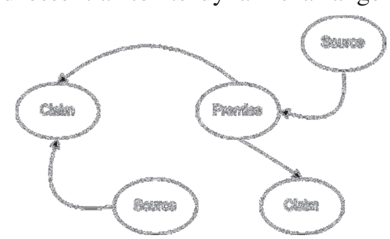

Figure 4: An Argumentation Graph

We imagine an *Argumentation Graph*, $G_A = (V, E, f)$ composed of a set of vertices, V, edges, E, and a function f, which maps each element of E to an unordered pair of vertices in V. Each fundamental Claim, Premise, or Source in an argument constitutes an atomic argumentation component, v_a, and is embedded as a vertex in the graph such that $v_a \in V$. The vertices contain not just the component's semantic content, but also the ratings, authority, trust, and other attribute dimensions of each atomic argumentation component. The edges $e \in E$ contain weights along the various dimensions of trust and authority, while the function f maps how they're connected. Depending on the context of the argument, this graph can be undirected or directed, where the temporal component gives the direction to the directed graph.

In this approach, a Stance is a sub-graph or tree of the argument, G_A. A particular path traversal would show the weights or quality of the Stance. Depending on the specific path taken through such an argumentation graph, the connections would allow atomic components to be incorporated in different Stances, with each Stance represented by some traversal of the graph.

Related Work

There has been some recent work on argument structures and consensus building by a community (Iandoli, Klein, & Zollo, 2007). That work focuses on a community of experts sharing their alternative views, and uses complex argument structures that those experts understand. For our work, we need simple argument structures that will enable end users to contribute to the argument and to understand the multiple views.

There is a variety of work in the area of wikis since the larger the number of contributors and the more diverse they are, the more likely that there will be conflicting views. Wikis include a discussion page for each topic page. The discussion page is often used for coordination and editorial activities, mediating and settling disagreements, and polling among others (Schneider, Passant, & Breslin, 2010). There has been some work on structuring discussion pages, although it has focused on managing and visualizing threads[1]. Also relevant are studies of conflict in wikis (Kittur & Kraut, 2010; Kittur, Suh, Pendleton, & Chi., 2007), which typically focus on what editorial policies and other coordination activities are appropriate for resolution.

Another wiki effort to handle conflicting information is Shortipedia (Vrandecic, Ratnakar, Krötzsch, & Gil, 2010), an approach to validate with volunteer contributors many such triples that already exist in the Web published by a variety of sources. In particular, Shortipedia imports triples from the "Linked Open Data (LOD) cloud", a community-built resource that as of September 2010 contained more than 203 data sets totaling over 25 billion interlinked RDF triples. Such diverse sources produce conflicting assertions. Shortipedia can attach provenance information to each assertion, so that they can co-exist even if they contradict one another. Trellis is a system for collaborative argumentation, allowing contributors to add new claims or sources (Chklovski, Ratnakar, & Gil, 2005). Trellis shows that using very simple structures allows users to understand what had changed in an argument since they last viewed it. We use the same principle in our design of stances.

Conclusion

In our work, we focus on supporting critical thinking via social collaborative argumentation, reflecting alternate views on the stances in the gestalt answer formulation, and creating and utilizing Rated Sources. All of these, in our formulation, are used for learning via critical thinking rather than consensus building alone.

Our approach generalizes to a variety of discussion thread platforms like eCollege and Blackboard, where the argument's overall structure is often obfuscated by a static and unorganized discussion thread structure. Thus, our approach can prove indispensible to online learning frameworks as well as wiki sites, which currently host discussion threads as crucial, yet unwieldy, components of their core mission. This disorganization inhibits not only critical reasoning but learning itself.

Acknowledgments

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[1] http://www.mediawiki.org/wiki/Extension:LiquidThreads