MAgtALO: Using Agents, Arguments, and the Web to Explore Complex Debates

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Abstract. This paper introduces the MAgtALO system, a prototype environment for online debate that aims to provide a mechanism for supporting naturalistic dialogue. MAgtALO demonstrates how dialogue protocols can be harnessed to achieve two objectives: first, to support flexible intuitive interaction with data in complex, contentious domains in order to facilitate understanding and assimilation; and second, to provide mechanisms for structured knowledge elicitation that allow the resources in those domains to be expanded.

1 Introduction

Online argumentation systems are designed to support humans in arguing on specific topics. Over the past two decades there have been an enormous number of software systems developed to support such online argumentation. Many of these systems have remained within the confines of the academic laboratory, but some larger-scale projects have been deployed in the wild [6], [1].

Possibly spurred by the high-visibility arguments expressed in the *Iraq Study Group Report* and *The Stern Review on the Economics of Climate Change* which feature strong explicit argumentative structure, the online community has expressed interest in arguments and the processes through which they are developed. For example, two recent systems which stem from the online community demonstrate the growing appetite for argumentation, *convinceme.net* and *debatepedia.com*.

Convinceme.net, illustrated below, utilises paired message boards, one supporting and one attacking the topic of debate, and provides a Web 2.0 based environment for the construction and exploration of arguments so constructed. Both active participants within a debate and spectators can vote on specific posts and the relative positions of posts is determined based upon (i) the number of votes garned in open debate, (ii) the total number of votes cast in the head-to-head arguments, and (iii) a fixed number of points awarded to the arguments which become "*King of the Hill*" by attracting more votes that any other in a single debate.

Debatepedia.com, illustrated below, uses a wikipedia style interface as a tool for exploring complex topical debates. Structure and rules are imposed on contributors to encourage the construction of *logic trees* which are used to break a thesis down into a set of subquestions which can attract a variety of evidence pro and con. The aims of each tool are different, convinceme.net is developed as a source of competitive entertainment whereas debatepedia.com aims to facillitate the public understanding of complex domains.

Academic-oriented systems are generally built upon a sound argumentation theoretic foundation which provides a rich set of argumentative moves and structures. The presentation and framing of these systems however can be a barrier to wider public adoption. In contrast the online systems enjoy a broad user base but little foundation in argumentation theory leaving their users with an impoverished set of moves and tools that they can use.

This paper introduces MAgtALO (Multi-AGenT Argumentation, Logic and Opinion; also a Tagalog word for disagreement), a prototype system that aims to incorporate the strengths of each approach, building upon the foundations found in argumentation theory which provides theoretical models of argument and argumentative interaction during dialogue, and adopting the appealing and

intuitive interfaces and interaction mechanisms found in contemporary online-community originated argumentation systems. This is achieved through the adoption of a Web 2.0 interface, a multiagent system based backend and integration of representation formats for exchange of arguments and regulation of argumentative interaction. The goal is to support users in their engagement with complex domains in which there are multiple, conflicting points of view, allowing users to intuitively navigate the disagreement space, and facilitating the structured expansion of the argument resources available to the system through argument-based knowledge elicitation.

2 Theoretical Foundations

Argumentation theory provides the theoretical foundations which underlie the knowledge structure and interactions of MAgtALO agents. Agent knowledge is structured using the *Argument Markup Language* (AML) [13] which provides a way to relate statements to form argument structures. Agent interactions are specified using *Dialectical games* which have recently become a popular way of structuring inter-agent communications [10].

2.1 Dialectical Games

When a user interacts with MAgtALO the interaction proceeds according to a protocol which specifies what kinds of things can be said at each juncture in the dialogue. The protocol is a type of simple *Dialectical Game* developed specifically to underpin online argumentation in ill-structured and contentious domains. Dialectical games are turn-taking games which are used to structure the interactions between a dialogue's participants. Players use their turn to make moves which correspond to the kinds of things that they can say for example, asserting, conceding, &c. and the rules specify which moves are legal during any given turn. *Dialogical commitment* is recorded in stores associated with each player and is used as the basis for formulating some rules and as a way to record each player's position.

Dialectical games have been explored in philosophy as a way of analysing particular types of reasoning such as the fallacy of begging the question [8]. More recently, they have also been used as normative ideals for discourse in specific domains such as ethical discussion [15]. These philosophical investigations have, over the past decade or so, been providing rich resources for building inter-agent communication protocols. One of the earliest and best known is Mackenzie's game called DC [8]. DC specifies three types of rule; *Locutional rules* specify the types of moves available; *Commitment rules* specify how commitment stores are updated after a move; *Rules of dialogue* specify when moves are legal. The rules of DC are as follows:

Locutions
(i) Statements. 'P', 'Q', etc. and truth-functional compounds of statements: 'Not P', 'If P then

Q', 'Both P and Q'.
(ii) Withdrawals. The withdrawal of the statement 'P' is 'No commitment P'.
(iii) Questions. The question of the statement 'P' is 'Is it the case that P?'
(iv) Challenges. The challenge of the statement 'P' is 'Why is it to be supposed that P?' (or briefly 'Why P?').
(v) Resolution Demands. The resolution demand of the statement 'P' is 'Resolve whether P'.

Commitment Rules

Statements, $\mathbf{CR}_S$: After a statement 'P', unless the preceding event was a challenge, 'P' is included in both participants' commitments.
Defences, $\mathbf{CR}_{YS}$: After a statement 'P', when the preceding event was 'Why Q?', both 'P' and 'If P then Q' are included in both participants' commitments.
Withdrawals, $\mathbf{CR}_W$: After the withdrawal of 'P', the statement 'P' is not included in the speaker's commitment. The hearer's commitment is unchanged.
Challenges, $\mathbf{CR}_W$: After the challenge of 'P', the statement 'P' is included in the hearer's commitment; the statement 'P' is not included in the speaker's commitment; and the challenge 'Why P?' is included in the speaker's commitment.
Questions and Resolution demands, $\mathbf{CR}_Q$ and $\mathbf{CR}_R$: These locutions do not themselves affect commitment.
Initial Commitment, $\mathbf{CR}_0$: The initial commitment of each participant is null.

Rules Of Dialogue

$\mathbf{R}_{Form}$: Each participant contributes a locution at a time, in turn; and each locution must be either a statement, or the withdrawal, question, challenge or resolution demand of a statement.
$\mathbf{R}_{Repstat}$: No statement may occur if it is a commitment of both speaker and hearer at that stage.
$\mathbf{R}_{Imcon}$: A conditional whose consequent is an immediate consequence of its antecedent must not be withdrawn.
$\mathbf{R}_{Quest}$: After 'Is it the case that P?', the next event must be either 'P', 'Not P' or 'No commitment P'.
$\mathbf{R}_{LogCall}$: A conditional whose consequent is an immediate consequence of its antecedent must not be challenged. **$\mathbf{R}_{Chall}$:** After 'Why P?', the next event must be either;

1. 'No commitment P'; or
2. The resolution demand of an immediate consequence conditional whose consequent is 'P' and whose antecedent is a conjunction of statements to which the challenger is committed; or
3. A statement not under challenge with respect to its speaker (i.e. a statement to whose challenge its hearer is not committed).

$\mathbf{R}_{Resolve}$: The resolution demand of 'P' can occur only if either;

1. 'P' is a conjunction of statements which are immediately inconsistent and to all of which its hearer is committed; or
2. 'P' is of the form 'If Q then R', and 'Q' is a conjunction of statements to all of which its hearer is committed; and 'R' is an immediate consequence of 'Q'; and the previous event was either 'No commitment R' or 'Why R?'.

$\mathbf{R}_{Resolution}$: After 'Resolve whether P', the next event must be either;

1. The withdrawal of one of the conjuncts of 'P'; or
2. The withdrawal of one of the conjuncts of the antecedent of 'P'; or
3. The consequent of 'P'.

2.2 Araucaria and the Argumentation Markup Language

Araucaria is an application used to mark up and analyse monologic argument based on the *Argumentation Markup Language* (AML) which is formulated in XML. The syntax of AML is specified in a Document Type Definition (DTD) which imposes structural constraints on the form of valid AML documents. AML was primarily produced for use in the Araucaria tool but has subsequently been adopted in other contexts such as within MAgtALO. AML is used to structure the internal knowledge of an agent such that natural language statements are related using argument theoretic concepts. This allows an agent to easily retrieve a supporting statement to use to defends its position if that position comes under attack. The benefit of adopting AML as the internal representation of agent knowledge is that Araucaria can be used as a graphical tool to construct

the agents knowledge by marking up existing natural language texts. Such an approach was used to provide initial agent knowledge so that MAgtALO agents could represent the views held by two prominent contributors to the ID card debate as garnered from their public statements on the subject.

3 The MAgtALO Architecture

MAgtALO consists of a multiagent system back-end and an AJAX-based web interface front-end. The web interface uses client side javascript to ensure that a responsive user interface is provided to the end-user. The interface is served from an Apache web server, MySQL database, and hypertext pre-processor (PHP) application stack running on a FreeBSD server. The multiagent system back-end uses the Jackdaw University Development Environment (JUDE) developed by Calico Jack Ltd [7]. JUDE is a Java based, lightweight, flexible and industrial strength agent development platform that takes a modular approach to agent development. Individual agents consist of a standard core module, provided by the agent framework, which is extended via dynamically loadable modules to provide domain specific capabilities. When a dialogue commences a number of agents are loaded to represent the various participants. Each agent loads a module which provides the capabilities required of an agent to act in the MAgtALO domain, e.g. respond to the users questions, interject when conflicting statements are made and defend its own position when attacked. The connection between the web interface and the agent system is achieved using a proxy web server agent which is provided as standard in the JUDE distribution. The proxy agent communicates HTTP traffic over a nominated port and routes messages from the web interface to the appropriate recipient agent. Similarly outgoing messages from the individual agents to the user are routed via the proxy agent to the web interface where they are displayed.

The key aspects of the MAgtALO system are representation of differing points of view within a specific topic, the capability for the user to engage in dialogue, according to a dialectical game protocol, with a number of agents and explore those differing points of view, and the ability to extend the system and provide new data for the system to use merely through interacting with the existing system. These aspects are explored in more depth in the following sections.

3.1 Points of View

MAgtALO uses agents in a multi-agent system to represent the views of participants. Pre-existing arguments can be analysed for their argumentative structure using tools like Araucaria [13]. The Argumentation Research Group at Dundee have conducted large scale analyses which are available in an online corpus (at araucaria.computing.dundee.ac.uk). The arguments in this corpus are stored using AML, the XML-based Argument Markup Language, and can easily be read into data structures. In this way, an agent can have its beliefs automatically

populated with propositions that correspond to real, analysed, natural text. In the same way, an agent can automatically acquire the argumentative relations between those propositions, as they are represented in the AML source analyses.

By taking several corpus arguments that are in the same domain, but that have been articulated by different authors, it is possible to have multiple agents storing – or "representing" – the points of view expressed in those different arguments. Of course, if multiple arguments are taken from the corpus and used to populate the beliefs of multiple agents, there is the risk that two arguments make the same (or almost the same) claim using different text. There is no reliable way to process natural language to identify such correspondences, so the MAgtALO team currently mark them manually where they arise. In this way, agents may end up with arguments that have overlapping sets of premises or conclusions.

Fig. 1. The main MAgtALO interface

With a multi-agent system populated by agents representing sets of arguments of specific authors, it becomes possible to interact with the data in interesting ways. The interface provides an indication of which points of view are represented. (The running example shown in the figures concerns a current debate

in the UK regarding the issue of identity cards. Two prominent contributors to the debate are Martin Linton, Labour MP for Battersea, and John Wadham, director of the lobby and campaign group Liberty. Some of the recent arguments of these two protagonists have been analysed and loaded into two agents in the system.) MAgtALO uses the metaphor of a meeting, and provides the user with the privileged position of chair. The user can ask individual agents for arguments pro or con a given claim, or can ask one agent to attack the arguments of another, or can ask whether an agent concurs with a claim, and so on. The user is thus responsible for the direction of the virtual discussion modulo the rules of engagement for arguments in meetings - i.e. the dialogue protocol.

Turn	User	Statement
1	System	New discussion started! With the point "Identity cards are a bad idea"
2	User	"I agree. They will undermine civil liberties"
3	John Wadham	"Yes, I agree. The real target is the people whom the home office has lost"
4	User	"Why do you think the current point is true John?"
5	John Wadham	"It will be black people and those from ethnic minorities who will find that they need to show their card most often"
6	Martin Linton	"No, I don't agree. If you are saying the police might discriminate against black people (even though it is illegal), that is a serious problem that needs to be tackled. But should not stop us having ID cards"
7	User	"I'd like to go back to the point that was made earlier... Identity cards are a bad idea"
8	User	"Do you agree with the current point Martin?"
9	Martin Linton	"No, I don't agree. They will not undermine civil liberties"
10	User	"No, I don't agree. Storing potentially vast amounts of sensitive data about every citizen in one place presents danges"

Fig. 2. An example dialogue between a user and two MAgtALO agents, one representing John Wadham of Liberty, and the other representing the Labour MP Martin Linton

3.2 Dialogue

One aim of MAgtALO is to enable the participants to engage in a discussion rather than an interrogation. This means that the protocol by which the players interact must allow for more sophisticated behaviours than just questioning the other players and thereby exploring a knowledge base. Each player must be able to interject with their own opinions, especially when something is said with which they disagree. To enable this kind of behaviour a simple dialogue game protocol was developed to govern the kinds of things that the players can say at each point in the dialogue. This protocol has been developed to ensure that each participant is fairly represented and that individual standpoints

can be investigated, whilst ensuring that the burden on the human participant does not become onerous. (Although there are many techniques and theories available in argumentation theory, rhetoric, and the communication sciences for explaining and structuring exchanges of this sort [4], dialogue games provide the right mix of abstraction from linguistic content and constraint on the role that such content plays dialectically. The abstraction is vital to obviate the need for natural language processing; the constraint is necessary to connect and structure the propositional content).

Dialogues begin from a fixed initial topic, for example, "*identity cards are a bad idea*" which is illustrated in turn 1 of figure 2. This topic does not necessarily represent any given participant's position but serves as the focus for the dialogue. Once the initial topic has been selected, the user is presented with the option to agree, disagree, or to find out where the other agents stand with respect to it. If the user selects either to agree or disagree with the initial point then they are invited to support their position with a reason such as that "*they will undermine civil liberties*". In figure 2 the user has opted to indicate their agreement with the initial point.

Although the user is nominally in control of the dialogue, agents may automatically interject after a statement is made if the agent has a sufficiently strong *desire to speak* regarding that statement. The function that currently calculates desire-to-speak is simple: it is the difference between the number of points in support and the number of points against the statement within an agent's knowledge base. If the value is around zero then the agent has mixed feelings regarding the point. If the value is greater (or less) than zero, then the agent has strong feelings for (or against) the point. Each agent has a threshold value which enables the strength of feeling for a given point to be determined individually. If the threshold is exceeded then the agent will automatically express its viewpoint in the dialogue at that point. Though it is possible to imagine more complex desire-to-speak functions, we have found that even such a simple mechanism provides engaging behaviour with appropriate threshold values. (Notice that there is a strong relationship between the desire-to-speak function and argument aggregation functions. Fox and Das [5] have demonstrated that very simple aggregation functions are often all that is required for appropriate automated reasoning in many situations). Automatic interjection enables the dialogue to proceed with a more natural rhythm. Without such a facility either the user must ask each agent for their view at each turn, or else the agents must all respond to each statement that the other agents and the user make. In either case the resulting dialogue seems artificial and stilted. Though sensitive to the threshold settings, automatic interjection can make the dialogue seem much more natural. This is illustrated in figure 2 in which the agent associated with John Wadham interjects with "*Yes, I agree. The real target is the people whom the home office has lost*" after the user has agreed with the initial point. This indicates that John Wadham has a strong desire to speak in agreement with the last statement made by the user.

Fig. 3. Dialogical interaction in MAgtALO

Once an agent has interjected, the dialogue game allows the user to either agree or disagree with the current point, the last point that was made during the interjection, or to question the agent that made the point to explore that agent's position. This can be as simple as asking, *Why?*, in order to get underlying reasons and so expose the basis for the agent's position. If the agent's point failed to persuade the user, further justification can be solicited. The focus of a dialogue generally follows the last point that was made, but by asking for further reasons the user is switching focus back to an earlier point to get extra, independent support for the point. This process of focus switching allows the user to return to any earlier point in the dialogue, simply by selecting the new focus-point from the dialogue transcript displayed on screen. Such a switch of focus is illustrated in turn 7 of the dialogue in figure 2 whereby the user indicates that they wish to return to an earlier point. In this case the earlier point is the initial point of the dialogue and the user further indicates that they wish to explore Martin Linton's position. The result of such focus switching is that the user is able to explore new threads of reasoning and expose different arguments for and against each point made rather than being locked into a particular path through the dialogue. Again this is an example of how the protocol enables a natural rhythm to be maintained in which, when the user is dissatisfied with the current position, they can return to the point of contention and explore it some more.

MAgtALO is not in the business of calculating a "solution" to a debate, or of evaluating points of view, or of persuading a user that a particular viewpoint is superior. Though such things may be interesting to investigate (as is hinted at, at least in part, in section 5), they are peripheral to the main focus, which is squarely upon providing a rich, flexible, but intuitive interface by which online users can interact with and explore complex debates, thereby gaining a deeper and more sophisticated understanding of the topic. One rather more direct additional benefit of using the theory of dialogue games as a foundation upon which to build such an interface is that the process of extracting structured knowledge from the user is made significantly easier.

3.3 Knowledge Elicitation

The process of uncovering a user's position on a given topic is a form of knowledge elicitation - what [15] refer to as the maieutic function of dialogue. MAgtALO uses a simple dialogue game protocol to expose this knowledge and to record it into the system in a structured fashion. Use of a dialogue game enables the underlying argumentative structure of the dialogue to be captured. This is because each statement is uttered in relation to some earlier statement. For example, offering justification for agreement with a position corresponds to an inference being drawn between the two points, one giving a conclusion and the other giving a reason in support of the conclusion. The use of a dialogue game protocol therefore helps to ensure that each new entry into the dialogue is

dialogically relevant. Such dialogical relevance is important to enable new information to be recorded for reuse in future dialogues. This approach to knowledge elicitation enables the user to express their position and underlying reasons, whilst avoiding the feeling that there is an interrogation occuring. The dialogues are not heavily weighted towards any given participant because any agent may interject at any point if their interjection threshold is exceeded. Meanwhile the user remains in control and moves the focus back and forth, following a natural path through the dialogue. These two elements help to ensure that the resulting dialogue feels natural to the user and thereby gives the user some incentive to continue with the discussion.

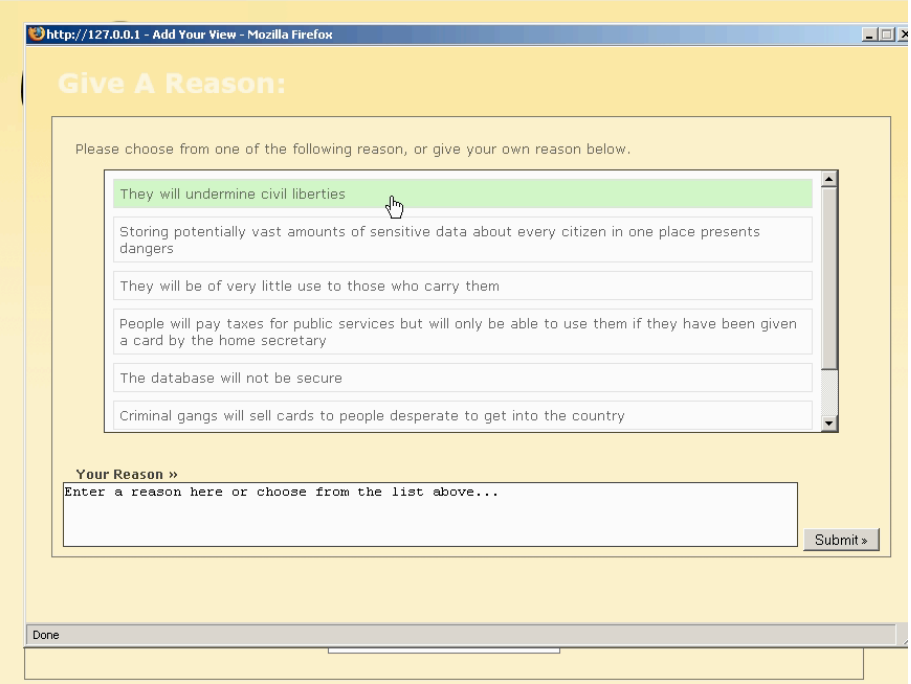

Fig. 4. Knowledge elicitation in MAgtALO

This argument-based knowledge elicitation has some interesting aspects. The amount of new, typed user input is minimised by allowing the user to select from previously recorded statements first, then allowing the user to type in new statements only if there is nothing appropriate already recorded. In the dialogue illustrated in figure 2 the user's views are represented by existing statements in the system until turn 10 at which point the user introduces a new statement as a reason for their disagreement. The benefit of this approach, as well as maintain-

ing user interest by minimising typing, is that existing statements are reused, possibly in new ways so connections can be made between different threads of argument on a topic. Additionally, this approach avoids the need for natural language processing as propositional statements are recorded in their entirety. When statements are reused in new ways it is because the user has linked the statement to some point expressed within a dialogue. Rich, structured knowledge is thus accumulated through a lightweight, naturalistic interaction with the user. The knowledge collated during any given dialogue represents a user's position on the topic of the dialogue. This knowledge can then be reused in subsequent dialogues to provide the knowledge for a new agent representing the last user. Therefore each time a user engages in a dialogue within MAgtALO, there is a structured expansion of the knowledge base, which increases the number of agents who can potentially take part in future dialogues, as well as also increasing the size of the pool of statements from which the next user can select.

4 Argument Ontology

Although the use of AML has been widespread due to the popularity of Araucaria, there has not been a single shared, agreed notation for representing argumentation and arguments and this deficiency has been a major barrier in the deployment of practical argumentation systems. The *Argument Interchange Format* (AIF) [3] is a draft specification for representing information about arguments and exchanging it between argumentation tools and agent-based applications. Adoption of the AIF as the format for representing arguments within individual MAgtALO agents, and as a means to exchange information between MAgtALO installations has a number of benefits. Primarily it enables new online argumentation tools such as ArgDF [12] to be used as source of analysed argument with which to populate the agent's knowledge bases. Additionally, the AIF can be used to distribute argument data between MAgtALO installations so that a user interacting with one instance of MAgtALO, and thereby expanding the available pool of arguments through interactive knowledge elicitation, also provides data that further users interacting with other instances of MAgtALO can make use of. Finally, each dialogue, conceived as a sequence of utterances made by the user and agents in turn, can be recorded, shared, and analysed, both within MAgtALO and with other argument analysis tools.

4.1 The Argument Interchange Format

There have been a number of attempts to construct argument mark-up languages. For example two particularly relevant examples are, AML discussed in section 2.2 and used in the Araucaria system, and *ClaiMaker* which provides a suite of tools for publishing and contesting ideas and arguments. However there are limitations associated with these approaches which motivated the need to for a common interchange format. A number of limitations of existing approaches were identified [3]. Firstly, that each language was designed primarily to be used

by particular software tools, such as Araucaria using AML, rather than facilitating interoperability with other tools. A second limitation is that the existing languages were developed to support graphical in which the user graphically constructs diagrams showing the argumentative linkages between natural language sentences.

The AIF was developed to overcome these limitations with the following primary aims; firstly to facilitate the development of multiagent systems capable of argumentation-absed reasoning and interactions; and secondly to facilitate data interchange between tools that support argument manipulation, visualisation, and utilisation. Two aspects of the AIF that are of particular importance in relation to the MAgtALO system are its use in the representation of *monologic argument* and its use in the representation of *dialogic argument*.

4.2 Monologic Argument Representation

The primary mode of use of the AIF is to represent monologic arguments. In this mode, argument entities are represented as nodes in a directed graph (digraph) informally known as an *argument network*. Two primary types of node are supported, *information nodes* (I-nodes), which relate to argument content and are used to represent claims, and *scheme application nodes* (S-nodes), which are used to represent domain independent, stereotypical patterns of reasoning. Three sub-categories of S-node are currently supported, the *rule application node* (RA-node), the *preference application node* (PA-node), and the *conflict application node* (CA-node). The notion of support in an argument is supported in an AIF argumentation network using edges. If an edge runs from node A to node B then it is said that A supports B. Consequently an argument network can be constructed by connecting the requisite node types according to the specified support semantics of AIF.

4.3 Dialogic Argument Representation

MAgtALO does not currently make a record of the actual dialogue that occurs between the user and the agents, although any new statements entered by the user, or inferences drawn, are recorded into the knowledge base available in subsequent dialogues. It would of course be useful to record the dialogues that occur, so that the user make a record of their interaction, and so that analysis can be made of the ways that users interact with the topic under discussion. Such an ability could be incorporated in MAgtALO using the AIF both to record the entire dialogue and as the format for exchange of messages within a dialogue between the communicating agents. An extension to the AIF that supports such an application is due to Modgil and McGinnis [11] and proposes the introduction of *protocol interaction application* (PIA-nodes) to account for dialogue specific requirements along with adoption the *Lightweight Coordination Calculus* (LCC) [14] as a means to specify a protocol language.

5 Challenges & Directions

It has been suggested that argument provides a more intuitive and accessible means of presenting and assimilating complex data [5], and that structured argumentation can be applied to discussions of complex domains involving real risks [9]. In MAgtALO, both monologic argument structures and dialogic argument protocols are used to give the user intuitive control over navigation of a complex disagreement space. Presenting and organising material explicitly as arguments should mean that users find it easier to understand the relations between the various positions in comparison to sources which have a more discursive style (such as newspaper reports). One would expect the same to be true for other argument-based systems such as debatapedia. But providing an intuitive interaction metaphor with which the user is expected to be familiar (chairing a meeting), and allowing the user active participation in both directing the discussion and contributing to it, it is further expected that MAgtALO should offer an appreciable benefit over formats that allow little or no active participation with the material (such as reports from the traditional media) or that offer a weak, non-argumentative interaction model (such as or wiki pages and discussion boards). Although informal, small-scale evaluations conducted at Dundee suggest that this benefit is substantial, larger scale investigations are required. Testing these hypotheses on specific user groups is a key step for guiding both the MAgtALO project specifically, and the online argumentation research area in general.

From a technical perspective there are two key advances in the underlying representations that structure MAgtALO's immediate development. First is to allow the system to use a variety of different dialogue protocols, so that such protocols might be explored and evaluated, using both the representational style and evaluative approach of [16]. Second is to replace the existing machinery for processing arguments based on the Araucaria representation format AML, and instead equip agents in the system with the ability to import from, and export to, the argument interchange format [3]. The AIF represents a nascent standard for argument representation: by extending MAgtALO to support the AIF, it becomes one of a constellation of systems that can offer an interface to existing argument resources, and provide a means of creating new such resources. By moving to the AIF, it will also become easier to make use of argument computation services that are now under development, for connecting the linguistic, textual analysis, elicitation and interaction with underlying formal models and semantics. It will, for example, become feasible to compute acceptability of each agent's position according to one or more argumentation semantics [2], and provide this information to users as the dialogue progresses.

6 Conclusions

MAgtALO already represents the first example of an implemented online system that uses a closely specified argument-based dialogue protocol combined with a

rich monologic argument representation language to provide a tool for intuitive user exploration of a space of disagreement. As an additional benefit of the approach, it is possible to expand the argument resources through knowledge elicitation that is structured by the argument dialogue protocol. The continuing aim of the research is to use the advances in the theory of argumentation to push the practice of argumentation technology in providing tools and interfaces that have wide appeal.

7 Acknowledgements

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