Contextual Extension with Concept Maps in the Argument Interchange Format

Conference Paper · January 2008

DOI: 10.1007/978-3-642-00207-6_5 · Source: DBLP

Adrian Groza
Universitatea Tehnica Cluj-Napoca

Contextual Extension with Concept Maps in the Argument Interchange Format

Ioan Alfred Letia and Adrian Groza

Technical University of Cluj-Napoca
Department of Computer Science
Baritiu 28, RO-400391 Cluj-Napoca, Romania
{letia,adrian}@cs-gw.utcluj.ro

Abstract. In our approach of argumentation we focus on formalizing the context of arguments and its propagation within the argumentation chain, aiming to facilitate the re-usability of arguments in the World Wide Argument Web. The contextual extension is based on intensional operators used to update the context for different arguments. We extend the ontology of the Argument Interchange Format with context nodes and visualize the arguments as concept maps.

1 Introduction

We are in the age when we can imagine a World Wide Argument Web (WWAW) infrastructure, native to the Internet, enhancing software agents with the ability to debate, rise argumentation, or analyze ideas, in order to provide a more effective dissemination of the information to the more and more knowledge driven, but lost, human agents.

The WWAW [1] is a large scale network of inter-connected arguments created by human agents in a structured manner. From the idea of integrating structured argumentation within the WWW [2], the current vision aims to create an infrastructure for mass-collaborative editing of structured arguments in the style of the Semantic Wikipedia. One desiderata of the WWAW is to employ a unified argumentation ontology that can be extended [1].

The current trend consists in developing hybrid approaches that combine the advantages of formal (logic-based) and informal (argumentation schemes-based, diagramming reasoning) ideas [3]. Among the variety of prototype systems that support argumentation: Rationale [4], Araucaria [5], Carneadas [6], Reasonable, Magtalo[1], Aver[2], Compendium[3], none seem to overcome a minimum number of users. The above approaches aim to simplify the argumentation process by providing graphical representations and by hiding irrelevant or improbable information. During the inference process, this information is left aside and is no longer accessible in a later stage.

[1] MultiAgent Argumentation, Logic and Opinion at www.arg.computing.dundee.ac.uk
[2] Argument visualization for evidential reasoning.
[3] http://compendium.open.ac.uk

I. Rahwan and P. Moraitis (Eds.): ArgMas 2008, LNAI 5384, pp. 72–89, 2009.

Consequently, this research focuses on formalizing the context of arguments and its propagation within the argumentation chain, aiming to facilitate i) the re-usability of arguments in WWAW and ii) identifying inconsistencies between consequents and the actual contexts or world state. The vision is that the resulting context-aware argument networks will make use of the Argument Interchange Format (AIF) ontology for developing large scale argumentation networks.

2 Aspects of Arguments

The acceptance of an argument is a combination of intrinsic and extrinsic factors. A successful argument in a context might have no relevance in another one. Consider a chess player who browses opening collections, trying to figure out the best move for a particular board position. The collection provides a trace of moves (the structure or *form* of the argumentation chain), and a value estimating the current position[4] (the *content* of the argument). Happily, during one tournament, he meets a known position and he recalls the best recommended move. Facing this situation, a wise player takes into consideration three contextual factors (*context* of the argument):

1. *Social context*: the re-usability of the move depends on the knowledge about the current opponent: "If I make that move, I will enter in an "open position", and my opponent loves such positions."
2. *Intentional context*: the re-usability of the move is influenced by the current goal: "If I re-use the move, I will get some advantage, but the position becomes unstable. My goal in this game is to obtain a tie, therefore I should better consider other options."
3. *Dialectical context*: the re-usability depends on the time available: "After this move the position will become very complex. My remaining time is less than that of my opponent and I cannot afford it in this situation."

The multifaceted argument is modeled by three vectors: form, content and context.

Form. The form reveals the structure of the argument: the layout and the link between reasons and conclusion [7]. Analyzing the form shows if the premises are capable of supporting a justified conclusion, on the assumption that the antecedents are true. If the structure of the argument is weak the argument will be weak too. If there is a high reliance on the form of the argument, the argument is called strict: whenever the premises are true, so is the conclusion. Strict arguments are associated with the analysis of concepts or epistemic knowledge. If this is not the case, we have defeasible arguments: the link between premises and conclusion is weak; therefore it can be attacked with undercutting defeaters [8].

The newly proposed AIF ontology [9] focuses on the representation of the *argument form*. Patterns of arguments come in different shapes and we find two approaches: logic based (modus ponens, defeasible modus ponens, modus tollens,

[4] A qualitative one, as "white ahead" in chess algebraic notation, or a quantitative one, a subunit number computed by chess programs.

abductive arguments, inductive arguments), and a more informal one, given by argumentation schemes (presumptive, inductive, or defeasible argumentation schemes [10]).

Content. The analysis of the content of an argument deals with two issues: i) it reveals if the premises are actually true, and ii) it assures that the set of antecedents are semantically coherent [7]. If the form of the argument encapsulates common patterns of human reasoning, the content of the argument is domain dependent: to establish the degree of truth of the premises requires knowledge of the domain[5].

Regarding the first issue, the degree of support (*dos*) assigned to an argument can be expressed either qualitatively or quantitatively. To evaluate the degree of belief in an argument a flattening function is necessary to aggregate different representations of the reliance upon subarguments [2]. Some inference engines for computing the acceptability of arguments have been developed in the ASPIC project[6]. To prove the AIF concepts in this prototype, each node has a degree of support ($dos \in [0, 1]$) attribute. Also, the computation of the *dos* of a conclusion based on the *dos* of its premises is based on the weakest link principle[7]. In the large-scale, open context of WWAW, these attributes might not suffice due to: i) standards of evaluating arguments are domain dependent; ii) the applicable principle of inference for computing the reliance on an argument may change during the course of argumentation. iii) the applicable principle of inference depends on the current context; iv) different principles require different attributes attached to the premises (instead of the degree of support) such as fuzzy numbers or rough intervals.

Regarding the second issue, a standard of thematic coherence must be defined in order to validate the content of an argument. Arguments usually contain questionable premises: “is the probability of a premise so high?”, “is the source that posted the argument reliable?”. Critical questions on the argumentation scheme model deal with the content analysis by questioning the truth or the semantic coherence of the premises.

Context. Arguments are conveyed for a particular purpose in the context of an action. In order to effectively support a consequent, flexible control must be exercised over the extrinsic factors by providing a context [7]. The context helps agents to discover the available means of persuasion for the current debate. The success of an argument-based agent in WWAW regards its ability to re-use arguments by changing their context[8]. The following contextual dimensions can be formalized for a general argument.

[5] With the exception of *tautologies*, where the truth depends only on the form, regardless of the content. On the contrary, some fallacious reasoning, or arguments with bad form, can be perfectly acceptable in specific contexts.

[6] http://www.argumentation.org

[7] The *dos* of the consequent is the minimum degree of support of its antecedents.

[8] To re-use arguments is certainly an easier task for a software agent than to create them from scratch. The re-use of arguments would be equivalent to re-creating them in a different context.

Dialectical Context. It refers to the discourse or the debate protocol in which the arguments have been conveyed. The communication context formalizes the participants (IDs, roles such as pro, con, persuader, buyer, seller), the topic of the dialog (useful when searching arguments in WWAW), or the type of dialog (persuasion, negotiation, dispute resolution, interview[9]). The last issue opens the perspective of developing protocol-based reasoning agents in WWAW.

Intentional Context. Usually, the utterance of an argument serves in achieving a goal during the debate, negotiation, or persuasion protocol in which the argumentation takes place. The intentional context models the relationship between the specific arguments and the plans of the arguers [7]. Thus, a good argument is one which fits the current goal of the arguer. Providing an intentional context representation helps to mediate a debate by accepting only the relevant arguments.

Social Context. It encapsulates the human factors related to the context, or agent attitudes and strategies in the case of interacting software entities. The human factors might refer to: information on the user (knowledge of habits, emotional state), social environment (co-location of friends, social interaction), cultural issues (e.g. acquisition of context), relationship between the specific arguments and the plans of the arguers. The context of an argument can be seen as representing subjective perspectives on the argument.

3 Extending the Argument Interchange Format

Two extensions of the AIF ontology are: Argument Schemes [1], and Protocol Interaction Application Nodes [11]. The first one enhances agents with both reasoning capabilities: logic based argumentation and scheme based argumentation, and it also focuses on representing the *form of an argument*. The second one allows agents to represent the dialectical part of arguments.

We introduce a new node type, *context node* ($CO - node$), arguably needed since context exists independently of any object. One context may be used to evaluate different arguments, while the same argument can be evaluated in different contexts. The separation of the argument structure, modeled with *I-nodes* and *Scheme-nodes*, from contexts, provides more power to the re-use of arguments, and flexibility in the representation and acceptance [12].

Definition 1. *The extended-AIF ontology has five disjoints sets of nodes:* N_I, N_S, N_{PIA}, N_F, *and* N_{CO}.

- *An information node* $I - node \in N_I$ *represents passive information of an argument such as: claim, premise, data, locution, etc.*
- *A scheme node* $S - node \in N_S$ *captures active information or domain-independent patterns of reasoning. The schemes are split in three disjoint sets, whose elements are: rule of inference schemes* ($RA - node$)*, conflict application node* ($CA - node$)*, preference application node* ($PA - node$)*.*

[9] It can point to a more elaborate dialog topology.

– *Forms of arguments $f \in N_F$ model argumentation schemes, by defining the premise descriptor, the conclusion descriptor, presumptions and exceptions.*
– *Protocol interaction nodes ($PIA - node$) are used to constrain the dialog moves within an argumentation process.*
– *Context application nodes ($CO - nodes \in N_{CO}$) are used to capture the context of the above node types in order to increase the re-usability of arguments in WWAW.*

$RA - nodes$ are used to represent logical rules of inference such as modus ponens, defeasible modus ponens, modus tollens. $CA - nodes$ represent declarative specifications of possible conflicts. $PA - nodes$ allow to declaratively specify preferences among evaluated nodes. $F - nodes$ focus on the form aspect of arguments by allowing the introduction of argumentation schemes in the AIF ontology. A $PIA - node$ encodes the range of possible speech acts as reply to an *I-node* of type locution, and their preconditions and effects [11]. In WWAW, a mediator agent deploys $PIA - nodes$ for dialog representation accessible to the participating agents. When dealing with such a node, one can either i) use this node, by providing $I - nodes$ encapsulating the speech acts specified into the $PIA - node$, or ii) attack the node by instantiating a scheme node having the $PIA - node$ as conclusion.

Definition 2. *An argument map Θ in AIF is a directed graph consisting of a set N of nodes and a binary relation $\xrightarrow{edge}: N \times N$ representing edges, where $\nexists (i, j) \in \xrightarrow{edge}$, where both $i, j \in N_i$.*

The informal semantics of the edges from a CO-node to the existing nodes of the AIF-core ontology is:

– to an *I-node*: apply a context to the data in the I-node;
– to an *RA-node*: apply a context to the inference application in the RA-node;
– to a *CA-node*: apply a context to the conflict application in the CA-node;
– to a *PA-node*: apply a context to the preference application in the RA-node;
– to a *PIA-node*: apply a context to a move in the dialog in the PIA-node;
– to an *F-node*: apply a context in relation to the presumptions in the F-node.

The inverse relation, from the nodes of the AIF ontology to a CO-node, is:

– from an *I-node*: I-node data is used to apply a context;
– from an *RA-node*: infer a conclusion in the form of a context application;
– from a *CA-node*: apply a conflict definition to the context application in the CO-node
– from a *PA-node*: apply a preference on a context application;
– from a *PIA-node*: apply a dialog move on the context application in the CO-node.
– from an *F-node*: apply an argumentation scheme on a context application in the CO-node.

4 Context Calculus in the Extended AIF

4.1 Context Representation

We approach the context issue by using the intensional programming paradigm, which has its foundations in intensional logic. Intensional logic adds *dimensions* to logical expressions and *intensional operators* are used to navigate in the context space. Consider the following *I-node* of type claim:

$$I - node_1 : \text{"}This\ year\ the\ acceptance\ rate\ of\ this\ conference\ is\ 25\%.\text{"}$$

The claim is intensional because its truth value (or content) depends on the context in which it is evaluated. Two intensional operators in the $I - node_1$ are "this year" and "this conference", which refer to two contextual dimensions: *time* and *conference*. One extension $I' - node_1$ is illustrated in table 1 where the content of the claim depends on the year and conference name, and it is represented as boolean values.

Table 1. Extension of the claim $I - node_1$

	AAMAS	*IAT*	*ECAI*
2008	True	True	True
2007	True	False	False
2006	False	False	True

The context is defined as a subset of finite union of relations [12], where *DIM* represents dimension names and the function f_{dimtag} associates a tag X_i with each $D_i \in DIM$.

Definition 3. *A context C, given DIM and $f_{dimtotag}$, is a finite subset of $\bigcup_{i=1}^{n} P_i$, where $P_i = d_i \times f_{dimtotag}(d_i), 1 \leq i \leq n$. The degree of context C is $|\Delta|$, where $\Delta \subset DIM$ represents the dimensions that appear in C. A context C is simple if $(d_i, x_i), (d_j, x_j) \in c \Rightarrow d_i \neq d_j$. A simple context of degree 1 is called a micro context.*

4.2 Context Application Schemes

We formalize context operators as rule application schemes in AIF, with the following operators [12]:

- Set schemes: *difference* $\ominus$, *conjunction* $\sqcap$, disjunction $\sqcup$;
- Selectors: *projection* $\downarrow$, *hiding* $\uparrow$;
- Constructors: *cons* [_:_], used to create a micro context, *enrich* $\otimes$, reduce $\div$;
- Predicates: *comparison* $=$;
- Change schemes: *override* $\oplus$, *substitute* $/$, *choice* $|$ (accepts a finite number of contexts and nondeterministically returns one of them).

Protocol application nodes can be used to define precedence rules for all these operators. In the case of the override operator (figure 1), if c_1 is a context with

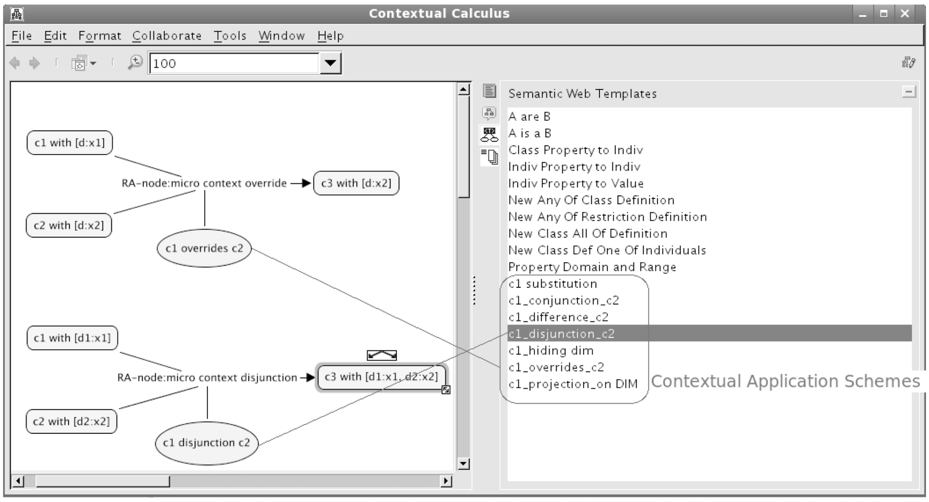

Fig. 1. Override and disjunction operators as RA-nodes in a micro context

dimension d and tag x_1, c_2 is a context with the same dimension d and tag x_2, the resulting context c_3 will have the tag x_2 associated with the dimension d. Accepting the conclusion of an $F - node$, the context of that conclusion is enriched with the presumptions assumed during the inference process. In the case of the disjunction operator, the resulting context c_3 will incorporate both dimensions and the corresponding tags ([d1:x1, d2:x2]) of the input contexts.

Example: Consider two contexts:

$$c_1 = [year : 2008, year : 2007, conf : AAMAS]$$

$$c_2 = [year : 2008, conf : AAMAS, location : Estoril]$$

and the dimension set DIM={conf, location}. Applying the contextual operators we obtain:

- c_2 overrides c_1: $c_1 \oplus c_2$=[year:2008, conf:$AAMAS$, location:Estoril];
- c_1 difference c_2: $c_1 \ominus c_2$=[year:2007];
- c_1 conjunction c_2: $c_1 \sqcap c_2$=[year:2008, conf:$AAMAS$];
- c_1 disjunction c_2: $c_1 \sqcup c_2$=[year:2008, year:2007, conf:$AAMAS$ location: Estoril];
- c_1 projection on DIM: $c_1 \downarrow D$=[conf:$AAMAS$];
- c_1 hiding DIM: $c_1 \downarrow D$=[conf:$AAMAS$];
- c_2 substitution [conf:IAT, location:Sydney]: c_1/ [conf:IAT, location:Sydney]: [year:2008, conf:$AAMAS$, location:Sydney].

5 Visualizing AIF Arguments in Concept Maps

As concept maps provide intuitive visualizations of the argument networks, we have chosen CMap servers[10] to provide robust displays of the arguments in the WWAW. When an argument map is saved on a CMap server, a web page version is also stored. A WWW browser is therefore sufficient to browse the argumentation chains.

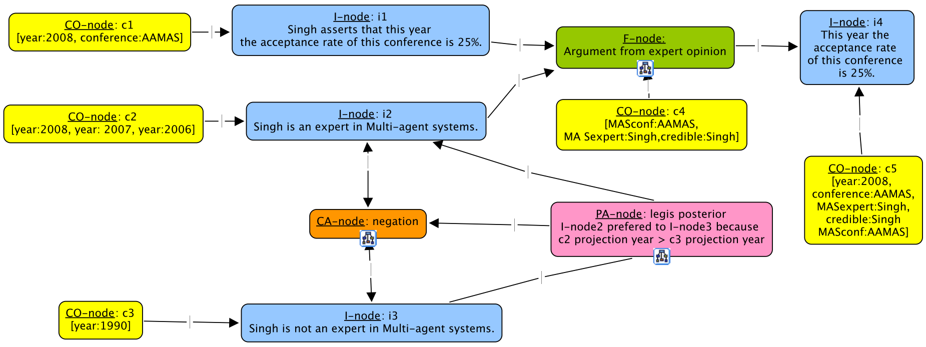

Fig. 2. Contextual Argument in CMaps

5.1 Example of Contextual Form Node

Two premises are defined, in the argument map illustrated in the figure 2, by the $I - node_1$ and $I - node_2$ concepts. $I - node_1$ has two explicit intensional operators, captured by the context node c_1.

$$c_1 = [year : 2008, conference : AAMAS]$$

$I - node_2$ has a hidden context time, captured by the context node:

$$c_2 = [year : 2008, year : 2007, year : 2006]$$

stating that the claim in $I-node_2$ is known to be true in the years 2008, 2007, and 2006. Based on the presumptive $F - node_{ArgumentFromExpertOpinion}$, the claim may be plausibly taken to be true. The $F-node_{ArgumentFromExpertOpinion}$ points to its structural representation as conceptual map (figure 3). Anyone who wants to inspect or attack it can browse its presumptions or expected exceptions. Every $F - node$ has its own formula to propagate the context to the conclusions. In the case of an *Argument from Expert Opinion*, the context of the major premise is enriched with the assumed presumptions, using the relation *enriches context* (figure 3).

$$c_4 = c_1 \sqcup [MASexpert : Singh, credible : Singh]$$

[10] http://cmap.ihmc.us/

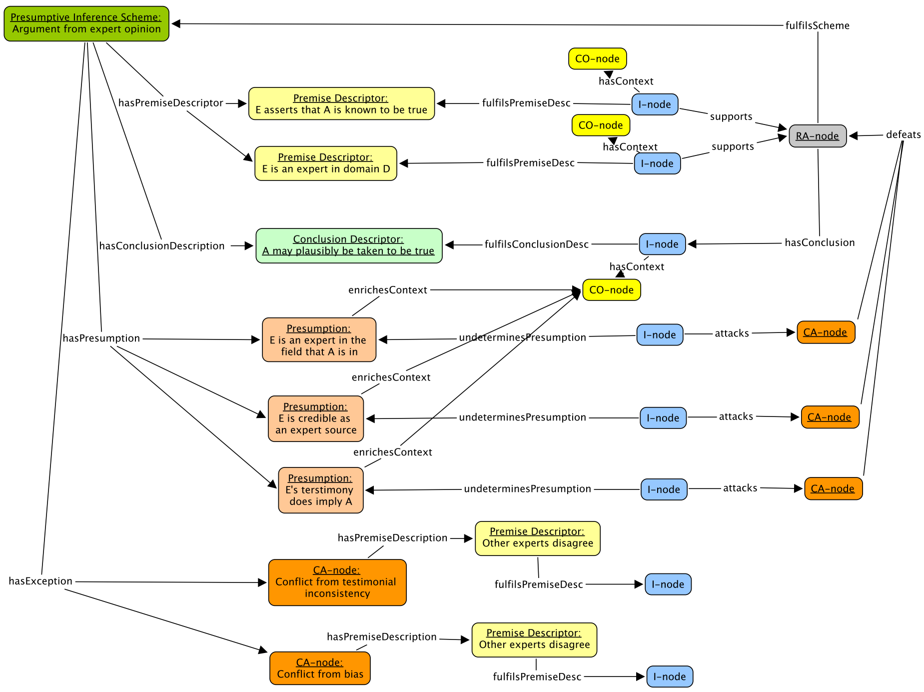

Fig. 3. F-node: *Argument from expert opinion* enriched with context, in CMaps

By applying the $CO - node_4$ in this scheme some presumptions are stated explicitly ("Singh is an expert in MAS" and "Singh is credible"), but presumptions that have not been initially encapsulated in the F-node, as "AAMAS and IAT are MAS conferences", may also be added.

$$c_4 = c_4 \sqcup [MASconf : AAMAS, MASconf : IAT]$$

As these presumptions are usually domain dependent, the context-node is used to represent them. Suppose that the claim in i_3 is identified on the Internet. Therefore, the conflict application node *negation* may be applied to represent the rebuttal attacking relation between nodes i_2 and i_3 (figure 2).

One question regards how contextual information may impact argument reusability. Depending on the context dimensions of the data in $I - node_3$ that the arguer can obtain, the specific preference application criteria $(PA - node)$ can be used to resolve the conflict. The difference between the contexts of conflicting nodes is useful when searching for proper preference criteria.

$$c_3 \ominus c_2 = [year : 1990]$$

In this case, the difference refers to the time dimension, and is also relevant to the content of the argumentation chain. Therefore, the preference application node *legisposterior* can be used (figure 2). The "Legis Posterior" principle stipulates that the last known data or norm dominates. By comparing the time dimension of both conflicting nodes, using formulas of the context calculus:

$$c_1 \downarrow year > c_3 \downarrow year$$

the i_2 is considered to have its content true. By clicking on the $PA - node_{LegisPosterior}$, a new concept map will be opened, revealing its structure.

When we want to re-use the above argument for another multi-agent system conference, we enrich the $CO - node_1$ context:

$$c_1 \sqcup [conf : IAT] = [year : 2008, conf : AAMAS, conf : IAT]$$

Given that a context c_5=[conf:IAT] has been defined, the override operation:

$$c_1 \oplus c_5 = [year : 2008, conf : IAT]$$

might also be used.

5.2 Example of Contextual Protocol

In the chess example considered in section 2 (figure 4), the first move $e4$ encapsulated in the data node $I - node_1$ has the contextual information:

$$c_1 = [player : DeepBlue, goal : 1/2 - 1/2, time : 2.00h]$$

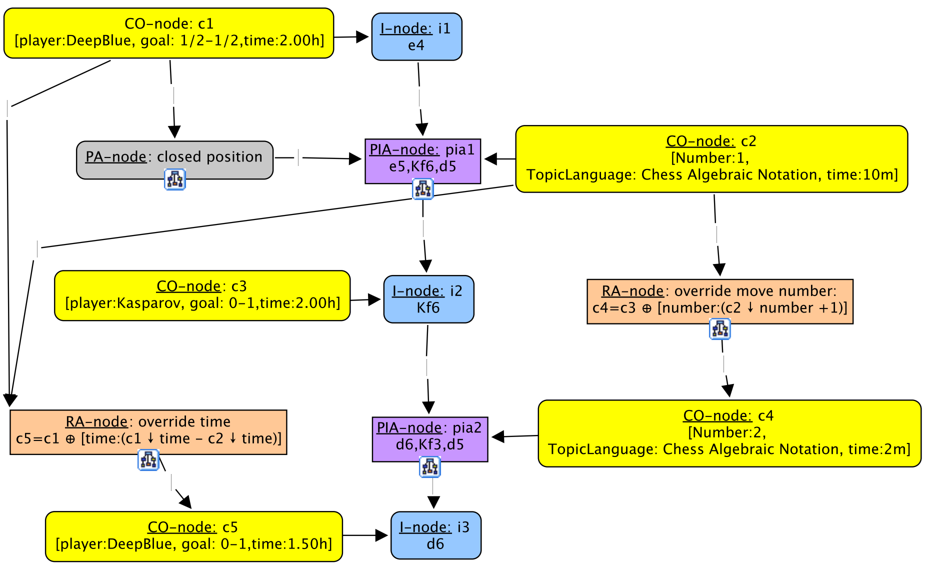

Fig. 4. Contextual protocol

which encapsulates the social context of the game (*player* dimension), the intentional context (the *goal* is to obtain a tie), and the dialectical context (available *time* to end the protocol). It points to the protocol application node pia_1 recommending the best (according to a preference criterion $PA - node_1$) possible moves in the current state (figure 4). The preference criterion *closed positions* depends on the current context. The PIA_1 node has a context denoting the topic language and the elapsed time.

$$c_2 = [TopicLanguage : ChessAlgebraicNotation, time : 10m]$$

From the available locutions, the opponent chooses *Kf6* in the node i_2. This passive information has a different context attached:

$$c_3 = [player : Kasparov, goal : 0 - 1, time : 2.00h]$$

where both the social aspect and the intentional context have been changed. Observe that the context attached to a PIA-node denotes objective information, while the context attached to the locutions in I-nodes has a subjective perspective on the game. Using the available contextual information, the context can be updated by instantiating the rule application node *override time*. Thus, the *time* dimension of the context attached to the next move will be overridden by the remaining time, the difference between the available time (in c_1) and the elapsed time (in c_2).

$$c_5 = c_1 \oplus [time : (c_1 \downarrow time - c_2 \downarrow time)]$$

The context c_4 of the protocol node PIA_2 is calculated similarly, based on the $RA - node_2$, which overrides the number of the move.

$$c_4 = c3 \oplus [number : (c_2 \downarrow number + 1)]$$

5.3 CMap Functionalities for WWAW

The following functionalities from the CMap tool can be used to visualize the WWAW architecture:

- *Deploying arguments in WWAW*: The system allows users to save their arguments on the available public servers, if the proper user name and password are provided.
- *Searching Arguments*: The CMap tool provides searching capabilities for identifying arguments within both public argument maps and the WWW.
- *Validating and fixing links.* Due to the dynamics of WWW resources, web pages having the role of supporting arguments might no longer be available. The tool can check if a chain of an argument is available at a certain time.
- *Allowing modification of argument maps*: If the proper user name and password are provided the user can modify publicly deployed argument maps, in the style of Wikipedia.
- *Public character of the arguments*: Some debates, such as Online Dispute Resolution, need to maintain some arguments as private. Even if they are posted on the WWW, only the arbitrator might have the right to read them.

– *Providing evidence:* The piece of evidence is often relevant in the course of argumentation. An argument is stronger if some evidence is provided for its premises. The system enhances parties with the ability to point towards relevant evidence in a different number of formats: video, html pages.

The resulting conceptual maps are saved in the XML format, which allows the integration of software agents within the WWAW.

5.4 Crisis Mediation

This section illustrates how a real life scenario is modeled using our approach. Engineering the conceptual argumentation maps is based on four templates (right part of figure 5): i) the basic AIF nodes (i, ra, ca, pia, pa, f, co); ii) the contextual operators nodes ($disjunction$, $conjunction$, $substitution$, $difference$, $hiding$, $overrides$, $projection$); iii) the existing argumentation schemes modeled as f-nodes (*Argument from expert opinion*, *Argument from position to know*, *Argument from reputation*, *Argument from legal rule*, etc.); and semantic web templates that facilitate interaction with software agents (*A are B*, *A is B*, *Property domain and range*, *Class property to Individual*, etc.). Using the above (extensible) templates, the process of modeling the argumentation chain is simplified for the human agent. At the same time, the IHMC_COE[11] tool that we use is able to export the argument map in the OWL format. Therefore a software agent knowing the AIF ontology will be able to reason on the existing argumentation chains.

We consider the crisis scenario that took place in 1995 between Canada and Spain. Canada, acting unilaterally to protect depleted fishing stocks, has seized a Spanish trawler just outside Canadian territorial waters. The crisis started when a Canadian fishing patrol cut the net of a Spanish trawler caught overfishing in international waters. Canada confiscated illegal nets whose mesh size were to small, so that turbot too young to spawn would be caught. Spain claimed that the seizure of the ship was a breach of international law; therefore the evidence discovered could not be used against them. The crisis has several contextual dimensions, such as legal, economical, political, environmental. The legal context is exemplified in the following paragraphs.

Assume that the starting legal context is given by the *NAFO* (Northwest Atlantic Fisheries Organization) illustrated by CO-node c_1 in figure 5. Based on the Argument from expert opinion f_1, the nets used by the Spanish trawler don't let the turbot fish to spawn (i_2). On the one hand, in the context $c_1 = [law : NAFO]$, which stipulates that the fish cannot be caught before reaching a certain age (i_3), based on the f_3 argument from legal rule, one can infer that Spain has breached the regulations (i_6). If we also consider the issue in the context of year 1995 (c_1), by applying the ra_0 contextual operator, we validate the fact that the fishing quota for EU boats is set to 34000 tones (i_4). In the context c_2, Canada claims that, according to its observations (f_2), the fishing quota has already reached 70.000 tones (i_5). This discrepancy, modeled by the

[11] http://coe.ihmc.us

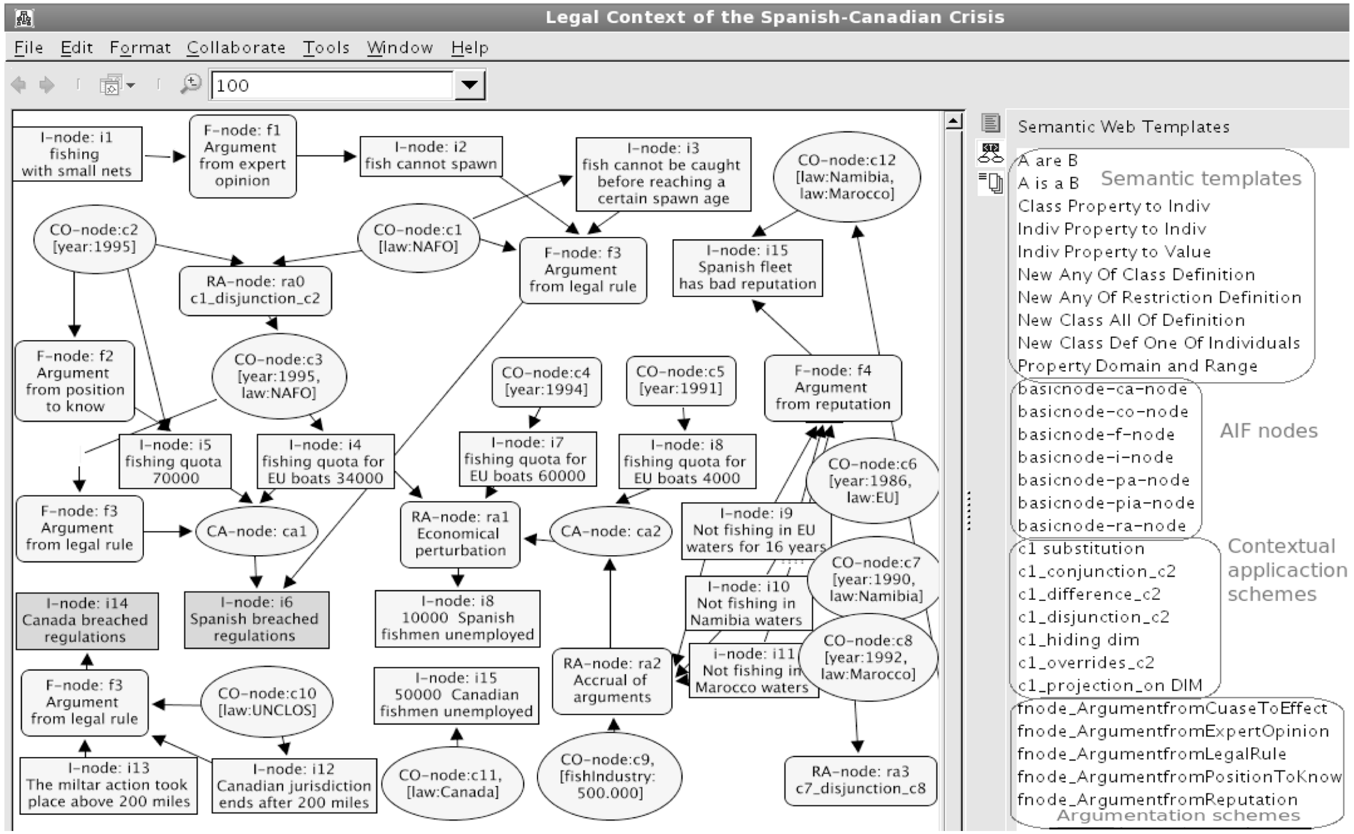

Fig. 5. Legal context of the Canadian-Spanish fishing crisis. I-nodes are represented with rectangles, Scheme Application nodes with rounded rectangles, and CO-nodes with ovals.

conflict application node ca_1 and based on the same f_3 pattern of argumentation also supports the consequent i_6. Notice that the argument from legal rule f_3 was applied in a different context c_3, opposite to its first application in the c_1 context, which exemplifies the re-use of arguments in different contexts.

The Spanish government claims that the recently (context node c_4) decreasing of fishing quota from 60000 (i_7) to 34000 tones has produced economical perturbations (ra_1), which might lead to serious labor problems in the Spanish fishing industry (i_8). If one looks at the issue from the context of 1991 (c_5), when the fishing quota was only about 4000 tones (i_8), one can find a conflict (ca_2) between Spanish claims, which defeats the application of the ra_1 scheme[12].

The Spanish advocate can enrich the legal context by the EU legislation (c_6). When Spain entered the European Union in 1986, it was not allowed to fish in European waters for 16 years (i_9). In the same line, under the Namibia law (c_7), one can find that in 1990 the Spanish boats have been kicked out from its territorial waters (i_{10}). Similar regulations (i_{11}) have been put into force by Morocco in 1992 (c_8). These correspond to the period when Spanish fleet started to over-fish in North Atlantic. In the context of 500000 employers in the Spanish fishing industry (c_9), by accrual of these perturbations (ra_2), the social argument of the Spanish government has stronger support, but it also contributes to the bad reputation of the Spanish fleet (i_{15}). Note that the Spanish fleet bad reputation is inferred only in the context c_{12} of Namibia and Morocco legislation, obtained from:

$$c_{12} = (c_7 \downarrow law) \sqcup (c_8 \downarrow law)$$

From the viewpoint of the other side, Canada has stricter regulations than *UNCLOS* (The United Nation Convention Law of the Sea), but they are applied only to its own citizens. As a consequence of these norms (c_{11}), 50000 fishermen became unemployed (i_{15}) and the Canadian government spent 3 billion Canadian dollars to assist them. Thus, both Canadian and Spanish governments face similar social problems.

On the other hand, *UNCLOS* stipulates that only 200 miles are under Canadian jurisdiction. Consequently, in this legal context c_{10}, considering that Canadian action took place after this limit (i_{13}), the Canada is the one that has breached the law. Note again, that the same argument from legal rule was re-used in a different context.

One conclusion is that context is very relevant to understand and to identify the causes and solutions of such a crisis. By exporting the above structure in OWL, the software agents can analyze and contribute to the argument map.

6 Related Work

A fundamental difference between human and agent societies is that humans demonstrate some heterogeneity in their interpretation of what an argument

[12] By attacking the link between the premises i_4, i_7 and the conclusion i_8, it represents an undercutting defeater.

represents. The AIF ontology basically tries to structure argumentation without affecting this flexibility. Compared to existing work, our approach refines the flexibility provided by the AIF ontology, adding the context explicitly.

Rationale [4] is an instance of an emerging category of argumentation tools, aiming to improve argumentation abilities of human agents, based on the semi-formal concept of diagramming reasoning. The advocated advantages of the tool consists in its usability and semi-formality. Quite the contrary, this research focuses on re-usability, flexibility, and the open world assumption needed in large environments such as WWAW. In the WWAW arguments are no longer ordered sequentially or chronologically as in the discussion threads, but rather according to their functional role. The context of an argument is introduced to facilitate the composition of argument along several contextual dimensions.

The Logical Argument Mapping [13] (LAM) provides for structuring arguments a seven step methodology. The ontology of LAM maps distinguishes statements and relations. Statements have a graphical representation according to their importance for cognitive change. Contrary to the AIF ontology, relations in LAM have a fixed set of labels: therefore, opposes, refutes, rejects, questions, supports, etc. An *AU:* tag is used to identify the author of an argument. Instead, we use PIA-nodes and the dialectical context of the argument to represent the dialogical aspect of an argument.

Different types of premises are used in the Carneades Argumentation framework [6]: ordinary, presumptions, and exceptions. The context of an argument depends on the status of the claims (accepted, rejected), proof standard (preponderance of evidence, beyond reasonable doubt) and weights attached to claims. In our approach, these notions regard the content of the argument, while the context is closely related to the presumptions in Carneades.

7 Discussion

Argumentation schemes in F-node are fixed structures of inference [1] reflecting common patterns of human reasoning. In our view, they should sometimes be slightly changed in order to fit a particular case. Contextual nodes allow to extend the presumptions in a particular argumentation scheme. Therefore, unexpected rebuttal facts which attack the newly introduced assumptions can be accepted to defeat the conclusion of the scheme.

The relevant question is what makes an argument successful. The strength of its form, the truth of its content, its application in the adequate context, a combination of these aspects? How will successful arguments replicate within WWAW, as *memes*[13] for instance, is the subject of new fields of exploration. A situation in which some arguments will be preferred by humans and others by software agents is not very hard to imagine.

In order to deploy agent-based applications on the WWAW, ideas from the REST architecture style of web services [14] can be applied, by considering each

[13] Term coined by Richard Dawkins on the analogy of *gene*, to define the cultural copying unit.

argument as a web resource. The agent progresses through an argument chain by selecting links, in this case state transition, resulting in a new page transferred to the user, according to the requested form, content, or context. In this approach, the re-usability of the arguments is increased due to the *loose coupling* property of the argument networks. Also, this design reflects the fact that, in a debate, the information is revealed gradually. Depending on the form, content, or context provided at each stage of the argumentation, the new state will be computed accordingly.

According to the premises of the game theoretic approach, a rational agent cannot be persuaded. It will always choose the best action independently of persuasion attempts. In the utility-based negotiation model [15] agents do not attempt to persuade each other or to explain why the proposal should be accepted, which are not necessary in domains with complete information. The fish dispute between Canada and Spain is seen as such a domain. In our view, each crisis is characterized by gradually revealed information. Of course, we assume that a crisis is an unanticipated event, not designed by some political circles. Consequently, at the beginning of the crisis, each party takes some actions based only on partial or distorted pieces of information. The need of negotiation itself is questioned when all the information is available: a decision system which compute the optimal outcome will suffice.

Quite the opposite to repetitive disputes, such as simple e-commerce contract breaches, international disputes are characterized by high dependence on context. They depend on the political context, social context, economical context, and a very complex and multi-jurisdictional legal context. For instance, in [15] the name of the states have been hidden during experiments. Consequently, the context was deeply altered, which leads to a severe limitation of the means of negotiation and the ability of negotiators to identify new solutions during the mediation. The experiments also deviate from the real life in the sense that only one negotiator was used. During an international crisis an entire team of experts is empowered by the government to handle the issue. We argue that the argumentation approach based on collaborative editing of conceptual maps is better suited to such scenarios.

8 Conclusions

Our approach aims to refine the argumentation process, by providing a context to each claim or scheme application. The contributions of this paper are: i) extending AIF ontology with context nodes, and ii) enacting AIF ontology as concept maps.

Future work regards the representation of data in I-node within AIF. In order to be effectively used by the software agents, the facts should be available as pieces of evidence that agents can refer to. The Common Knowledge Library can be particularly useful to represent the evidence in a structural form[14]. Although Compendium/ClaiMaker [16,17] has some similarities with our work, we have

[14] http://piex.publ.kth.se/ckl/index.html

preferred to use CMap as it was easier to connect to our system, but further consideration will be paid to that research in the near future.

In the game theoretic approach each player is selfish. It aims to maximize its expected utility and it does not take into consideration equity and social welfare. Quite the opposite, the argumentation approach aims to maximize the global welfare. As in real life, it is characterized by cooperation too, and not just competition between agents.

This paper focused on simplifying the argumentation process for the human agent, but keeps enough formality to allow interaction with software agents. The future work deals with the use of the exported argument map in OWL by the AIF-based software agents.

Acknowledgments

We are grateful to the anonymous reviewers for the very useful comments. Part of this work was supported by the grant 27702-990 from the National Research Council of the Romanian Ministry for Education and Research.

References

1. Rahwan, I., Zablith, F., Reed, C.: Laying the foundations for a world wide argument web. Artificial Intelligence 171, 897–921 (2007)
2. Reed, C.: Representing and applying knowledge for argumentation in a social context. AI and Society 11, 138–154 (1997)
3. Hunter, A.: Real arguments are approximate arguments. In: 22nd AAAI Conference on Artificial Intelligence, pp. 66–71 (2007)
4. van Gelder, T.: Rationale: Making people smarter through argument mapping. Law, Probability and Risk (submitted, 2007)
5. Reed, C., Rowe, G.: Araucaria: Software for argument analysis, diagramming and representation. International Journal on Artificial Intelligence Tools 13, 961–979 (2004)
6. Gordon, T.F., Prakken, H., Walton, D.: The Carneades model of argument and burden of proof. Artificial Intelligence 171, 875–896 (2007)
7. O'Rourke, M.: Critical Thinking Handbook. University of Idaho (2005)
8. Pollock, J.L.: Defeasible reasoning with variable degrees of justification. Artificial Intelligence 133, 233–282 (2001)
9. Chesnevar, C., McGinnis, J., Modgil, S., Rahwan, I., Reed, C., Simari, G., South, M., Vreeswijk, G., Willmott, S.: Towards an argument interchange format. The Knowledge Engineering Review 21, 293–316 (2006)
10. Reed, C., Walton, D.: Towards a formal and implemented model of argumentation schemes in agent communication. Autonomous Agents and Multi-Agent Systems 11, 173–188 (2005)
11. Modgil, S., McGinnis, J.: Towards characterising argumentation based dialogue in the argument interchange format. In: Argumentation in Multi-Agent Systems, May 2007, Hawai US (2007)
12. Alagar, V.S., Paquet, J., Wan, K.: Intensional programming for agent communication. In: Leite, J., Omicini, A., Torroni, P., Yolum, p. (eds.) DALT 2004. LNCS, vol. 3476, pp. 48–56. Springer, Heidelberg (2005)

13. Hoffmann, M.: Logical argument mapping: a cognitive-change-based method for building common ground. In: 2nd International Conference on the Pragmatic Web, Tilburg, The Netherlands, pp. 41–47 (2007)
14. Fielding, R.T., Taylor, R.N.: Principled design of the modern web architecture. In: 22nd International Conference on Software Engineering, pp. 407–416. ACM, New York (2000)
15. Kraus, S., Hoz-Weiss, P., Wilkenfeld, J., Andersen, D.R., Pate, A.: Resolving crises through automated bilateral negotiations. Artificial Intelligence 172, 1–18 (2008)
16. Buckingham Shum, S.: Hypermedia discourse: Contesting networks of ideas and arguments. In: Priss, U., Polovina, S., Hill, R. (eds.) ICCS 2007. LNCS, vol. 4604, pp. 29–44. Springer, Heidelberg (2007)
17. Uren, V., Buckingham Shum, S., Bachler, M., Li, G.: Sensemaking tools for understanding research literatures: Design, implementation and user evaluation. International Journal of Human-Computer Studies 64, 420–445 (2006)