COMP 8920 - Computational Reasoning in AI

Literature Review

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1 Introduction

This literature survey focuses on research that uses Subjective Logic to deal with uncertainty in the domain of argumentation. In Section 2, we review the work of F. Santini et al. in [1], which explores the use of Abstract Argumentation Frameworks (AAFs) to help agents determine whether an argument or attack is trustworthy and provide a new approach to the use of AAFs with Subjective Logic. Section 3 reviews the work of A. Koster et al. in [2] on the use of Belief Revision operators. N. duy Hung in [3], evaluates the use of Probabilistic Assumption Based Argument Frameworks which is reviewed in Section 4. In Section 5, the concept of dialogue based information exchange in argumentation using sensors by N. Oren in [4] is surveyed. Finally, in Section 6, we take a look at the work of A. Groza et al. in [5] for a practical implementation of subjective logic in argumentation, by determining the acceptability of arguments related to climate change denial.

2 Are my arguments trustworthy? Abstract argumentation with Subjective Logic

2.1 Problem Addressed

P. M. Dung's Abstract Argumentation Frameworks[6] proved to be an effective method for the representation of arguments and conflicts expressed in natural language. However, these frameworks ignore any relationship between the arguments in conflict. Arguments can be fallacious due to the presence of enthymemes, wherein a premise is not stated, thereby leading to uncertainty of trustworthiness. Furthermore, due to characteristics of natural language, the attack of one argument upon another may not be present at all, but an agent may interpret it as one.

2.2 Previous work

The authors do not point out any drawbacks in the approaches taken by the authors of the below papers but rather refer to them as varied approaches to tackling uncertainty and subjective belief in AAFs.

E. Dunne et al. introduced the concept of weighted arguments in [7], which uses a characteristic referred to as an inconsistency budget that determines how much inconsistency the AAF can tolerate. The authors of [1] draw a parallel between the use of weights and the use of subjective beliefs as the latter being a different interpretation of the former.

S. Bistarelli et al. in [8], pointed out the drawbacks in [7] and the possibility of a ripple effect arising due to a minor conflict in arguments, which may adversely affect the strength of a defense. To address this issue, the authors use a commutative semiring structure to implement new weighted notions that effectively provide relaxation to the approach used in [7], thereby improving the quality of solutions offered by the agent, and reducing the effect of noise generated by harmful elements(trolls) in an abstract framework.

The authors of [1] also speak briefly about the concepts implemented in [2] and [4] and the difference between the scenarios that the concepts are targeted towards concerning [1]. These papers will be reviewed at length in Sections 3 and 4.

2.3 Proposed Approach

The authors improve upon a Constellations approach defined in [9] that assigns a probability distribution over argument sets. They replaced the probability distribution with Subjective Logic since SL provides a mechanism to take uncertainty into account. An AAF that uses Subjective Logic is defined by the authors to be an slAAF.

2.4 Analysis of the Proposed Approach

The paper measures the impact of subjective opinion on the parameters required for an argument to be considered an *Accepted Argument* viz. conflict-free sets, admissible sets, complete semantics, preferred semantics and stable semantics. An AAF consisting of arguments that can be considered Accepted Arguments can be induced from an slAAF if it satisfies the following criteria:

- The set of arguments in the AAF is a subset of the arguments in the slAAF,
- The attacks in the AAF are a subset of the intersection of the set of attacks in the slAAF with the Cartesian product of the set of induced arguments with itself,
- For every argument in the set of arguments in the slAAF, the belief score is 1.
- For every attack between two arguments in the slAAF, the belief score is 1.

In the induced AAF, the set of arguments consisting of enthymemes and fallacies are assigned a belief score of lower than 1 and an uncertainty score greater than 1. The sum of all expectation values of all the AAFs that can be induced from an slAAF is 1.

The authors also analyse different approaches towards fusion of subjective belief in the Constellations approach. *Averaging Fusion* is used for fusing beliefs over a set of arguments in an slAAF.

2.5 Authors' Conclusions and Future Plans

The authors explain their reasoning behind the use of subjective logic in Constellaion AAFs and how it can be used to determine trustworthiness of arguments. In the future, they intend to bring a similar approach to Epistemic AAFs, in which an agent is less likely to believe in an attacking argument, if its belief in the defending argument is higher. They also intend to use Subjective Logic to perform ranking of arguments by computing the effect of each argument upon the other.

3 Liar liar, pants on fire; or how to use subjective logic and argumentation to evaluate information from untrustworthy sources

3.1 Problem Addressed

The authors approach the conflict of arguments and information in a system where communication between agents plays a major role in the functioning of the system. The system has to decide which agent is providing more trustworthy information and the revision of belief based on trustworthiness. An example of such a system in which the authors implement their approach is that of a collaborative traffic information application.

3.2 Previous Work

The authors state that most of the related work in the domain of belief revision lack proper treatment of aggregation of credibility of various sources that contribute information, based on the trustworthiness of each source. They point out that the establishment of a predetermined ordering of belief change in the work of Falappa et. al in [10] is based on a confidence level which is not updated with a change in trustworthiness of the agent.

The authors describe the similarity and differences between their work and that of Tang et al. in [**?**] regarding belief revision, wherein the update of information is considered to be only from a single source and the lack of a mechanism to deal with similar propositions from multiple agents.

The work of Pereira et al. in [11] uses possibilistic logic in belief revision. In this approach, if there are multiple trustworthy agents that provide conflicting information to each other, the system believes in neither agent.

3.3 Proposed Approach

To overcome the drawbacks of the approaches in [10] and [**?**], the authors proposed a new type of Belief Change Operator. The agent receives information in two forms: large amount of conflicting data, and a belief change operator that includes subjective logic into an argumentation framework to make the agent provide higher importance to some part of the conflicting data over the rest. The authors use the argumentation framework suggested by Amgoud and Vesic in [12] as they believe it provided a better way of representing preference ordering using subjective logic compared to Dung's [6] AAF model.

The authors detail a set of specifications that determine how an agent's beliefs are computed based on received information. These are defined as follows:

1. Information collection

   A trust model is used to determine how trustworthy a source is and how credible the information provided by the source is. The authors claim that most belief revision operators do not focus on this step as much as they do on deciding what information to believe in.

2. Aggregation of Information

   To combine the opinion of different opinions of the same proposition, the cumulative fusion operator is used.

3. Selection of Information to believe in

   On a set of Arguments that can be generated from a set of Propositions a resulting base belief set is obtained. We provide a preference relation to this set. A tuple consisting of a set of arguments, the relationships between these arguments, and the preference ordering of these arguments acts as the Belief Change Operator.

3.4 Analysis of Proposed Approach

The authors conduct two sets of experiments to determine the effectiveness of using belief revision in a collaborative agent-based traffic model. Two paths are presented from a source to a destination on a map. The agents receive information that one path is longer than the other. However, the shorter path is considered to be dangerous according to the beliefs of other people. Therefore, more people choose to take the longer route which ends up being congested.

In the first experiment, the agent runs for 100 iterations. Various levels of trustworthiness are applied to different sources of information received about the dangerousness of the shorter path which affects the agent's choice to decide on a route. 300 agents are used in total, of which a major part are classified as private drivers, and the rest are divided into professional drivers and authority drivers. A certain percentage of each class of drivers are also considered to be liar agents. Sometimes, information is not broadcast to all of the agents in the experiment. The ability of each agent to update its belief based on the various sources of information it receives is analysed.

3.5 Results of Experimentation

The authors observed that when all the agents have perfect information about the dangerousness of the shorter path, they chose it over the longer path. When a small amount of discomforting information is provided, the randomness in choice of paths increases when using possibilistic logic. However, in the subjective logic based framework, the authors noted that belief revision occurs properly and the agents make the right choice to follow the shorter path.

When both liar agents and information broadcast were added, the belief revision operator helped agents filter out untrustworthy information over time and in the end, all the agents ended up choosing the shorter path.

3.6 Authors' Conclusions and Future Plans

The authors claim that their Belief Revision Operator performs as well as existing models, if not better. They point out that the performance of the approach taken by Pereira et al. is much poorer than theirs due to the lack of a robust framework.

The authors plan to explore the use of their Belief Revision Operator when false institutional memory is present in a social environment.

4 Probabilistic Assumption-based Argumentation with DST evidence

4.1 Problem Addressed

The author tackles the mathematical inequivalence of Dempster Shafer Theory and Probabilistic Assumption-based Argumentation(PABA) to demonstrate the need for an argumentation framework

in a scenario where DST based evidence is insufficient.

4.2 Previous Work

A variety of approaches to handle reasoning with DST based evidence and their limitations is described by the author. The work of Kohlas et al. in [13] to associate probability mass to compute belief measures is noted by the author to be limited by its ability to function only with conjunctions of literals.

The author details the work of various authors on the combination of argumentation with probability theory to propose different Probabilistic Argumentation frameworks.

4.3 Proposed Approach

To study the relationship between a PABA framework and DST based evidence, the author uses the PABA model proposed in [14]. To demonstrate the relationship, the author shows that each DST body of evidence can be represented by a PABA framework wherein grounded semantics and credulous semantics are mapped to DST belief and plausibility functions. The mass functions are constructed in the form of a PABA network. The criteria for a PABA framework to be considered a relatively grounded framework is applied to the PABA representing DST evidence and is proven. Then the author proceeds to define DST belief and plausibility degrees in PABA semantics.

4.4 Author's Conclusions

The author details the possible application of PA frameworks in many practical scenarios involving DST and claims that this paper will appeal to a large community of DST users. He also claims that DST is limited in the approach towards a unified theory of logical and probabilstic reasoning.

5 Subjective logic and arguing with evidence

5.1 Problem Addressed

The authors attempt to address situations consisting of different agents that are trying to reach a shared conclusion about a particular state of the environment they are present in. Various assumptions are made, such as:

- the information obtained through sensors could potentially be wrong,
- some subsets of the environment are observable
- agents are self interested and may have opposing goals

5.2 Previous Work

The authors point out the weaknesses in various probabilstic approaches in the construction of evidence based argumentation frameworks such as Haenni [15] as they perform inference when faced with uncertainty and conflicting arguments. They also briefly mention Dempster Shafer evidence based argumentation that was reviewed in Section 3 of this literature survey.

5.3 Proposed Approach

The authors identified the need for four layers of an argument framework to have agents engage in dialogue and obtain shared information from different sensors to construct a shared world view. These layers are implemented as below:

- Logical Layer: Built using Subjective Logic as proposed by Prof. Josang
- Dialectic Layer: Construction of arguments and represent the accrual of arguments and argument schemes
- Procedural Layer: Sensors to capture environment information
- Heuristic Layer: Provides decision making capabilities for the agents to decide on which sensors to use for probing

Across multiple layers of the framework, instances of arguments are represented in the form of tuples comprised of a set of Possible Facts about the universe associated with the environment and a set of Argument Schemes.

5.4 Analysis of Proposed Approach

An example consisting of two agents and a set of argument schemes is set up with the intent to determine the amount of building materials required. Agent α is assigned to be responsible for the stock and supply of steel, whereas β is responsible for the supply of concrete. Both agents have self-serving (opposing) agendas in the same environment - to minimize the amount of their corresponding building material used in the bridge.

A set of argument schemes consisting of the various requirements that each material must satisfy for its use is defined. On experimentation, a dialogue takes place between the two agents by each probing a different sensor of the other to see if the building conditions are satisfied in a manner most suitable to its own goal. To tackle uncertainty of any sensor, belief opinions are used. As the dialogue proceeds, each agent accrues a set of arguments that assign an opinion value to its base predicates.

5.5 Results of Experimentation

The authors observed that both agents agreed to come to a solution that satisfies their self serving goals. Through repeated probing of sensors and handling of uncertainty, arguments were accrued in favor of one agent. Fig. 1 represents the dialog that took place between the two agents and the probing of various sensors.

5.6 Authors' Conclusions and Future Plans

The authors claim that the model is general enough to be applied to almost any area in which argument is employable. However they also state that this applies only to the lower levels of the model, whereas the higher levels require evidence based reasoning. In the future, they aim to enrich the sensor model in order to provide better opinions on information as well as to achieve a mapping between dialogue based argument framework and Dung's argumentation Framework [6].

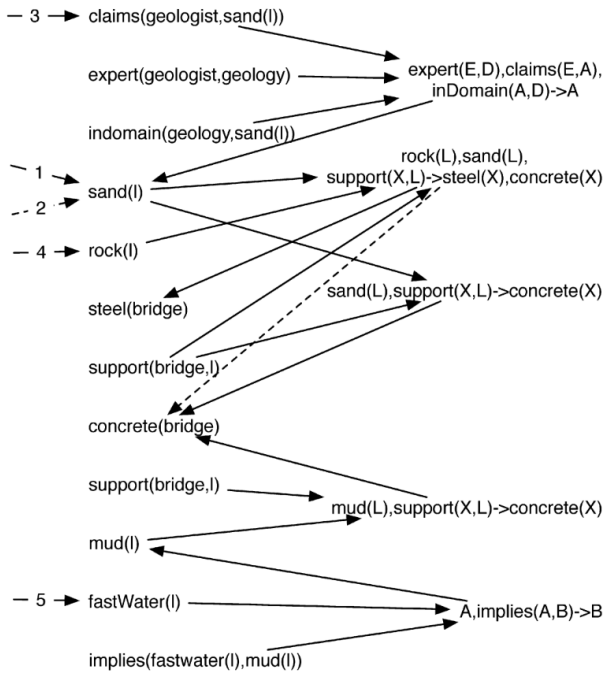

Figure 1: Dialog Argument Graph between the two agents. Image taken from [4].

6 Analysing climate change arguments using subjective logic

6.1 Problem Addressed

The authors attempt to analyse various arguments on the issue of climate change, obtained from online debate websites. However, when dealing with a large amount of collective opinion, an aggregation of arguments is required to obtain a top-level view of people's beliefs.

6.2 Previous Work

To analyse trust networks, the authors cite the approach taken by A. Josang et al. in [16] using subjective logic. In this approach, the trust in the overall system is measured based on trust between each agent.

The authors also cite the work of N. Oren et al. in [4] and draw similarities to their approach which includes belief and ignorance. However, they state that the approach taken in [4] focuses on the constant updation of accrued beliefs and arguments, whereas their approach deals with aggregation of arguments.

6.3 Proposed Approach

The authors constructed a corpus of arguments from three debate sites to evaluate the binomial opinion on user posted topics/hypotheses. A *collective opinion* parameter is defined by the authors as a binomial opinion on a given hypothesis h, represented as a quadruple consisting of the belief

value, disbelief value, the ignorance degree, and the prior information available on that topic. The collective opinion on each hypothesis is measured across different communities of users, with care taken to avoid accidental duplicate arguments posted by users. Furthermore, a consensus operator is defined by the authors to help aggregate opinions across communities.

The potential of clustering the hypotheses is identified and its use in determining ignorance levels is measured. To cluster hypotheses, an Affinity Propagation algorithm [17] is implemented by the authors.

6.4 Results of Experimentation

The authors observed that upon aggregation of opinion on higher number of arguments, a consensual opinion had lower ignorance levels, therefore resulting in higher confidence levels on a given set of hypotheses. This operator also helps determine if an entire community is in support of a certain hypothesis by ranking the computed distance of opinions between two communities.

Upon analysis of the clustered hypotheses, the authors note that out of 193 clusters, only one cluster had a balanced score in favour of a higher disbelief degree for the hypothesis *Developed countries should have a moral obligation to mitigate the effects of climate change*, as well as the lowest ignorance score.

6.5 Authors' Conclusions

The authors conclude that a low level of ignorance is the result of a large number of arguments being posted about this topic, which means there is a high level of interest for that topic. The ignorance level helped measure the expectancy of any given argument to be considered an *accepted argument.*

7 Conclusion of Survey

In this literature survey, we have looked at various approaches towards the implementation of subjective logic and belief theory in argumentation. We compared the use of Abstract Argument Based Frameworks with that of a Structured Framework, and we looked at an implementation of such an AAF on a real-time debate forum. A majority of the papers that were surveyed are from the past 2 years. Therefore their impact in related research hasn't been very profound at this moment in time.

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