A Preliminary Study of Argumentation Frameworks and Argumentation Schemes that appeal to Expert Opinion

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Abstract. The research in argumentation has produce systems with a human-like mechanism for commonsense reasoning. One form of representing arguments is called Argumentation Schemes, in which are argument forms that represent inferential structures of arguments used in everyday discourse, and in special contexts like legal argumentation, scientific argumentation, and especially in *AI*. One type of argumentation scheme corresponds to *appeal to Expert Opinion or Position-to-Know argumentation*. *Position-to-know* reasoning is typically used in an information seeking type of dialogue where one has to depend on a source.
Most of such argumentation frameworks are based on Dung's seminal work characterizing *Abstract Argumentation Frameworks*. In this work we introduce a novel framework, called *Expert Argumentation Framework (EAF)*, extending AF with the capability of modeling the quality of expert associated with the arguments that proposed.

1 Introduction

Argumentation research has contributed with a human-like mechanism to the formalization of commonsense reasoning. In a general sense, argumentation can be associated with the interactive process where arguments for and against conclusions are offered, with the purpose of determining which conclusions are acceptable. Several argument-based formalisms have emerged, with application in many areas such as legal reasoning, recommender systems and multi-agent systems [2, 3, 7].

Argumentation Schemes [8, 9] offers the possibility of representing arguments in a semi-formal way; in this argument forms inferential structures of arguments used in everyday discourse are represented and in special contexts such as legal argumentation, scientific argumentation, and *AI* systems in general. This simple device allows to represent arguments in a form that is closer to natural language usually used to represent them in free text. A particular type of argumentation scheme corresponds to *appeal to Expert Opinion* or *Position-to-Know argumentation*. In the latter, reasoning is typically used in an information seeking type of dialogue where it is necessary to depend on a source.

Most argumentation frameworks are based on Dung's seminal work characterizing *Abstract Argumentation Frameworks (AF)* [4]. We present a proposal to formalize an argument schemes proposed by Walton [8–10]; to formalize the argument scheme we start from the framework proposed by Dung as an abstraction of a defeasible argumentation system. In argumentation framework (AF), an argument is considered as an abstract entity with unspecified internal structure, and its role in the framework is completely determined by the relation of attack it maintains with other arguments.

In our work, we proposed an extension called *Expert Argumentation Framework (EAF)*, to allow the representation of an expert, the properties associated with it, and the association of a particular expert with an argument. For that, we extend the AF framework to a 4-tupla $\Theta = \langle AR, EXP, ATTACK, ASSERT \rangle$, where EXP represent a set of experts or proponents and $ASSERT$ represent a function that relates the experts with the arguments. By defining the set of experts or proponents (EXP) we consider the six basic critical questions matching the appeal to expert opinion offered by Walton, that support this argument scheme.

The central contribution of this paper is the increase in the ability to represent and model the quality of an expert associated with the arguments that proposed; to that effect we will extend Dungs framework appropriately. Next, we will introduce Dung's abstract argumentation in Section 2, then we will briefly present argument schemes in Section 3. In Section 3 we will introduce our proposal, ending the paper in Section 5 with some conclusions and an outline of some possible future work.

2 Abstract Argumentation

Dung [4] introduced the notion of *Argumentation Framework (AF)* as a convenient abstraction of a defeasible argumentation system. In an AF, an argument is considered as an abstract entity with unspecified internal structure, and its role in the framework is completely determined by the relation of attack it maintains with other arguments; thus, the only elements in the AF are a set the arguments and the attack relation defined among them. The following definition captures this abstract entity.

Definition 1 (Argumentation Framework [4]) *An argumentation framework (AF) is a pair $\langle AR, Attacks \rangle$, where AR is a set of arguments, and $Attacks$ is a binary relation on AR, i.e., $Attacks \subseteq AR \times AR$.*

Given an AF, an argument A is considered *acceptable* if it can be defended, using arguments in AR, from all the arguments in AR that attack it (also called *attackers*). This intuition is formalized in the following definitions, originally presented in [4].

Definition 2 (Acceptability) *Let $AF = \langle AR, Attacks \rangle$ be an argumentation framework.*

- *A set $S \subseteq AR$ is called* conflict-free *if there are no arguments $A, B \in S$ such that $(A, B) \in Attacks$.*
- *An argument $A \in AR$ is* acceptable *with respect to a set $S \subseteq AR$ iff for each $B \in AR$, if B attacks A then there is $C \in S$ such that $(C, B) \in Attacks$; in such case it is said that B is attacked by S.*
- *A conflict-free set S is* admissible *iff each argument in S is acceptable with respect to S.*
- *An admissible set $E \subseteq AR$ is a* complete extension *of AF iff E contains each argument that is acceptable with respect to E.*
- *A set $E \subseteq AR$ is the* grounded extension *of AF iff E is a complete extension that is minimal with respect to set inclusion.*

Dung [4] also presented a fixed-point characterization of the grounded semantics based on the characteristic function F defined below.

Definition 3 *Let $\langle AR, Attacks \rangle$ be an AF. The associated characteristic function $F : 2^{AR} \rightarrow 2^{AR}$, is $F(S) =_{def} \{A \in AR \mid A \text{ is acceptable w.r.t. } S\}$.*

The following proposition suggests how to compute the grounded extension associated with a *finitary* AF (*i.e.*, such that each argument is attacked by at most a finite number of arguments) by iteratively applying the characteristic function starting from $\emptyset$. See [1, 6] for details on semantics of AFs.

Proposition 1 ([4]) *Let $\langle AR, Attacks \rangle$ be a finitary AF. Let $i \in \mathbb{N} \cup \{0\}$ such that $F^i(\emptyset) = F^{i+1}(\emptyset)$. Then $F^i(\emptyset)$ is the least fixed point of F, and corresponds to the grounded extension associated with the AF.*

Example 1 *Consider the AF $\langle AR, Attacks \rangle$ (graphically represented in Fig. 3), where $AR = \{A, B, C, D, E, F, G\}$ and $Attacks = \{(B, A), (C, B), (E, A), (G, E), (F, G), (G, D)\}$. The set $S = \{C, D, E, F\}$ is admissible, since it defends all the arguments it contains. S is also complete since it contains all the arguments in AR defended by S. Finally, it can be verified that S is the minimal set satisfying the previous conditions, and therefore it corresponds to the grounded extension of AR. Next we show how to obtain the grounded extension by applying the fixed point characterization from Prop. 1.* $F^0(\emptyset) = \emptyset$

$F^1(\emptyset) = F(\emptyset) = \{C, F\}$

$F^2(\emptyset) = F(\{C, F\}) = \{C, F, D, E\}$

$F^3(\emptyset) = F(\{C, F, D, E\}) = F^2(\emptyset)$

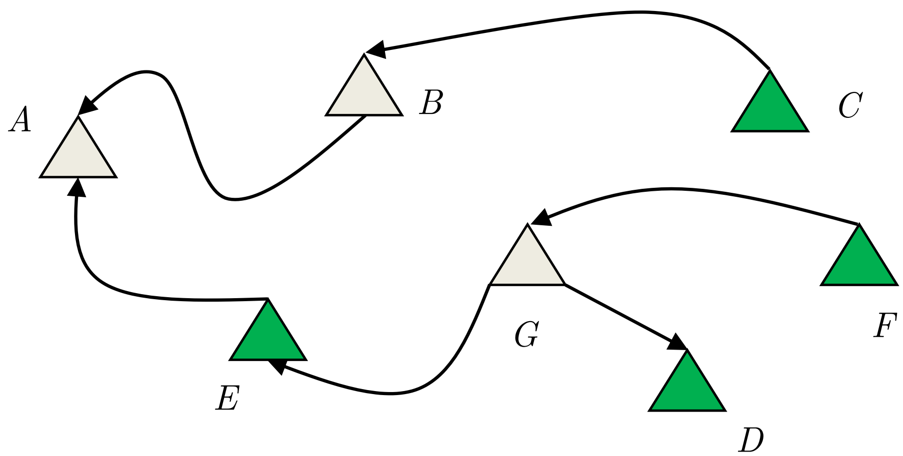

Fig. 1. Argumentation Framework

3 Argumentation Schemes

Argumentation schemes [8, 9] are argument forms that represent inferential structures of arguments used in everyday discourse, and in special contexts like legal argumentation, scientific argumentation, and especially in AI. Deductive forms of inference like modus ponens and disjunctive syllogism are very familiar. But some of the most common and interesting argumentation schemes are neither deductive nor inductive, but defeasible and presumptive.

When the arguments are not deductive or inductive, are said defeasible arguments. These arguments are inherently presumptive, and thus they are different in nature from deductive and inductive arguments. Each of the forms of this argument is used as a presumptive argument in a dialogue that carries a weight of plausibility. In the case that, the respondent accepts the premises then that gives him a good reason also to accept the conclusion. But it does not mean that the respondent should accept the conclusion uncritically, each form of argument is a set of appropriate critical questions to ask.

In a given case, there may be a balance of considerations to take into account, there may be some arguments in favor of the conclusion and some against it. These forms of inference are called argumentation schemes, and they represent many common types of argumentation that are familiar in everyday conversations.

One type of argumentation scheme corresponds to *appeal to Expert Opinion or Position-to-Know argumentation. Position-to-know* reasoning is typically used in an information seeking type of dialogue where one has to depend on a source. Where a is a source of information, the following argumentation scheme represents the form of *position-to-know argumentation*(see Figure 2):

– Is a in a position to know whether A is true (false)?
– Is a an honest (trustworthy, reliable) source?
– Did a assert that A is true (false)?

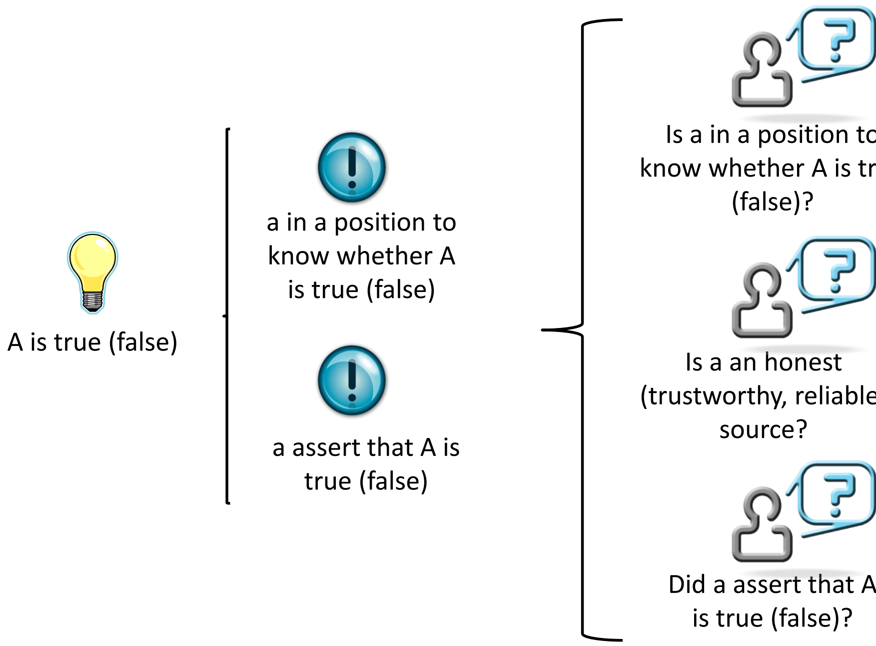

Fig. 2. Argumentation Scheme - Position-to-Know Argumentation

The form of argument can be plausible, but it is also defeasible. It can be critically questioned in a dialogue by raising doubts about the truth of either premise or by asking whether a is an honest (trustworthy) source of information. The second critical question concerns the credibility of the source.

The appeal to expert opinion, sometimes also called *argument from expert opinion*, is an important subspecies of position-to-know reasoning. It is based on the assumption that the source is alleged to be in a position to know about a subject because he or she has expert knowledge of that subject.

Appeal to expert opinion should, in most typical cases, be seen as a plausible but defeasible form of argumentation. The six critical basic questions matching the appeal to expert opinion are listed below [8]:

1. **Expertise Question:** How credible is E as an expert source?.
2. **Field Question:** Is E an expert in the field that A is in?.

3. **Opinion Question:** What did E assert that implies A?.
4. **Trustworthiness Question:** Is E personally reliable as a source?.
5. **Consistency Question:** Is A consistent with what other experts assert?.
6. **Backup Evidence Question:** Is E assertion based on evidence?.

The idea behind using critical questions to evaluate appeals to expert opinion is dialectical. The assumption is that the issue to be settled by argumentation in a dialogue hangs on a balance of considerations. One can critically question an appeal to expert opinion by raising doubts about any of the premises.

4 Argumentation Framework of a Argumentation Schemes that appeals to Expert Opinion

In recent years the field of application of the argument has been expanded. In addition, there have been numerous studies to demonstrate the value of argumentation schemes. However, no investigations have been developed enough to formalize the structures of these schemes . In this section, we will make a first approximation of this formalization through an extension of AF called *Expert Argumentation Framework (EAF)*, that takes in consideration the quality of expert that proposed the arguments.

We define EAF as a 4-tuple $\Theta = \langle AR, EXP, ATTACK, ASSERT \rangle$ where:

- AR is a set of arguments,
- $ATTACK$ is a binary relation of attack between arguments belonging to the set $AR, ATTACK \subseteq AR \times AR$
- EXP is the set of experts or proponents who put forward an argument,
- $ASSERT$ is a function defined as $ASSERT : EXP \rightarrow AR$, that determines which expert claims or wields what argument.

We define the component EXP of the tuple presented, based on the scheme proposed by Walton [8–10].

Definition 4 *Let EXP a set of expert. We defined a expert $X_i \in EXP$ as a 4-tuple $X_i = (Q, C, B, S)$ where:*

- Q *denotes that the argument comes from a qualified expert in the subject.*
- C *denotes that the argument comes from a trusted expert.*
- B *the argument of the expert is better than any argument from any expert.*
- S *the argument is safe, able to overcome an argument from another expert.*

We say that, each argument of AR is associated with the properties Q, C, B, S. Note that, the presence of a properties is represented by 1 and the absence of a properties is denoted by 0. For example, the arguments $A \in AR$ can be associated with an expert X_1 where $X_1 = (1, 1, 0, 0)$, *i.e.*, the expert X_1 has the properties Q and C.

Now we expand the definitions of Dung [4], broadening conflict-free set and acceptable element definitions.

Definition 5 (Exp-Conflict-Free) *A set $S \subseteq AR$ is called* exp-conflict-free *if there are no arguments $A, B \in S$ such that $(A, B) \in Attacks$, and whether such arguments are put forward by the same or different expert, formally must hold the following points:*

$$\nexists\ A, B \in S \ \textit{and}\ (X_i, A) \in ASSERT \ \textit{and} \\ (X_j, B) \in ASSERT \mid (A, B) \in ATTACK,\ \textit{with}\ i = j\ \textit{or}\ i \neq j.$$

Definition 6 (Exp-Acceptable) *An argument $A \in AR$ is* acceptable *with respect to a set $S \subseteq AR$ iff for each $B \in AR$, if B attacks A then the experts who put forward it are different, formally:*

$$\textit{If}\ A \in S \wedge B \in AR,\ (X_1, A) \in ASSERT,\ (X_2, B) \in ASSERT\ \textit{and} \\ (A, B) \in ATTACK, \textit{then}\ X_1 \neq X_2.$$

Once expanded the definitions of conflict-free set and acceptability of an item, we can define the acceptability of a set of arguments.

Definition 7 (Exp-Acceptability) *Let $\Theta = \langle AR, EXP, ATTACK, ASSERT\rangle$ be an expert argumentation framework. The acceptability of a set S of arguments such that $S \subseteq AR$, is given by the following conditions:*

- *A set $S \subseteq AR$ is a* Exp-Conflict-Free.
- *An argument $A \in AR$ is a* Exp-Acceptable *with respect to a set $S \subseteq AR$.*
- *An Exp-Conflict-Free set S is* admissible *iff each argument in S is acceptable with respect to S.*
- *An admissible set $E \subseteq AR$ is a* complete extension *of EAF iff E contains each argument that is acceptable with respect to E.*
- *A set $E \subseteq AR$ is the* grounded extension *of EAF iff E is a complete extension that is minimal with respect to set inclusion.*

Example 2 *Consider the EAF $\langle AR, EXP, ATTACK, ASSERT\rangle$, where:*
$AR = \{A, B, C, D, E, F, G\}$
$EXP = \{X_1 = (1, 1, 1, 1); X_2 = (1, 1, 0, 0); X_3 = (1, 1, 0, 1)\}$
$ATTACKS = \{(B, A), (C, B), (E, A), (G, E), (F, G), (G, D)\}$.
$ASSERT = \{(X_1, C); (X_1, F); (X_2, A); (X_3, B); (X_3, D); (X_3, E); (X_3, G)\}$.

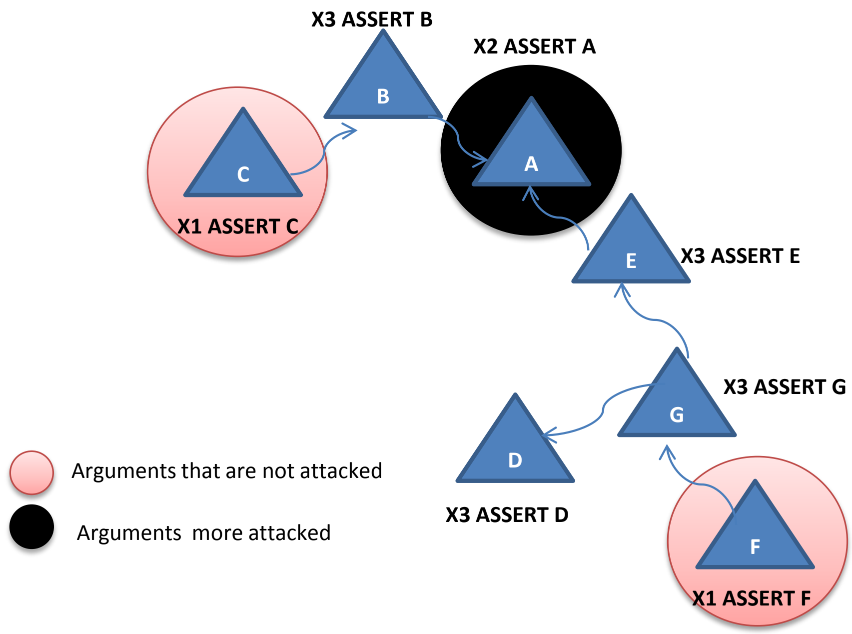

Fig. 3. Expert Argumentation Framework

In this example, we define a $Exp - Conflict - Free$ *set* $S = \{C, F\}$. *These arguments are put forwards for the same expert and do not attack each other. However, the set* $S' = \{B, D, E, G\}$ *is not considered* $Exp - Conflict - Free$ *because the argument* G *attacks the argument* E*, although they are advanced by the same expert. In this example, we can find another* $Exp - Conflict - Free$ *set* $S'' = \{A\}$.

With regard to $Exp - Acceptable$*, we can say that* $A \in AR$ *is* acceptable *with respect to* $S'' \subseteq AR$ *because the arguments* B *and* E *attack* A*, and* A *is put forwards by* X_2 *while* B *and* E *are advanced by* X_3. *But if we consider the argument* $E \in AR$ *is not acceptable with respect to* $S' \subseteq AR$ *because* G *attacks* E*, and both are put forward for the same expert. As for the arguments* C *and* F*, not be attacked by other arguments, we believe that these are acceptable arguments.*

Now, consider the conflict-free sets $S \subseteq AR$ *and* $S'' \subseteq AR$. *In these sets the arguments do not attack each other, so we can say that both* S *and* S'' *are* admissible. *We can not analyze the admissibility of the set* S' *because it is not a conflict-free set.*

The admissible set S is complete extensions *of EAF,because S contains each argument that is acceptable with respect to S. The same applies to the set S''. We can not say the same of the set S' as this set is not admissible.*

5 Conclusions and Future Work

Argumentation has contributed to the study and formalization of commonsense reasoning with a human-like mechanism. In a general sense, argumentation can be associated with the interaction of arguments for and against conclusions, with the purpose of determining which conclusions are acceptable. One form of advancing in the representation of arguments is called Argumentation Schemes.

In this paper we presented a novel formalism for *appeal to Expert Opinion or Position-to-Know argumentation scheme* proposed by Walton [8, 9], formalism is understood as an extension of AF Dung [4]. The main extension is to consider as part of this formalism the characteristics required of an expert and the relationship between an expert and the arguments put forward by him. For this we have proposed EAF as a 4-tuple $\Theta = \langle AR, EXP, ATTACK, ASSERT \rangle$. This tuple contains a set of arguments, a set of experts or proponents to put forward arguments, attack relations between arguments, and a function that determines who put forward the argument.

The expert is described by the use of other 4-tuple that contains the properties which characterize the expert according to Walton[8] and can take the value 0 or 1: $X_i = (Q, C, B, S)$. We apply EAF extension to a simple example that contains three major subsets of arguments. These subsets are defined according to the expert who wields the arguments. The set S corresponds to the Expert X_1, S' corresponds to the expert X_2 and S'' corresponds to the expert X_3. We note that in one of the sets there are arguments that attack, which is useful to differentiate the application of the extended definitions.

As lines of future research, first it is necessary to refine the definition of the 4-tuple containing the properties of the expert, so it does not considers just a binary value giving the possibility that these properties can be weighted. Secondly, we need to analyze and study the extensions to the classical semantics proposed by Dung within the proposed framework. Also, it seems necessary to formalize other argumentation schemes also proposed by Walton [8], since little research has been done over the formalization of their structures; that will open the possibility of further implementation with Defeasible Logic Programming.

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