Revisiting Support in Abstract Argumentation Systems

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Abstract. Dung's original argumentation frameworks have been extended in various ways. One such extension introduces positive interactions, or support, between arguments. Frameworks containing evidential, necessary, and deductive supports have been proposed, and it is natural to compare these and analyse whether translations between these are possible. Although a positive answer was given in the necessary and deductive cases, it was claimed that evidential support cannot be expressed by any other type and that it cannot be handled together with them in a single framework. In this paper we show that it is not the case and that there exists a natural translation between argumentation frameworks with necessities and evidential argumentation systems.

Keywords. abstract argumentation, evidential support, necessary support

1. Introduction

Dung's abstract argumentation frameworks (abbreviated AF) [5] focuses on the attack relation between arguments, and the manner in which arguments defend each other. Many extensions to basic AFs have been proposed, utilising concepts such as preferences, as well positive interactions between arguments (referred to as *support*). An initial version of support, introduced in [3] had several drawbacks, leading to the development of several other more specialised frameworks with support, with the most recognised being deductive [2], necessary [6], and evidential [9] supports. [4] showed that a translation exists between deductive and necessary support, but claimed that evidential support cannot be represented using the other two approaches. In this paper we show that there *is* a translation between evidential argumentation systems and argumentation frameworks with necessities. We begin by recalling Dung's AFs, with Sections 3 and 4 describing evidential argument frameworks and abstract frameworks with necessities. Section 5 compares these systems, and describes a translation between them. Section 6 concludes.

2. Dung's Frameworks

We will briefly recall Dung's abstract argumentation framework [5] and its semantics [1].

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Definition 2.1. *A* ***Dung's abstract argumentation framework*** *(AF for short) is a pair (A,R), where A is a set of* ***arguments*** *and $R \subseteq A \times A$ represents an* ***attack*** *relation.*

Definition 2.2. *Let $AF = (A,R)$ be a Dung's framework. We say that an argument $a \in A$ is* ***defended*** *by a set $S \subseteq A$ in AF iff for each $b \in A$ s.t. $(b,a) \in R$, there exists $c \in S$ s.t. $(c,b) \in R$. A set $S \subseteq A$ is:*

- ***conflict–free*** *in AF iff for each $a,b \in S$, $(a,b) \notin R$.*
- ***naive*** *in AF iff it is maximal w.r.t. set inclusion conflict–free.*
- ***admissible*** *in AF iff it is conflict–free and defends all of its members.*
- ***preferred*** *in AF iff it is maximal w.r.t. set inclusion admissible.*
- ***complete*** *in AF iff it is admissible and all arguments defended by S are in S.*
- ***stable*** *in AF iff it is conflict–free and for each $a \in A \setminus S$ there exists an argument $b \in S$ s.t. $(b,a) \in R$.*

Definition 2.3. *The* ***characteristic function*** *$F_{AF} : 2^A \to 2^A$ is defined as: $F_{AF}(S) = \{a \mid a$ is defended by S in $AF\}$. The* ***grounded extension*** *is the least fixed point of F_{AF}.*

Lemma 2.4. ***Dung's Fundamental Lemma*** *Let S be an admissible extension, a and b two arguments defended by S. Then $S' = S \cup \{a\}$ is admissible and b is defended by S'.*

Theorem 2.5. *The following holds:*

1. *Every stable extension is a preferred extension, but not vice versa.*
2. *Every preferred extension is a complete extension, but not vice versa.*
3. *The grounded extension is the least w.r.t. set inclusion complete extension.*

3. Evidential Argumentation Systems

Unattacked arguments serve as the strongest source of defence within AFs. However, in many cases, the lack of an attack is insufficient to consider an argument acceptable. In areas such as legal reasoning, one is required to support a claim with facts or evidence so as to be convincing. For example, it does suffice to claim that a given person committed a crime in order to sentence them. Instead, evidence is required to prove guilt.

We can therefore distinguish between two types of arguments. The special arguments, often referred to as *prima facie* or evidence, act as an indisputable source of truth, while standard arguments must be supported by them in order to be considered acceptable. To handle such reasoning, the evidential argumentation systems (EASs) were created. Furthermore, since standard arguments must be supported, evidential frameworks address a critical drawback of abstract support in BAFs [3], namely that an argument could otherwise be present in an extension regardless of whether it is supported (see [8] for details). In this section, we introduce the evidential framework and its properties. In doing so, we provide corrections to the EAS formulation presented in [9, 10].

Definition 3.1. *An* ***evidential argumentation system*** *(EAS) is a tuple (A,R,E) where A is a set of* ***arguments***, *$R \subseteq (2^A \setminus \emptyset) \times A$ is the* ***attack*** *relation, and $E \subseteq (2^A \setminus \emptyset) \times A$ is the* ***support*** *relation. We distinguish a special argument $\eta \in A$ s.t. $\nexists (X,y) \in R$ where $\eta \in X$; and $\nexists X$ where $(X,\eta) \in R$ or $(X,\eta) \in E$.*

The special argument η represents *prima facie* arguments and is referred to as evidence or environment. This definition differs from [10] by removing the rction that there should be no argument x and set X s.t. XRx and XEx.

The core idea of evidential argument systems is that valid arguments (and attackers) need to trace back to the environment. It is captured with the notions of e–support and e–supported attack. The following are the corrected versions of those in [9, 10].

Definition 3.2. *An argument $a \in A$ has **evidential support** (e–support) from a set $S \subseteq A$ iff $a = \eta$ or there is a non-empty $S' \subseteq S$ such that $S'Ea$ and $\forall x \in S'$, x has evidential support from $S \setminus \{a\}$. An argument a has **minimal e–support** from a set S if there is no set $S' \subset S$ such that a has e–support from S'.*

Remark. Note that by this definition η has evidential support from any set.

Example 3.3. In its original version [9], the definition of being e–supported by a set S required that either SEa where $S = \{\eta\}$ or that $\exists T \subset S$ s.t. TEa and $\forall x \in T$, x is e–supported by $S \setminus \{x\}$. This led to counter-intuitive results with frameworks such as $(\{\eta, a, b, c\}, \emptyset, \{(\{a, b\}, c), (\{\eta\}, a), (\{\eta\}, b)\})$.

Definition 3.4. *A set $S \subseteq A$ carries out an **evidence supported attack** (e–supported attack) on a iff $(S', a) \in R$ where $S' \subseteq S$, and for all $s \in S'$, s has e–support from S. An e–supported attack by S on a is **minimal** iff there is no $S' \subset S$ that carries out an e–supported attack on a.*

Given these notions, we can define semantics for EASs built around the concept of acceptability in a manner similar to those of Dung's. However, in the latter, only attacks were considered. For EASs, arguments must also have sufficient support to be acceptable.

Definition 3.5. *An argument a is **acceptable** with respect to a set of arguments $S \subseteq A$ iff*

- *a is e–supported by S; and*
- *given a minimal e–supported attack by a set $T \subseteq A$ against a, it is the case that S carries out an e–supported attack against a member of T.*

Remark. The definition above is simpler than the one proposed in [9], but provides us with the same result.

Definition 3.6. *A set of arguments $S \subseteq A$ is:*

- ***self–supporting** iff all arguments in S are e–supported by S.*
- ***conflict–free** iff there is no $a \in S$ and $S' \subseteq S$ such that $S'Ra$.*
- ***admissible** iff it is conflict–free and all elements of S are acceptable w.r.t. S.*
- ***preferred** iff it is maximal w.r.t. set inclusion admissible.*
- ***complete** iff it is admissible and all arguments acceptable w.r.t S are in S.*
- ***stable** iff it is conflict–free, self–supporting, and for any argument a e–supported by A where $a \notin S$, S e–support attacks either a or every set of arguments minimally e–supporting a.*

As in AFs, the grounded semantics is defined via an identical characteristic function. We avoid formalising it due to space constraints, but refer the reader to Definition 2.3. Next, we describe the properties of EASs [8, 9]. Proofs can be found in [12].

Lemma 3.7. *If a set of arguments $S \subseteq A$ is a minimal e–support for some argument $a \in A$, then it is self–supporting.*

Lemma 3.8. *If $S \subseteq A$ is admissible, then it is self–supporting.*

Lemma 3.9. ***EAS Fundamental Lemma*** *Let S be an admissible set and x, y two arguments acceptable w.r.t. S. Then $S \cup \{x\}$ is admissible and y is acceptable w.r.t. $S \cup \{x\}$.*

Lemma 3.10. *Set S is an e–stable extension iff $S = \{a \mid a$ is e–supported and not attacked by $S\}$*

Lemma 3.11. *If a set of arguments $S \subseteq A$ carries out a minimal e–supported attacked on some argument $a \in A$, then it is self–supporting.*

Theorem 3.12. *The following holds:*
1. *Every stable extension is a preferred extension, but not vice versa.*
2. *Every preferred extension is a complete extension, but not vice versa.*
3. *The grounded extension is the least complete extension w.r.t. set inclusion.*

Example 3.13. Consider the EAS $(\{\eta, a, b, c, d, e, f\}, \{(\{b\}, a), (\{b\}, c), (\{c\}, b), (\{c\}, d), (\{d\}, f), (\{f\}, f)\}, \{(\{\eta\}, b), (\{\eta\}, c), (\{\eta\}, d), (\{\eta\}, f), (\{d\}, e)\})$ The admissible extensions are $\emptyset, \{\eta\}, \{\eta, b\}, \{\eta, c\}, \{\eta, b, d\}$ and $\{\eta, b, d, e\}$, with $\{\eta\}, \{\eta, c\}$ and $\{\eta, b, d, e\}$ being the complete ones. Obviously, the latter two are preferred. However, only $\{\eta, b, d, e\}$ is stable. Since a is not a valid argument (it is not e–supported in the framework), we do not have to attack it. Although $\{\eta, c\}$ attacks b and d (and by this, also e), it is not in conflict with f. The grounded extension is just $\{\eta\}$.

We propose an alternative definition of e–support, more in line with the style found in [6,11], and the argument chains of [10]. We also introduce a *minimal form* of an EAS.

Definition 3.14. *Given a set of arguments $X \subseteq A$, an* ***evidential sequence*** *for an argument $a \in X$ is a sequence of distinct elements of X $(a_0, .., a_n)$ s.t. $a_n = a$, $a_0 = \eta$, and if $n > 0$, then $\forall_{i=1}^{n}$ there exists a nonempty $T \subseteq \{a_0, ..., a_{i-1}\}$ s.t. TEa_i.*

Theorem 3.15. *Let $X \subseteq A$ be a set of arguments and $a \in A$. a is e–supported by X iff there exists an evidential sequence for a on $X \cup \{a\}$.*

Theorem 3.16. *Let $ES = (A, R, E)$ be an EAS. The* ***minimal form*** *of ES is a framework $ES^{min} = (A, R', E')$, where $R' \subseteq R$ (respectively $E' \subseteq E$) consists of those elements (T, a) in R (E) s.t. $\nexists T' \subseteq T, (T', a) \in R$ (E). Then a set S is a σ–extension in ES where $\sigma \in \{$admissible, preferred, complete, grounded,stable $\}$ iff it is a σ–extension in ES^{min}.*

4. Abstract Frameworks with Necessities

[7] introduced *necessary support*, following the intuition that if an argument a necessarily supports b, then acceptance of a is required for the acceptance of b. Although initially defined in a binary manner, [6] removed this restriction.

Definition 4.1. *An* ***abstract argumentation framework with necessities*** *(AFN) is a tuple (A, R, N) where A is a set of* ***arguments****, $R \subseteq A \times A$ represents the* ***attack*** *relation and $N \subseteq (2^A \setminus \emptyset) \times A$ represents the* ***necessity*** *relation.*

We say that a attacks b iff aRb. Abusing notation, we will write SRC to denote that there exists an argument $a \in S$ and $b \in C$ such that aRb.

While the support relation of EASs and AFNs are structurally identical, they capture different intuitions. In EASs, we say that a set of arguments $S \subseteq A$ supports an argument

$a \in A$ if $\exists X \subseteq S$ s.t. XEa. In AFNs, we are presented with a dual situation. S supports a if $\forall X \subseteq S$ s.t. $XNa, X \cap S \neq \emptyset$. This will be especially visible when we present the definition of a powerful sequence (Defn 4.2) and a translation between the two frameworks.

While EAS semantics imply acyclicity of the support relation among the accepted arguments through the requirement for evidence η, AFNs make this requirement explicit. One of the possible formulations for doing so is by the means of the powerful sequence:

Definition 4.2. *An argument a is **powerful** in $S \subseteq A$ iff $a \in S$ and there is a sequence $a_0,...,a_k$ of elements of S such that:*

- $a_k = a$
- *there is no $E \subseteq A$ s.t. ENa_0*
- *for $1 \leq i \leq k$: for each $E \subseteq A$, if ENa_i then $E \cap \{a_0,...,a_{i-1}\} \neq \emptyset$.*

*A set of arguments $S \subseteq A$ is **coherent** iff each $a \in S$ is powerful in S. A set of arguments is **strongly coherent** iff it is coherent and conflict–free w.r.t. R.*

Remark. There is a subtle difference between the sequences in AFNs (Defn. 4.2) and EASs (Defn. 3.14). The former states that if a supporter set exists, then it has an element in the sequence. The evidential sequence requires that a supporter exists and is contained in the sequence. This results from the fact that every valid argument (apart from η) needs to be supported by some set in the first place to even have a chance of tracing back to evidence. Thus, unsupported arguments are "filtered out" immediately.

Just like in EASs, the definition of defense (acceptability) in AFNs extends Dung's definition by introducing support requirements. Semantics are then defined as usual.

Definition 4.3. *Let $S \subseteq A$ and $a \in A$. We say that S **defends** a iff $S \cup \{a\}$ is coherent and for each $b \in A$, if bRa then for each coherent $C \subseteq A$ that contains b, SRC. We say S is:*

- ***admissible** iff it is strongly coherent and defends all of its arguments.*
- ***preferred** iff it is maximal w.r.t. set inclusion admissible.*
- ***complete** iff it is admissible and all arguments defended by S are in S.*

The grounded semantics is again defined via the characteristic function (2.3). We can now define the stable semantics, and show some properties of AFNs. Just like in EASs, we will also introduce the concept of a *minimal form* of an AFN.

Definition 4.4. *The set of arguments **deactivated** by S is defined by $S^+ = \{a \mid SRa \text{ or there exists } E \subseteq A \text{ s.t. } ENa \text{ and } S \cap E = \emptyset\}$. Then a complete extension S is **stable** iff $S^+ = A \setminus S$.*

Theorem 4.5. *The following properties holds:*

1. *Every stable extension is a preferred extension, but not vice versa.*
2. *Every preferred extension is a complete extension, but not vice versa.*
3. *The grounded extension is the least w.r.t. set inclusion complete extension.*

Example 4.6. Consider the AFN $(\{a,b,c,d,e\}, \{(b,a),(e,a),(c,d)\}, \{(\{b\},b),(\{b,d\},e), (\{a\},c)\})$. The admissible (also complete) extensions of this framework would be $\{d,e\}$, $\{a,c\}$ and $\emptyset$. The first two are the preferred and stable ones. $\emptyset$ is the grounded extension.

Theorem 4.7. *Let $FN = (A,R,N)$ be an AFN. The **minimal form** of FN is a framework $FN^{min} = (A,R,N')$, where $N' \subseteq N$ consists of those elements (T,a) in N s.t. $\nexists T' \subseteq T, (T',a) \in N$. Then a set S is a σ–extension in FN where $\sigma \in \{$admissible, preferred, complete, grounded, stable$\}$ iff it is a σ–extension in FN^{min}.*

5. Translations between evidential and necessary support

We now investigate translation procedures between necessary and evidential frameworks. It is obvious that moving from the binary (AFN) to set-form (EAS) of attack is trivial. Support however requires more consideration. First of all, recall the differences between support in AFNs and EASs, i.e. the N vs E relation. Let $A_1, ..., A_n$ be sets supporting an argument a in N. We say that a set of arguments S supports a iff for every such A_i, $S \cap A_i \neq \emptyset$. Verifying whether S supports a corresponds to checking whether S satisfies a propositional formula $\bigvee A_1 \wedge ... \wedge \bigvee A_n$, where $\bigvee A_i$ should be understood as a disjunction of elements of A_i. Should $A_1, ..., A_n$ be supporting a by E, we would produce a formula $\bigwedge A_1 \vee ... \vee \bigwedge A_n$, where $\bigwedge A_i$ stands for the conjunction of elements of A_i. Therefore, a translation between these relations can be seen as a conversion between CNF and DNF. More difficult is dealing with evidence. In EASs, evidence is the sole confirmation of validity and arguments need to be able to trace back to it (c.f., the evidential sequence). In AFNs, validity is obtained through acyclicity. We must be able to trace back from a valid argument to arguments that require no support (c.f., the powerful sequence). Therefore, for unsupported arguments to provide validity in the EAS setting, they (and only they) should be backed up by η. This observation allows us to define a translation as follows.

Translation 1. Let $FN = (A, R, N)$ be an AFN. The corresponding EAS $ES^{FN} = (A', R', E)$ is created as follows: **(1)** $A' = A \cup \{\eta\}$. **(2)** For every two arguments a, b s.t. $(a, b) \in R$, put $(\{a\}, b)$ in R'. **(3)** Let a be an argument in A and $Z = \{Z_1, .., Z_n\}$ be a collection of all sets Z_i s.t. $Z_i N a$. If Z is empty, add $(\{\eta\}, a)$ to E. Otherwise, for every subset Z' of $\bigcup_{i=1}^{n} Z_i$ s.t. $\forall_{i=1}^{n} Z' \cap Z_i \neq \emptyset$, add (Z_i, a) to E.

While correct (see Theorem 3.16), this translation can create redundant elements in E. We therefore propose the following translation instead.

Translation 1 (Continued)**.** Let a be an argument in A and $Z = \{Z_1, .., Z_n\}$ be a collection of all sets Z_i s.t. $Z_i N a$. If Z is empty, add $(\{\eta\}, a)$ to E. Otherwise, for all Z' in $Z_1 \times ... \times Z_n$, add (Z'_S, a) to E, where Z'_S is the set of all elements in Z'.

Theorem 5.1. *An argument a is powerful in $S \cup \{a\} \subseteq A$ in FN iff it is e–supported by $S \cup \{\eta\}$ in ES^{FN}. S is coherent in FN iff $S \cup \{\eta\}$ is self–supporting in ES^{FN}.*

There is an important difference between the definitions of defense (acceptability) in EASs and AFNs concerning support. In EASs, an argument a has to be e–supported by the set S. Consequently, it does not have to be the case that $S \cup \{a\}$ is self–supporting. In AFNs it is required that $S \cup \{a\}$ is coherent, which by Theorem 5.1 is visibly a stronger restriction. However, in order to have a chance to be an extension, a set has to be coherent (self–supporting) in the first place. Therefore, we focus on such sets in our analysis.

Theorem 5.2. *Let $S \subseteq A$ ($S \cup \{\eta\}$ once translated into an EAS) be a coherent (self–supporting) set in FN (ES^{FN}). An argument $a \in A$ is defended by S in FN iff it is acceptable w.r.t $S \cup \{\eta\}$ in ES^{FN}.*

Theorem 5.3. *Let $FN = (A, R, N)$ be an AFN and $ES_{FN} = (A', R', E)$ its corresponding EAS. Then a set S is a σ–extension in FN where $\sigma \in \{$admissible, preferred, complete, grounded, stable$\}$ iff $S \cup \{\eta\}$ is a σ–extension in ES_{FN}.*

Example 5.4. Consider the AFN of 4.6 above. By Translation 1 we obtain its EAS $((\{\eta,a,b,c,d,e\}, \{(\{b\},a), (\{e\},a), (\{c\},d)\}, \{(\{b\},b), (\{b\},e),(\{d\},e),(\{a\},c)\}), (\{\eta\},a),(\{\eta\},d)\})$. The maximal self–supporting sets are $\{\eta,a,c\}$ and $\{\eta,d,e\}$, thus b is correctly recognized as invalid. Our admissible extensions are $\emptyset,\{\eta\},\{\eta,a,c\}$ and $\{\eta,d,e\}$. It is easy to see they satisfy the completeness criterion as well. The latter two are also preferred and stable. Our grounded extension is $\{\eta\}$. Our results thus agree for both the AFN and translated EAS.

Since AFNs consider binary attacks, translation from EASs to AFNs requires the introduction of virtual arguments. This aspect of the translation is trivial but cumbersome, and due to space constraints, we focus on the translation of support between the two frameworks, illustrating the process through an example.

The differences between the E and N sets require a shift between relations similar to the one in Translation 1. The biggest difficulty here is the handling of η. Within EASs, η is the sole confirmation of "truth". Its presence at the start of an evidential sequence is required for argument validity. Arguments not supported by η act as (invalid) self–supporters. Due to AFNs acyclicity requirements, such an argument would be invalid.

This intuition can also be considered from a more structural point of view. Since any powerful sequence originates at an argument that requires no support, the translation from EASs to AFNs should ensure that η is the only argument meeting this requirement. Consequently, any other argument that requires no support in the EAS should be disqualified in its corresponding AFN, which is achieved easily by using a support cycle.

In order to omit the attack issues between EASs and AFNs, let us focus on a subclass of EASs that uses only binary conflicts, i.e. where every set of arguments S s.t. SRa for some $a \in A$, consists of a single element. We denote it by EAS^{bin}.

Translation 2. Let $ES = (A,R,E)$ be an EAS^{bin}. The corresponding AFN $FN^{ES} = (A,R',N)$ is created as follows: **(1)** The set of arguments remains the same. **(2)** For every two arguments a, b s.t. $(\{a\},b) \in R$, put (a,b) in R'. **(3)** Let $a \neq \eta$ be an argument in A and $Z = \{Z_1,..,Z_n\}$ be a collection of all sets Z_i s.t. Z_iEa. If Z is empty, add $(\{a\},a)$ to N. Otherwise, for every subset Z' of $\bigcup_{i=1}^{n} Z_i$ s.t. $\forall_{i=1}^{n} Z' \cap Z_i \neq \emptyset$, add (Z_i,a) to N.

Although the translation is correct in the sense that extensions produced by the frameworks coincide, redundancies can occur. Assuming minimality of Z' sets would remove some redundancy, while maintaining correctness (Theorems 4.7 and 3.16)..

Theorem 5.5. *An argument a is e–supported by $S \subseteq A$ in ES iff it is powerful in $S \cup \{a\}$ in FN^{ES}. S is self–supporting in ES iff it is coherent FN^{ES}.*

Theorem 5.6. *Let $S \subseteq A$ be a self–supporting (coherent) set in ES (FN^{ES}). An argument $a \in A$ is acceptable w.r.t. S in ES iff it is defended by S in FN^{ES}.*

Theorem 5.7. *Let $ES = (A,R,E)$ be an EAS^{bin} and $FN^{ES} = (A,R',N)$ its corresponding AFN. Then a set S is a σ–extension in ES where $\sigma \in \{$admissible, preferred, complete, grounded, stable$\}$ iff it is a σ–extension in FN^{ES}..*

Example 5.8. We can now construct an AFN (A,R,N) corresponding to the EAS of Example 3.13. The set of arguments remains the same and A is simply $\{\eta,a,b,c,d,e,f\}$. Since the EAS has only binary attacks, we can copy them across from the EAS to R. In this example, the necessity relation is $N = E \cup \{(a,a)\}$. a is the only argument that is not supported by anything at all in the EAS. Our admissible extensions are now

$\emptyset, \{\eta\}, \{\eta, b\}, \{\eta, b, d\}, \{\eta, b, d, e\}$ and $\{\eta, c\}$, which are exactly the same as in for the EAS. The AFN's complete extensions are $\{\eta\}, \{\eta, b, d, e\}$ and $\{\eta, c\}$ and again we obtain correspondence. The same trivially follows for the preferred semantics. It is easy to see that the stable set is also $\{\eta, b, d, e\}$ and the grounded $\{\eta\}$.

Example 5.9. Similarly, consider the AFN of Example 4.6, and the EAS obtained in Example 5.4. Let us now shift it back to AFN form via Translation 2. The produced framework, FN_2, is $(\{\eta, a, b, c, d, e\}, \{(b, a), (e, a), (c, d)\}, \{(\{b\}, b), (\{b, d\}, e), (\{a\}, c)\}), (\{\eta\}, a), (\{\eta\}, d)\})$ Therefore, we retrieve the original AFN extended with evidence and the resulting relations. We obtain four admissible extensions – $\emptyset, \{\eta\}, \{\eta, a, c\}$ and $\{\eta, d, e\}$, out of which only $\emptyset$ is not complete. $\{\eta, a, c\}$ and $\{\eta, d, e\}$ are the preferred and stable extensions. By removing η from the sets we retrieve the extensions of FN_1.

6. Discussion and Conclusions

This paper's examined the differences and similarities between support as used within Evidential Argument Systems and Argumentation Frameworks with Necessities. We provided a translation between AFNs and EASs and analyzed a possible translation going in the other direction. Additionally, we identified correspondences between the properties of both of these systems to the properties obtained in Dung's argumentation system. Finally, we corrected some important errors in the definitions of EASs.

We are pursuing several avenues of future work. First, as suggested above, we intend to fully formalize the translation from EASs to AFNs. Second, we wish to provide a mapping between the remaining types of support (deductive and abstract) to the systems discussed here (c.f. [4, 10]). Finally, we wish to identify a system useful for handling support as used by a knowledge engineer.

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