Using Argument Features to Improve the Argumentation Process

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Introduction

- Argumentation aims towards formalizing reasoning mechanisms with the capability of handling *contradictory*, *incomplete,* and/or *uncertain information*.
- The main purpose of argumentation is to *analyze* a particular *statement* considering reasons in *favor* and *against* that statement, where both the original statement and its support are subject to *scrutiny*.
- The evolution of applications based on argumentation mechanisms requires the development of more *sophisticated tools*.

Motivation

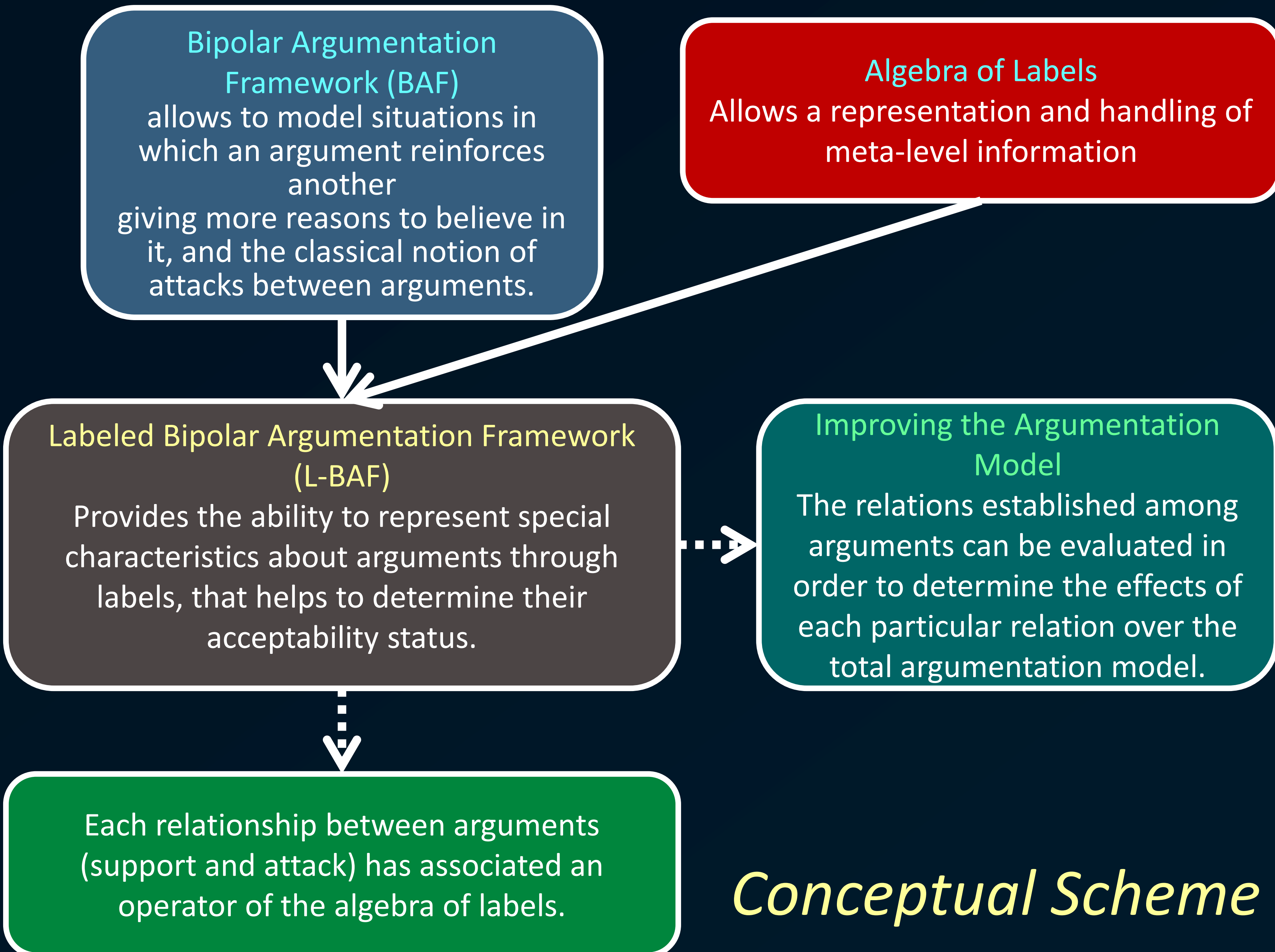
- C. Cayrol and M-C. Lagasquie-Schiex proposed a framework that takes into account *attack* and *support* which represent two independent types of interaction between arguments, introducing *Bipolar Argumentation Frameworks* allowing to model situations in which an argument reinforces another giving more reasons to believe in it.
- Although this formalization models certain aspects of real-world situations, it does not provide tools to represent particular *features* of *arguments*, such as its strength, reliability, or temporal availability, among others.

Contribution

- We present a form of BAF which adds the possibility of representing *properties* associated with the *arguments*, augmenting its representational capabilities.
- The *descriptive information* is attached to arguments through *argumentation labels*.
- These labels are affected by the existing relations among arguments; to that end, we propose an *algebra of argumentation labels*, which is an algebraic structure that helps to combine and propagate the information associated to arguments.

Contribution

- Using the extra information provided by these labels, we can *improve* the *acceptability semantics process* providing a more refined analysis.
- The *refinement* of the *support* and *conflict coefficients* for a finer-grained analysis of argument impact.
- Nine kinds of *extensions* resulting from combining the classical bipolar extensions with the results of the labeling process.
- The analysis of *underlying principles* for the labeling process, describe the behavior of valuations associated with arguments in the proposed framework.



Conceptual Scheme

Labeled Bipolar Argumentation Framework

- To *expand* the representation capabilities of the argumentative structures, we incorporate labels.
- These labels hold *specific information* regarding each argument, and the results obtained using the *algebra of argumentative labels* produced by the interactions that combine and propagate them.
- Through these labels it is possible to *refine* the acceptability process and offer more information in a compact way.

Labeled Bipolar Argumentation Framework

An *Algebra of labels* is a 6-tuple $\mathsf{A} = \langle \mathcal{L}, \leq, \oplus, \ominus, \top, \bot \rangle$ where:

- $\mathcal{L}$ is a set of labels referred to as the *domain of labels*.
- $\leq$ is a *partial order relation* over $\mathcal{L}$.
- $\oplus$: $\mathcal{L}$ x $\mathcal{L} \rightarrow \mathcal{L}$ is called the *support operator*.
- $\ominus$: $\mathcal{L}$ x $\mathcal{L} \rightarrow \mathcal{L}$ is called the *conflict operator*.
- $\top$ is the greatest element of $\mathcal{L}$, while $\bot$ is the least one. Furthermore, $\bot$ is the neutral element for $\oplus$ and $\ominus$.

Labeled Bipolar Argumentation Framework

The carrier set of this algebra is a set of argument labels:

- The *support operator* $\oplus$ will be used to obtain the meta-information associated with the resolution of the support relation between arguments; in this way, the strength of an argument *increases* with the quality of the arguments supporting it.

- The *conflict operator* $\ominus$ is associated with the resolution of conflicting arguments; the effects of this operator can be seen as a weakening operator which *reduces* the strength of the attacked argument based on the strength of the attacker.

Labeled Bipolar Argumentation Framework

A *Labeled Bipolar Argumentation Framework* (L-BAF) is a 5-tuple $\Theta = \langle \mathit{Args}, \mathrm{R_a}, \mathrm{R_s}, \mathrm{A_s}, \mathrm{F_v} \rangle$ where:

- $\langle \mathit{Args}, \mathrm{Ra}, \mathrm{Rs} \rangle$ is a Bipolar Argumentation Framework,
- As is a set of Algebras of Argumentation Labels $A_1, A_2, \ldots, A_n$ (one for each feature represented by the labels), and
- $\mathrm{F_v} : \mathit{Args} \mapsto A_1 \times A_2 \times \ldots \times A_n$ is a function that assigns to each element of Args an n-tuple of elements in the set of algebras $\mathrm{A_s}$

All the arguments have associated information on which they are based as we will see next.

Labeled Bipolar Argumentation Framework

Given a *Labeled Bipolar Argumentation Framework* Θ, G_Θ the bipolar argumentation graph associated with it, and A_i be an algebra in $\mathbb{A}_s$. A labeled bipolar graph is an assignment of three valuations in each of the algebras A_i to each argument $\mathbb{A}$ define in Θ, denoted with $\langle \alpha_i^{\mathbb{A}}, \mu_i^{\mathbb{A}}, \delta_i^{\mathbb{A}} \rangle$, where

– $\alpha_i^{\mathbb{A}}$ is the *original value* of the attribute assigned to the argument by the function $\mathbb{F}_v$,

– $\mu_i^{\mathbb{A}}$ accounts for the *aggregation* of the attributes of the arguments supporting $\mathbb{A}$, and

– $\delta_i^{\mathbb{A}}$ is obtained after taking into account the *attacks*.

Labeled Bipolar Argumentation Framework

Let $\mathtt{A}$ be an argument defined in Θ, its valuations are determined as follows:

- $\alpha_i^{\mathtt{A}} = \mathtt{F_v}(\mathtt{A})$ for all $\mathtt{A} \in \mathtt{Args}$.
- If $S^{\Rightarrow}(\mathtt{A}) = \varnothing$, then $\mu_i^{\mathtt{A}} = \alpha_i^{\mathtt{A}}$.
- If $S^{\rightarrow}(\mathtt{A}) = \varnothing$, then $\delta_i^{\mathtt{A}} = \mu_i^{\mathtt{A}}$.
- If $S^{\Rightarrow}(\mathtt{A}) \neq \varnothing$, then $\mu_i^{\mathtt{A}} = \alpha_i^{\mathtt{A}} \oplus (\oplus_{j=1 \dots n} \delta_i^{\mathtt{A}_j})$, with $\mathtt{A}_j \in S^{\Rightarrow}(\mathtt{A})$.
- If $S^{\rightarrow}(\mathtt{A}) \neq \varnothing$, then $\delta_i^{\mathtt{A}} = \mu_i^{\mathtt{A}} \ominus (\oplus_{j=1 \dots m} \delta_i^{\mathtt{B}_j})$, with $\mathtt{B}_j \in S^{\rightarrow}(\mathtt{A})$.

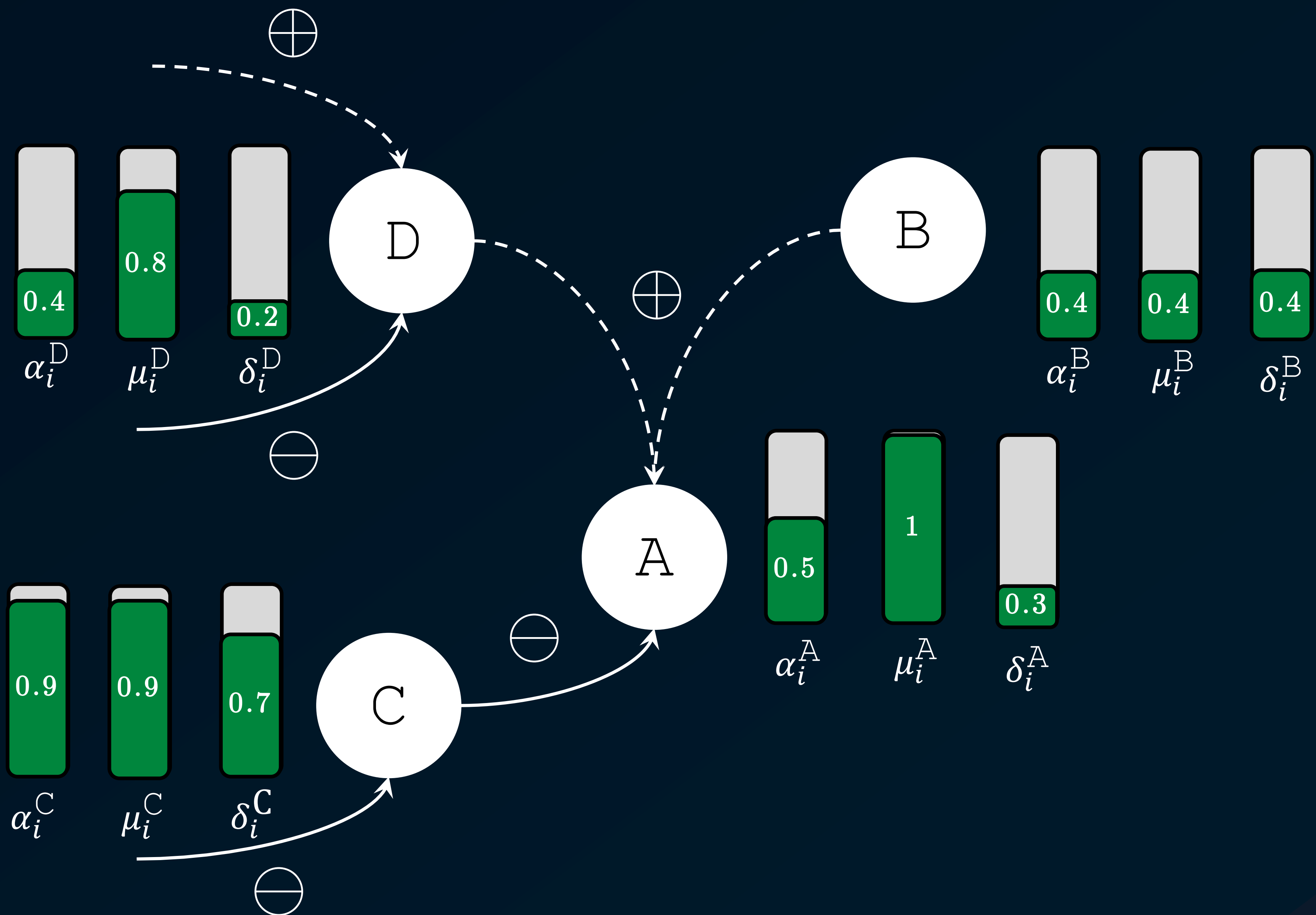
For all $\mathtt{A} \in \mathit{Args}$, the labels $\langle \alpha_i^{\mathtt{A}}, \mu_i^{\mathtt{A}}, \delta_i^{\mathtt{A}} \rangle$ satisfy:

i) $\mu_i^{\mathtt{A}} \geq \delta_i^{\mathtt{A}}$

ii) $\mu_i^{\mathtt{A}} \geq \alpha_i^{\mathtt{A}}$ and

iii) If $\mu_i^{\mathtt{A}} = \perp$, then $\delta_i^{\mathtt{A}} = \alpha_i^{\mathtt{A}} = \perp$ as well.

Labeled Bipolar Argumentation Framework

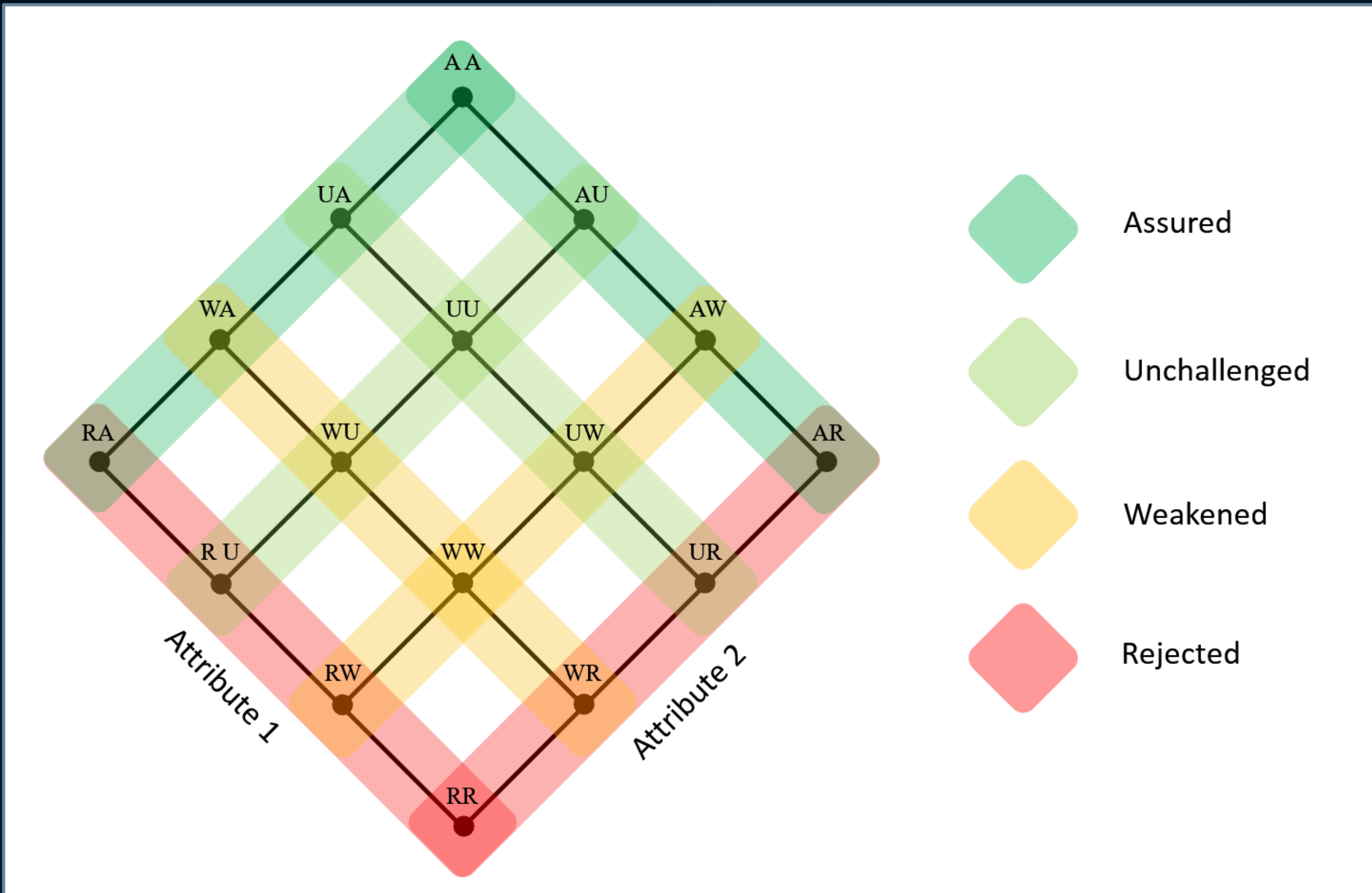


Labeled Bipolar Argumentation Framework

Given a *Labeled Bipolar Argumentation Framework* Θ, G_{Θ} the bipolar argumentation graph associated with it, and $\mathbb{A}$ be an argument defined in Θ. Then, for each algebra A_i defined in $\mathbb{A}_S$, $\mathbb{A}$ has assigned one of four possible statuses:

- Assured iff $\delta_i^{\mathbb{A}} = \top_i$
- Strengthened iff $\alpha_i^{\mathbb{A}} < \delta_i^{\mathbb{A}}$
- Unchallenged iff $\delta_i^{\mathbb{A}} = \mu_i^{\mathbb{A}} \neq \perp_i$
- Weakened iff $\perp_i < \delta_i^{\mathbb{A}} < \mu_i^{\mathbb{A}}$.
- Rejected or Defeated iff $\delta_i^{\mathbb{A}} = \perp_i$

Labeled Bipolar Argumentation Framework



Labeled Bipolar Argumentation Framework

Having extra information associated with arguments introduces the possibility of analyzing the argumentation model. In this sense, we can calculate the coefficients of conflict and support of the model, which give an indication of the efficiency of attacks and supports.

Particular Conflict Cf.

$$\omega_i^{\mathtt{a}} = \frac{\sum_{\mathtt{A} \in \mathtt{Arg}} \mu_i^{\mathtt{A}} - \delta_i^{\mathtt{A}}}{|\mathrm{R}_{\mathtt{a}}|}$$

Particular Support Cf.

$$\omega_i^{\mathtt{s}} = \frac{\sum_{\mathtt{A} \in \mathtt{Arg}} \mu_i^{\mathtt{A}} - \alpha_i^{\mathtt{A}}}{|\mathrm{R}_{\mathtt{s}}|}$$

General Conflict Cf.

$$\Omega^{\mathtt{a}} = \frac{\sum_{\mathtt{A}_i \in \mathtt{A}_{\mathtt{s}}} \omega_i^{\mathtt{a}}}{n}$$

General Support Cf.

$$\Omega^{\mathtt{s}} = \frac{\sum_{\mathtt{A}_i \in \mathtt{A}_{\mathtt{s}}} \omega_i^{\mathtt{s}}}{n}$$

If Ω^{a} = 1 and Ω^{s} = 0, then the Labeled Bipolar Argumentation Framework is equivalent to a Dung Framework.

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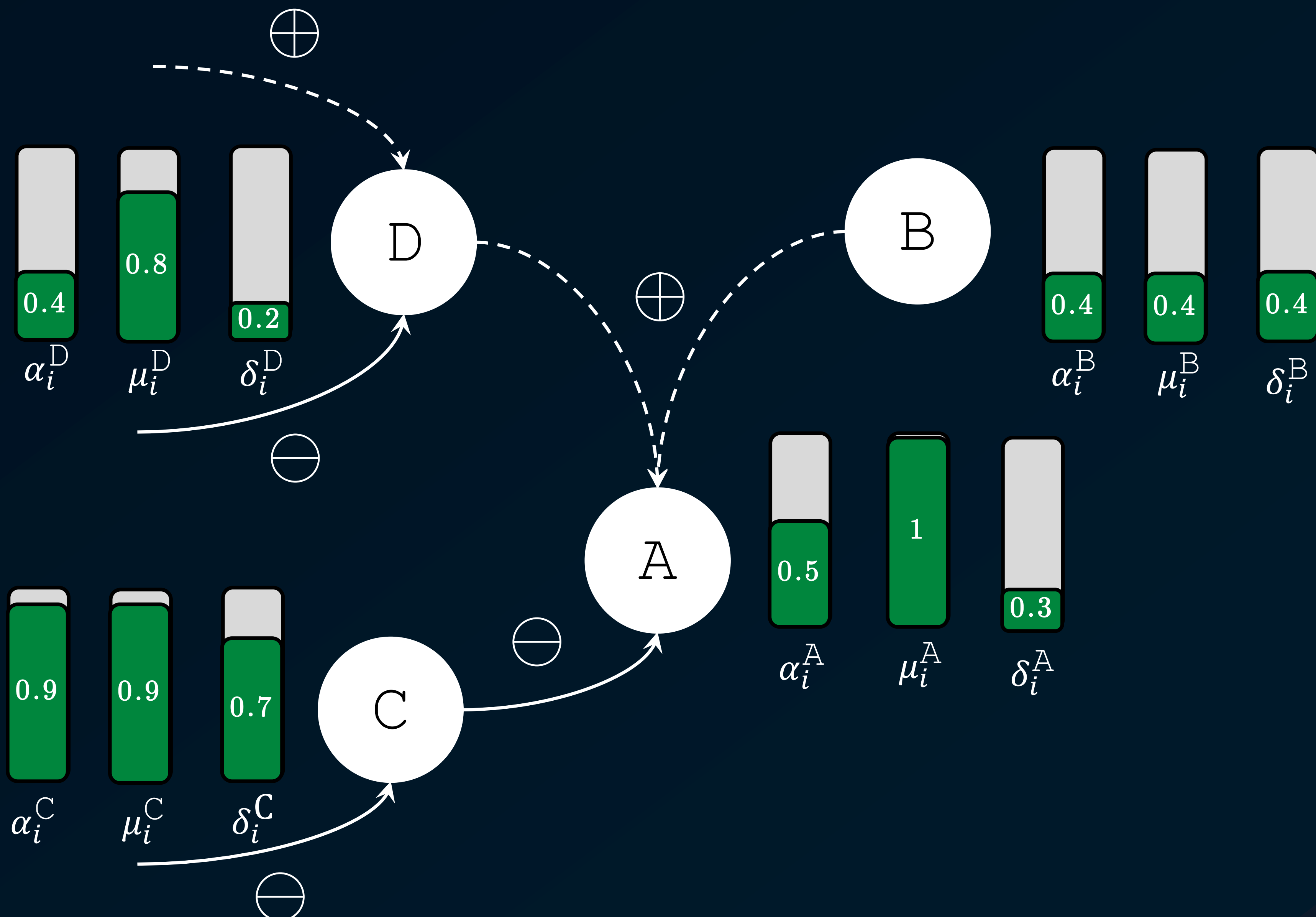
Labeled Bipolar Argumentation Framework



Conclusion and Future Works

- We combine Bipolar Argumentation Frameworks with Algebras of Argumentation Labels to extend the representation capability of argument structures, where labels represent argument features generalizing the notion of value and weight.
- The interaction between arguments can affect their labels, causing strengthening and weakening among arguments.
- The information contained in the labels allows us to improve the analysis performed over the argumentation model and refine it using only the set of relevant arguments.

Conclusion and Future Works

- We are currently working on:
  - The treatment of the different kind of support (deductive, necessary, and evidential), establishing the constraint that the operators defined in the algebra must fulfill to propagate the arguments features in a coherent way.
  - A novel pruning process that leverages the results of argument impact analyses in the removal of unwanted arguments.
  - An implementation of L-BAF instantiating it in the existing DeLP system as a basis.

Thank you!

Questions?