Semantics Hierarchy in Preference-Based Argumentation Frameworks

Rafael Silva    Samy Sá    João Alcântara

Department of Computer Science
Universidade Federal do Ceará - Brazil

COMMA, 2020
Preferences in Argumentation

How should preferences influence the evaluation of arguments?

- Tricky: several approaches with no consensus
- Limitations: depending on the strategy, some desirable semantic properties may be lost

We are interested in the *preservation* of semantic properties.
Approach 1: Attack Removal

Consider $AF = (\{A, B\}, \{(B, A)\})$ (below) and suppose $A > B$

Approach 1: Discard the attacks

- Amgoud and Cayrol, 2002; Bench-Capon, 2003; Modgil, 2009

BEFORE

\[ \text{Complete: } \{\{B\}\} \]

AFTER

\[ \text{Complete: } \{\{A, B\}\} \]
Approach 2: Reverse Attacks

Consider $AF = (\{A, B\}, \{(B, A)\})$ (below) and suppose $A > B$

Approach 2: Attacks to preferred arguments are reversed

- Amgoud and Vesic, 2009; Amgoud and Vesic, 2011

BEFORE

\[
\begin{array}{c}
B \\
\rightarrow \\
A
\end{array}
\]

Complete: $\{\{B\}\}$

AFTER

\[
\begin{array}{c}
B \\
\leftarrow \\
A
\end{array}
\]

Complete: $\{\{A\}\}$
Approach 3: Conditional Reversal

Consider $AF = (\{A, B\}, \{(B, A)\})$ (below) and suppose $A \succ B$

Approach 3: Attacks should be ignored only if it is symmetric

- Modgil and Prakken, 2013; Kaci et. al., 2018

**BEFORE**

![Before Diagram]

**AFTER**

![After Diagram]

Complete: $\{\{B\}\}$

Complete: $\{\{B\}\}$
Approach 3: Conditional Inversion

Consider $AF = (\{A, B\}, \{(B, A), (B, A)\})$ (below) and suppose $A > B$

Approach 3: Attacks should be ignored only if it is symmetric.

- Modgil and Prakken, 2013; Kaci et. al., 2018

**Before**

![Before Diagram]

Complete: $\{\emptyset, \{A\}, \{B\}\}$

**After**

![After Diagram]

Complete: $\{\{A\}\}$
Approach 1: Attack Removal

Consider $AF = (\{A, B\}, \{(B, A), (B, A)\})$ (below) and suppose $A \succ B$

Approach 1: discard the attacks

- Amgoud and Cayrol, 2002; Bench-Capon, 2003; Modgil, 2009

**BEFORE**

- $\{\emptyset, \{A\}, \{B\}\}$

**AFTER**

- $\{\{A\}\}$
Approach 2: Reverse Attacks

Consider $AF = (\{A, B\}, \{(B, A), (B, A)\})$ (below) and suppose $A > B$

Approach 2: Attacks to preferred arguments are inverted.

- Amgoud and Vesic, 2009; Amgoud and Vesic, 2011

**BEFORE**

![Before Diagram]

Complete: $\{\emptyset, \{A\}, \{B\}\}$

**AFTER**

![After Diagram]

Complete: $\{\{A\}\}$
Approach 4: Filter Extensions

Consider \( AF = (\{A, B\}, \{(B, A), (B, A)\}) \) (below) and suppose \( A > B \)

Approach 4: Select what extensions of \( AF \) respect the preferences

- Wakaki, 2015

**BEFORE**

- Complete: \( \emptyset, \{A\}, \{B\} \)

**AFTER**

- Complete: \( \emptyset, \{A\} \)
Approach 4: Filter Extensions

Consider \( AF = (\{A, B\}, \{(B, A)\}) \) (below) and suppose \( A > B \)

Approach 4: Select what extensions of \( AF \) respect the preferences.

- Wakaki, 2015

**Diagram:**

**Before:**

- Complete: \( \{\{B\}\} \)

**After:**

- Complete: \( \{\} \)
In Sum...

Changing the framework may break some things
- conflicting extensions may become admissible
- unattacked arguments may be defeated
- some semantics that are generally warranted may collapse

We are interested in the preservation of semantic properties.

In particular, we will be looking for relations between the original sets of extensions and the resulting sets of extensions.
Our Work...

We focus on Amgoud and Vesic 2011

- A PAF is a tuple \((A_r, att, \succeq)\)
- A semantic is characterized by a dominance relation \(\succeq\) on \(2^{A_r}\)
  - Extensions are the maximal elements of \((2^{A_r}, \succeq)\)
  - Defined pref-grounded, pref-stable, pref-preferred
- The pref-semantics generalizes a Dung AF-semantics if a "preferences-attacks agreement" preserves extensions
We focus on Amgoud and Vesic 2011

- A PAF is a tuple \((A_r, att, \succeq)\)
- A semantic is characterized by a dominance relation \(\succeq\) on \(2^{A_r}\)
  - Extensions are the maximal elements of \((2^{A_r}, \succeq)\)
  - Defined \textit{pref-grounded, pref-stable, pref-preferred}
- The pref-semantics \textit{generalizes} a Dung AF-semantics if a ”preferences-attacks agreement” preserves extensions

Important notes
- The preferences ”agree” with attacks if \(A > B\) implies \((B, A) \notin att\)
- \(\succeq\) must satisfy some consistency postulates (conflict-freeness, conditional priorities between preferences and attacks)
We focus on Amgoud and Vesic 2011

- A PAF is a tuple \((A_r, att, \succeq)\)
- A semantic is characterized by a dominance relation \(\succeq\) on \(2^{A_r}\)
  - Extensions are the maximal elements of \((2^{A_r}, \succeq)\)
  - Defined \(\text{pref-grounded, pref-stable, pref-preferred}\)
- The pref-semantics \textit{generalizes} a Dung AF-semantics if a "preferences-attacks agreement" preserves extensions

Our contributions (1/2)
- We characterized the \textit{pref-complete} semantics \(\succeq_c\)
Our Work...

We focus on Amgoud and Vesic 2011

- A PAF is a tuple \((A_r, att, \succeq)\)
- A semantic is characterized by a dominance relation \(\succeq\) on \(2^{A_r}\)
  - Extensions are the maximal elements of \((2^{A_r}, \succeq)\)
  - Defined pref-grounded, pref-stable, pref-preferred
- The pref-semantics generalizes a Dung AF-semantics if a "preferences-attacks agreement" preserves extensions

Our contributions (1/2)

Definition (Pref-complete semantics)

Let \(\mathcal{I} = (A_r, att, \succeq)\) be a PAF and \(E, E' \subseteq A_r\). It holds that \(E \succeq_c E'\) iff

- \(E \in CF(\mathcal{I})\) and \(E' \notin CF(\mathcal{I})\) or
- \(E, E' \in CF(\mathcal{I})\) and \(E \subseteq \{a \in A_r \mid d(a, E, E')\}\) and if \(E \subseteq E'\), then \((\{a \in A_r \mid d(a, E, A_r)\} - E) \subseteq (\{a \in A_r \mid d(a, E', A_r)\} - E').\)
We focus on Amgoud and Vesic 2011

- A *PAF* is a tuple \((A, r, att, \geq)\)
- A semantic is characterized by a *dominance relation* \(\succeq\) on \(2^Ar\)
  - Extensions are the *maximal* elements of \((2^Ar, \succeq)\)
  - Defined *pref-grounded, pref-stable, pref-preferred*
- The pref-semantics *generalizes* a Dung AF-semantics if a ”preferences-attacks agreement” preserves extensions

Our contributions (1/2)

- We characterized the *pref-complete* semantics \(\succeq_c\)
  - \(\succeq_c\) satisfies the consistency postulates
  - extensions are instead given by *maximal upper bounds*
  - \(\succeq_{c,ub}\) generalizes Dung’s complete semantics
Our Work...

Our contributions (2/2)

- The original pref-semantics are particular cases of *pref-complete*, therefore establishing a central point towards semantics hierarchy
  - pref-grounded extension is the minimal pref-complete extension
  - pref-preferred extensions are the maximal pref-complete extensions
  - pref-stable extensions are the pref-complete extensions s.t. $E \cup E^+ = Ar$

![Diagram of semantics hierarchy](Image)

*Pref-stable* → *Pref-preferred* → *Pref-grounded* → *Pref-complete*
Conclusion

- The literature is rich, but it lacks consensus on a standard approach.
- We contribute showing the preferential semantics of Amgoud and Vesic retain the usual hierarchy based on complete semantics.
Approach 1 (Attack Removal)


Approach 2 (Reverse Attacks)


Approach 3 (Conditional Inversion)


Approach 4 (Filter Extensions)