Ranking-Based Semantics from the Perspective of Claims

Stefano Bistarelli, Wolfgang Dvořák, Carlo Taticchi and Stefan Woltran
Some motivation

Ranking-based semantics refine the notion of acceptance, but have only been studied for abstract argumentation.
Some motivation

Ranking-based semantics refine the notion of acceptance, but have only been studied for abstract argumentation.

Abstraction alone is not sufficient:
- risk of ad-hoc modelings
- incorrect generalisation

Intermediate abstraction levels can be considered.
Some motivation

Ranking-based semantics refine the notion of acceptance, but have only been studied for abstract argumentation.

Abstraction alone is not sufficient:
- risk of ad-hoc modelings
- incorrect generalisation

Intermediate abstraction levels can be considered.

We study ranking-based semantics in the context of Claim Augmented Frameworks.
Overview

• Background notions

• Ranking claims on CAFs
  1. Desired properties
  2. Lifting via Lexicographic Order
  3. (Revisited properties of ranking semantics)

• Conclusion and future work
Ranking-based semantics

• Classical “Dung’s” semantics: _accepted/_ _rejected_  
  Dung 1995

• Labelling-based semantics: addition of _undec_  
  Caminada 2006

• Finer grain? Ranking over arguments
Ranking-based semantics

- Classical “Dung’s” semantics: *accepted* / *rejected*
- Labelling-based semantics: addition of *undec*
- Finer grain? Ranking over arguments
- How does one evaluate the arguments?

Some ranking/graded semantics:
- AB2013
- Bonzon 2016
- Thimm 2018
- Dondio 2018
- GM2019
Claim Augmented Frameworks

- Claim Augmented Frameworks (DW2010): arguments stands for a particular claim (or conclusion)

- Extensions of standard semantics of the underlying AF can be interpreted in terms of claims

![Diagram](image_url)
Claim Augmented Frameworks

- Claim Augmented Frameworks (DW2010): arguments stands for a particular claim (or conclusion)
- Extensions of standard semantics of the underlying AF can be interpreted in terms of claims
Ranking claims on CAFs
1) Desired properties

• We can interpret the extensions in terms of claims. 

DW2019
1) Desired properties

- We can interpret the extensions in terms of claims \( \text{DW2019} \)
- How to lift argument-ranking to claim-ranking?
1) Desired properties

- We can interpret the extensions in terms of claims
- How to lift argument-ranking to claim-ranking?
- Replacing arguments with their claims in the ranking does not work…
  - example: \( a \simeq d > b > c \rightarrow x \simeq z > y > x \)?
1) Desired properties

- A claim-based ranking semantics associates with any CAF $CF$ a total pre-order $\succeq_{CF}$ on $X_{CF}$

- Fundamental properties of a lifting:
1) Desired properties

- A claim-based ranking semantics associates with any CAF $CF$ a total pre-order $\succeq_{CF}$ on $X_{CF}$

- Fundamental properties of a lifting:
  - **Stronger Support (SD):** if the support sets of two claims are comparable, claims with stronger support are stronger

$$a_x \succeq e_y > d_z > b_x \succeq c_y \implies x \succeq y$$

Claim $x$ supported by: $a, b$
Claim $y$ supported by: $e, c$
1) Desired properties

- A claim-based ranking semantics associates with any CAF $CF$ a total pre-order $\succeq_{CF}$ on $X_{CF}$

- Fundamental properties of a lifting:
  - **Stronger Support (SD):** if the support sets of two claims are comparable, claims with stronger support are stronger

$$a_x \geq e_y > d_z > b_x \geq c_y \implies x \succeq y$$

Claim x supported by: a, b
Claim y supported by: e, c
1) Desired properties

- A claim-based ranking semantics associates with any CAF $CF$ a total pre-order $\succeq_{CF}$ on $X_{CF}$

- Fundamental properties of a lifting:
  - **Stronger Support (SD):** if the support sets of two claims are comparable, claims with stronger support are stronger

\[
\begin{align*}
  a_x & \succeq e_y > d_z > b_x \succeq c_y \implies x \succeq y \\
\end{align*}
\]

Claim $x$ supported by: $a, b$
Claim $y$ supported by: $e, c$
1) Desired properties

- A claim-based ranking semantics associates with any CAF $CF$ a total pre-order $\succeq_{CF}$ on $X_{CF}$

- Fundamental properties of a lifting:
  - **Stronger Support (SD):** if the support sets of two claims are comparable, claims with stronger support are stronger

$$a_x \succeq e_y \succ d_z \succ b_x \succeq c_y \implies x \succeq y$$

Claim $x$ supported by: $a, b$

Claim $y$ supported by: $e, c$
1) Desired properties

- A claim-based ranking semantics associates with any CAF $CF$ a total pre-order $\succeq_{CF}$ on $X_{CF}$

- Fundamental properties of a lifting:
  - **Stronger Support (SD):** if the support sets of two claims are comparable, claims with stronger support are stronger

\[
\begin{align*}
a_x &\succeq e_y > d_z > b_x \succeq c_y &\implies x \succeq y \\
\text{Claim } x \text{ supported by: } &a, b \\
\text{Claim } y \text{ supported by: } &e, c
\end{align*}
\]
1) Desired properties

• A claim-based ranking semantics associates with any CAF $CF$ a total pre-order $\succeq_{CF}$ on $X_{CF}$

• Fundamental properties of a lifting:
  
  • **Stronger Support (SD):** if the support sets of two claims are comparable, claims with stronger support are stronger
  
  • **Strict Stronger Support (SSD):** if the support sets of two claims are comparable, claims with strictly stronger support are strictly stronger
1) Desired properties

- A claim-based ranking semantics associates with any CAF $CF$ a total pre-order $\geq_{CF}$ on $X_{CF}$

- Fundamental properties of a lifting:
  - **Stronger Support (SD):** if the support sets of two claims are comparable, claims with stronger support are stronger
  - **Strict Stronger Support (SSD):** if the support sets of two claims are comparable, claims with strictly stronger support are strictly stronger
  - **Generalised Stronger Support (GSS):** the ranking of a claim is strengthened by additional support


2) Lifting via Lexicographic Order

Lexicographic order relation $\geq^L$:

- $A \geq^L \emptyset$, $\emptyset \geq^L A$, for $A \neq \emptyset$

- $A \geq^L B \iff i) \text{ max}(A) > \text{ max}(B)$, or
  
  \hspace{1cm} ii) $\text{ max}(A) \geq \text{ max}(B)$ and $A \setminus \text{ max}(A) \geq^L B \setminus \text{ max}(B)$

Lex-lifting: $x \geq y \iff A_x \geq^L A_y$
2) Lifting via Lexicographic Order

Lexicographic order relation $\succeq_L$:

- $A \succeq_L \emptyset, \emptyset \succeq_L A$, for $A \neq \emptyset$
- $A \succeq_L B \iff i) \, \max(A) > \max(B)$, or
  
  $ii) \, \max(A) \succeq \max(B)$ and $A \setminus \max(A) \succeq_L B \setminus \max(B)$

Lex-lifting: $x \succeq y \iff A_x \succeq_L A_y$

\[
\begin{align*}
  a &\simeq b > f > e > c > d \\
  A_x &\equiv \{a, f\}, \, A_y \equiv \{b, e\}
\end{align*}
\]
2) Lifting via Lexicographic Order

Lexicographic order relation $\succeq^L$:

- $A \succeq^L \emptyset, \emptyset \not\succeq^L A$, for $A \neq \emptyset$
- $A \succeq^L B \iff \begin{array}{l}
i) \text{ max}(A) > \text{ max}(B), \text{ or} \\
\text{ii) } \text{ max}(A) \succeq \text{ max}(B) \text{ and } A \setminus \text{ max}(A) \succeq^L B \setminus \text{ max}(B)
\end{array}$

Lex-lifting: $x \succeq y \iff A_x \succeq^L A_y$

$a \simeq b > f > e > c > d$
$A_x = \{a, f\}, A_y = \{b, e\}$
$A_x \succeq^L A_y \implies x > y$
2) Lifting via Lexicographic Order

Lexicographic order relation $\succeq^L$:

- $A \succeq^L \emptyset, \emptyset \succeq^L A$, for $A \neq \emptyset$
- $A \succeq^L B \iff i) \max(A) > \max(B)$, or
  
  $ii) \max(A) \succeq \max(B)$ and $A \setminus \max(A) \succeq^L B \setminus \max(B)$

Lex-lifting: $x \succeq y \iff A_x \succeq^L A_y$

\[ a \simeq b > f > e > c > d \]
\[ A_x = \{a, f\}, A_y = \{b, e\} \]
\[ A_x \succeq^L A_y \implies x > y \]
2) Lifting via Lexicographic Order

Lexicographic order relation $\succeq^L$:

- $A \succeq^L \emptyset$, $\emptyset \succeq^L A$, for $A \neq \emptyset$
- $A \succeq^L B \iff i) \ \max(A) > \max(B)$, or
  - $ii) \ \max(A) \succeq \max(B)$ and $A \setminus \max(A) \succeq^L B \setminus \max(B)$

Lex-lifting: $x \succeq y \iff A_x \succeq^L A_y$

$a \preceq b > f > e > c > d$

$A_x = \{a, f\}$, $A_y = \{b, e\}$

$A_x \succeq^L A_y \implies x \succ y$
2) Lifting via Lexicographic Order

Every lex-lifting of a ranking semantics satisfies:

- **Stronger Support (SD)**: if the support sets of two claims are comparable, claims with stronger support are stronger.

- **Strict Stronger Support (SSD)**: if the support sets of two claims are comparable, claims with strictly stronger support are strictly stronger.

- **Generalised Stronger Support (GSS)**: the ranking of a claim is strengthened by additional support.
2) Lifting via Lexicographic Order

Every lex-lifting of a ranking semantics satisfies:

- **Stronger Support (SD)**: if the support sets of two claims are comparable, claims with stronger support are stronger

- **Strict Stronger Support (SSD)**: if the support sets of two claims are comparable, claims with strictly stronger support are strictly stronger

- **Generalised Stronger Support (GSS)**: the ranking of a claim is strengthened by additional support

What about ranking semantics properties?
3) Revisited properties of ranking semantics

- Abstraction (Abs)
- Independence (Ind)
- Void Precedence (VP)
- Self-contradiction (SC)
- Cardinality Precedence (CP)
- Quality Precedence (QP)
- Counter-Transitivity (CT)
- Strict Counter-Transitivity (SCT)
- Defense Precedence (DP)

**Question:** if an argument-ranking satisfies one of the properties above, will the corresponding claim-ranking satisfy the revised version of such property?

If $a_x \simeq c_y \succ b_y$ satisfies VP,

will $y \succ x$ satisfy VP for claims?
3) Revisited properties of ranking semantics

- Abstraction (Abs)
- Independence (Ind)
- Void Precedence (VP)
- Self-contradiction (SC)
- Cardinality Precedence (CP)
- Quality Precedence (QP)
- Counter-Transitivity (CT)
- Strict Counter-Transitivity (SCT)
- Defense Precedence (DP)

- Some property are only lifted for well-formed (WF) and/or att-unitary (AU) CAFs

<table>
<thead>
<tr>
<th></th>
<th>Abs</th>
<th>Ind</th>
<th>VP</th>
<th>SC</th>
<th>CP</th>
<th>QP</th>
<th>CT</th>
<th>SCT</th>
<th>DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-</td>
<td>all</td>
<td>all</td>
<td>AU</td>
<td>WF and AU</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>AC-</td>
<td>all</td>
<td>WF or AU</td>
<td>all</td>
<td>all</td>
<td>AU</td>
<td>AU</td>
<td>AU</td>
<td>AU</td>
<td>AU</td>
</tr>
</tbody>
</table>
Conclusion
Conclusion

Study on **ranking-based semantics** in the context of **CAFs**
Conclusion

Study on ranking-based semantics in the context of CAFs

1. **Lex-lifting**: lift an argument-ranking to the level of the claims using a lexicographic order relation
Conclusion

Study on **ranking-based semantics** in the context of **CAF**s

1. **Lex-lifting**: lift an argument-ranking to the level of the claims using a **lexicographic order** relation

2. We introduced some desirable properties (**SD**, **SSD**, **GSD**) and showed that the lex-lifting satisfies them
Conclusion

Study on ranking-based semantics in the context of CAFs

1. **Lex-lifting**: lift an argument-ranking to the level of the claims using a lexicographic order relation

2. We introduced some desirable properties (SD, SSD, GSD) and showed that the lex-lifting satisfies them

3. We studied which properties hold for which classes of CAFs after a lex-lifting
   - **approach 1**: solely considering claims
   - **approach 2**: considering arguments with the same claim
Future Work
Future Work

• Ranking-based semantics directly on claims
Future Work

- Ranking-based semantics directly on claims
- Using scores assigned to arguments to rank the claims
Future Work

- Ranking-based semantics directly on claims
- Using scores assigned to arguments to rank the claims
- Complexity analysis
Future Work

- Ranking-based semantics directly on claims
- Using scores assigned to arguments to rank the claims
- Complexity analysis
- Fuzzy approaches
Future Work

- Ranking-based semantics directly on claims
- Using scores assigned to arguments to rank the claims
- Complexity analysis
- Fuzzy approaches
- Lex-lifting as a Galois connection
Ranking-Based Semantics from the Perspective of Claims

Stefano Bistarelli, Wolfgang Dvořák, Carlo Taticchi and Stefan Woltran
3) Claim-based ranking properties

- **Void Precedence**

  \[ \forall a, b \in A_F . (a^- = \emptyset \land b^- \neq \emptyset) \implies a > b \]

  \[ \forall x, y \in X_{CF} . (x^- = \emptyset \land y^- \neq \emptyset) \implies x > y \]

  \[ \forall x, y \in X_{CF} . (\exists a \in A_x : a^- = \emptyset \land \forall b \in A_y . b^- \neq \emptyset) \implies x > y \]

A claim with a non-attacked supporter is better than any claim for which all the supporters are attacked.

\[ x > y \]
3) Claim-based ranking properties

- **Void Precedence**
  
  **VP:** $\forall a, b \in A_F. (a^- = \emptyset \land b^- \neq \emptyset) \implies a > b$

  **C-VP:** $\forall x, y \in X_{CF}. (x^- = \emptyset \land y^- \neq \emptyset) \implies x > y$

  **AC-VP:** $\forall x, y \in X_{CF}. (\exists a \in A_x : a^- = \emptyset \land \forall b \in A_y. b^- \neq \emptyset) \implies x > y$

- $a \simeq c > b$ satisfies **VP**

- $y > x$ does not satisfy **C-VP**

- $y > x$ satisfies **AC-VP**

$a \simeq c > b \implies y > x$