FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

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# Conflicts in Abstract Argumentation[1]

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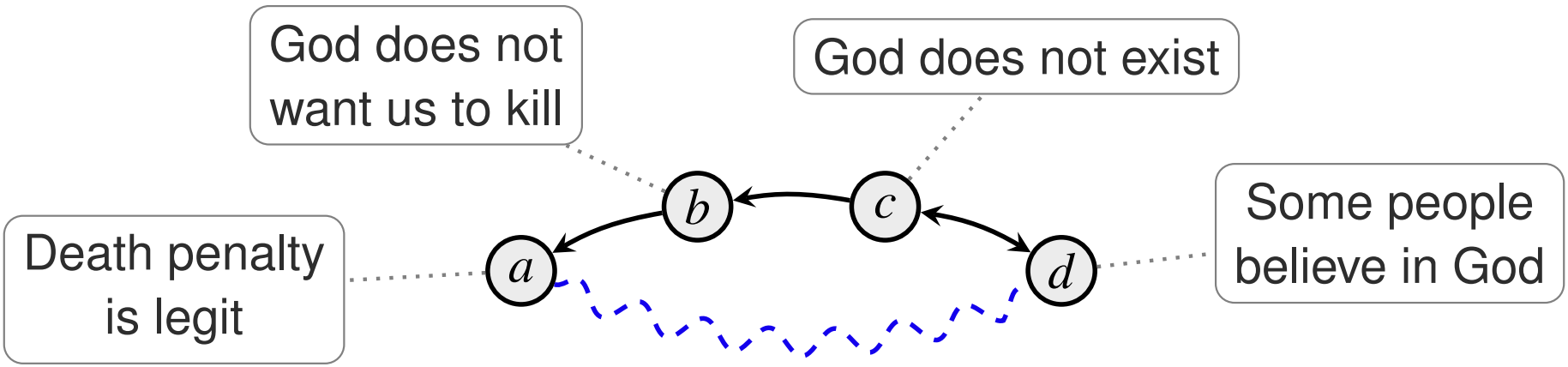
FWF Der Wissenschaftsfonds.

UNIVERSITY OF LIVERPOOL

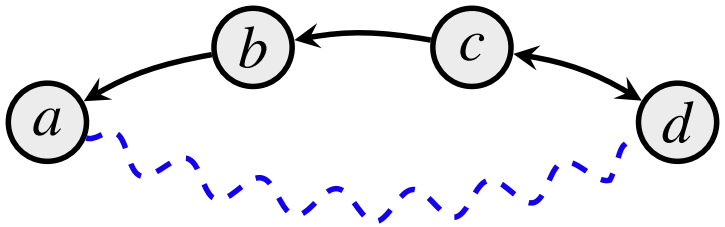
[1]This research has been supported by FWF (projects I1102 and I2854).

# Argumentation

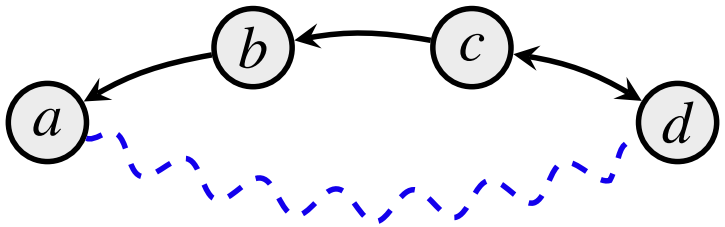



Natural Language Example, Is Death Penalty Legit?

# Abstract Argumentation



# Abstract Argumentation

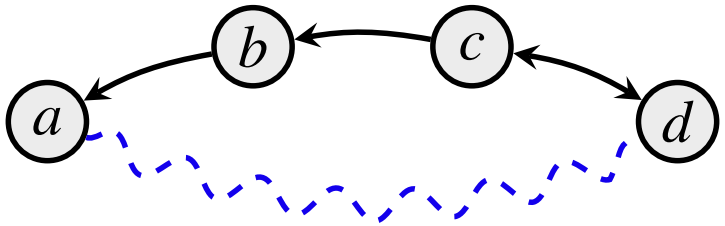



- Arguments: $a, b, c, d$
- Attacks: $(b, a), (c, b), (d, c), (c, d)$

## Definition (Abstract Argumentation, Syntax)

Argumentation Framework (AF): $F = (A, R)$
$A$: set of arguments
$R \subseteq A \times A$: set of attacks

# Abstract Argumentation



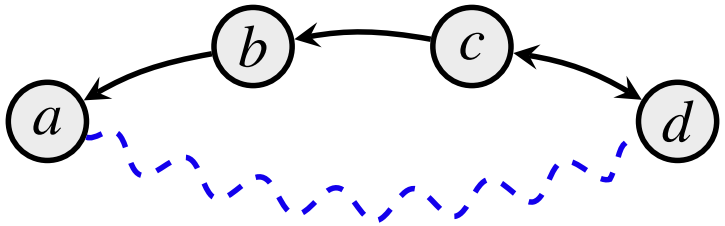

- Arguments: $a, b, c, d$
- Attacks: $(b, a), (c, b), (d, c), (c, d)$

- Conflicts: $[a, b], [b, c], [c, d]$

## Definition (Syntactic Conflict and Compatibility)

Syntactic Conflict, $[X, Y]_F$: $X$ attacks $Y$ or $Y$ attacks $X$
Syntactic Compatibility, $\{X, Y\}_F$: otherwise

# Abstract Argumentation

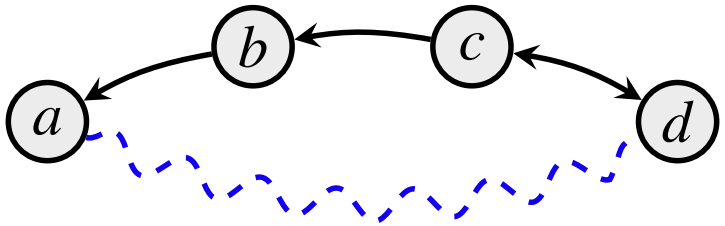



- Arguments: $a, b, c, d$
- Attacks: $(b, a), (c, b), (d, c), (c, d)$
- Extensions: $\{a, c\}, \{b, d\}$

## Definition (Argumentation Semantics)

Conflict-freeness, $S \in \mathit{cf}(F)$: $\{S, S\}_F$
Stable Extension, $S \in \mathit{sb}(F) \subseteq \mathit{cf}(F)$: $A \setminus S = \{x \in A \mid S \textit{ attacks } x\}$

# Abstract Argumentation

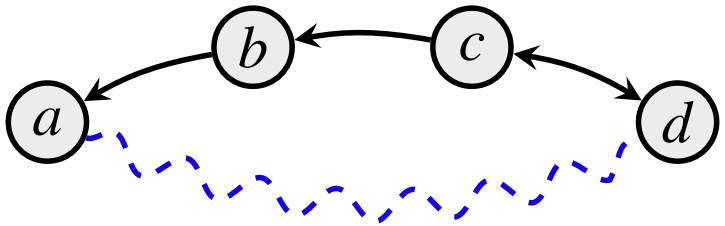



- Arguments: $a, b, c, d$
- Attacks: $(b, a), (c, b), (d, c), (c, d)$
- Extensions: $\{a, c\}, \{b, d\}$
- Conflicts: $[a, b], [b, c], [c, d], [a, d]$

## Definition (Semantic Conflict and Compatibility)

Semantic Compatibility, $\{X, Y\}_{\mathbb{S}}$: f.a. $x \in X, y \in Y$ ex. $S \in \mathbb{S}$, $\{x, y\} \subseteq S$
Semantic Conflict, $[X, Y]_{\mathbb{S}}$: otherwise

# Framework Modifications




- Arguments: $a, b, c, d$
- Attacks: $(b, a), (c, b), (d, c), (c, d)$
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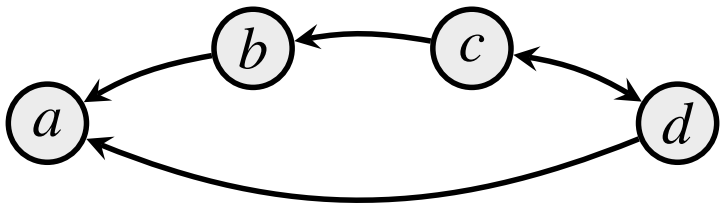
# Framework Modifications




- Arguments: $a, b, c, d$
- Attacks: $(b, a), (c, b), (d, c), (c, d), (d, a)$
- Extensions: $\{a, c\}, \{b, d\}$
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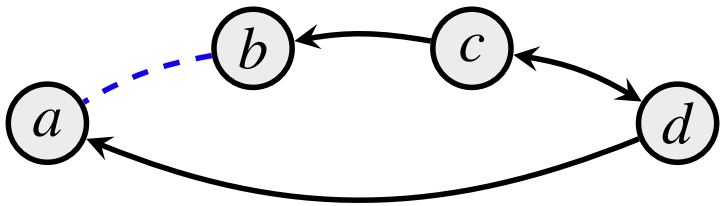
# Framework Modifications




- Arguments: $a, b, c, d$
- Attacks: ~~$(b, a)$~~, $(c, b)$, $(d, c)$, $(c, d)$,$(d, a)$
- Extensions: $\{a, c\}, \{b, d\}$
- Conflicts: $[a, b]$, $[b, c]$, $[c, d]$,$[a, d]$

# Realizability and Conflict

## Definition (Realizability)

$\mathbb{S}$ is $\sigma$-realizable if ex. AF $F$ with $\sigma(F) = \mathbb{S}$
$\mathbb{S}$ is $\sigma_A$-realizable if ex AF $F = (A, R)$ with $\sigma(F) = \mathbb{S}$

## Definition (Conflict)

A semantic conflict $[a, b]_{\mathbb{S}}$ is

- *pure* (semantic) if there is no realization $F$ with $[a, b]_F$;
- *necessary* (syntactic) if any realization $F$ has $[a, b]_F$;
- optional otherwise.

## Definition (Conditional Conflicts)

Extend pure, necessary and optional to $A$-realizability

# Levels of Conflict

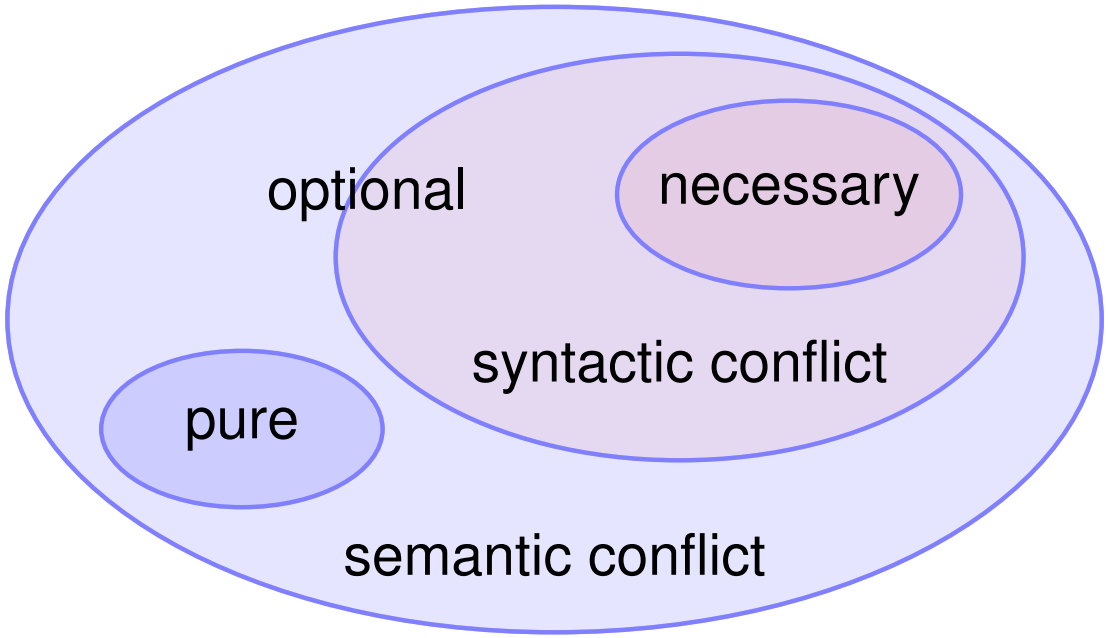
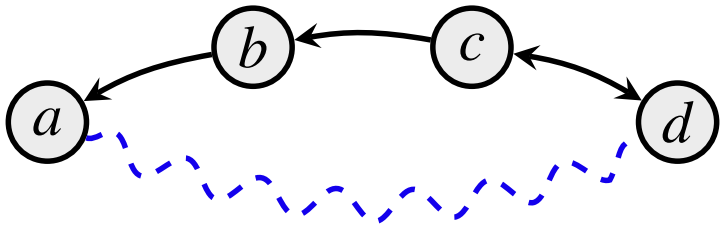



Figure : A Venn-diagram illustrating different levels of conflict.

# Arbitrary Modifications




- Arguments: $a, b, c, d$
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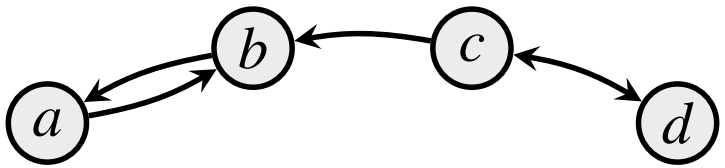
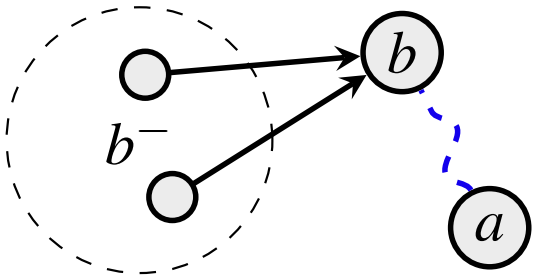
# Arbitrary Modifications

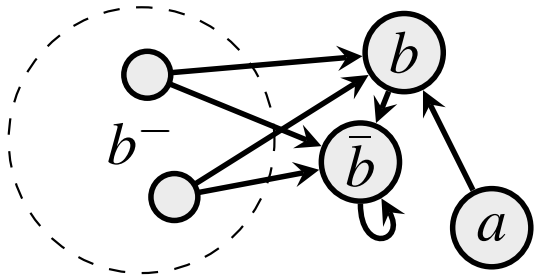



- Arguments: $a, b, c, d$
- Attacks: $(b, a), (c, b), (d, c), (c, d), (a, b)$
- Extensions: $\{a, c\}, \{b, d\}, \{a, d\}$
- Conflicts: $[a, b], [b, c], [c, d], \cancel{[a, d]}$

# Modifications for Stable Semantics

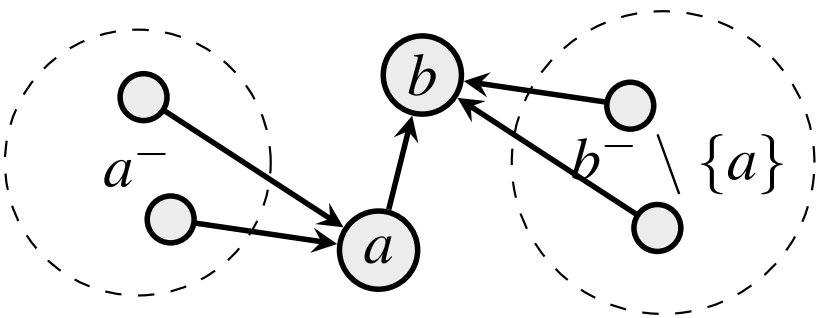



(a) Original AF, $[a, b]_{\mathbb{S}}$.

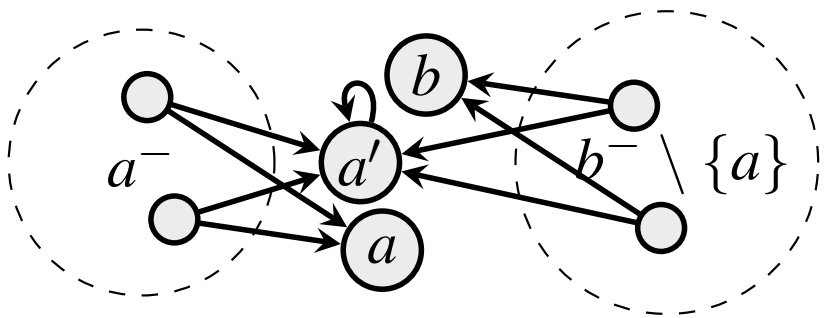



(b) Modified AF, $(a, b)_G$.

Figure : Forcing attacks for stable semantics.




(a) Original AF, $(a, b) \in R_F$.




(b) Modified AF, $(a, b) \notin R_G$.

Figure : Purging Attacks for Stable Semantics.

# Conflict Characterizations

## Theorem (Stable Conflicts)

$[a, b]_{\mathbb{S}}$ *is necessary attack* $(a, b)_F$ *for each sb-realization* $F$ *of* $\mathbb{S}$
*if and only if*
*there is* $S \in \mathbb{S}$, $a \in S$ *and* $\{b, S \setminus \{a\}\}_{\mathbb{S}}$.

*All other conflicts for sb are optional.*

# Illustration of Stable Modifications

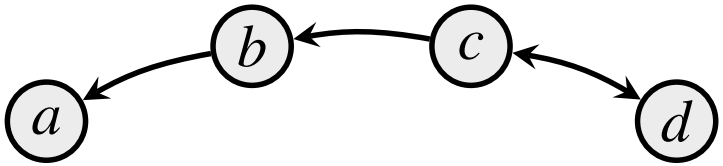
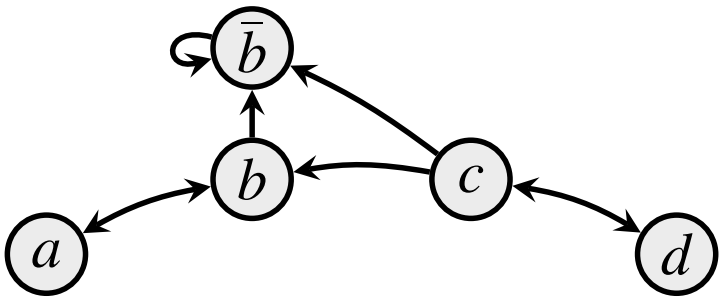
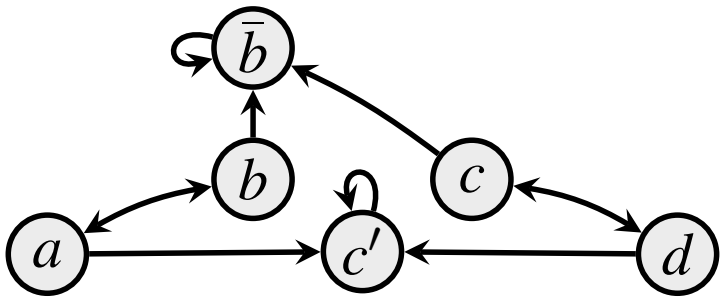



Figure : Original AF.

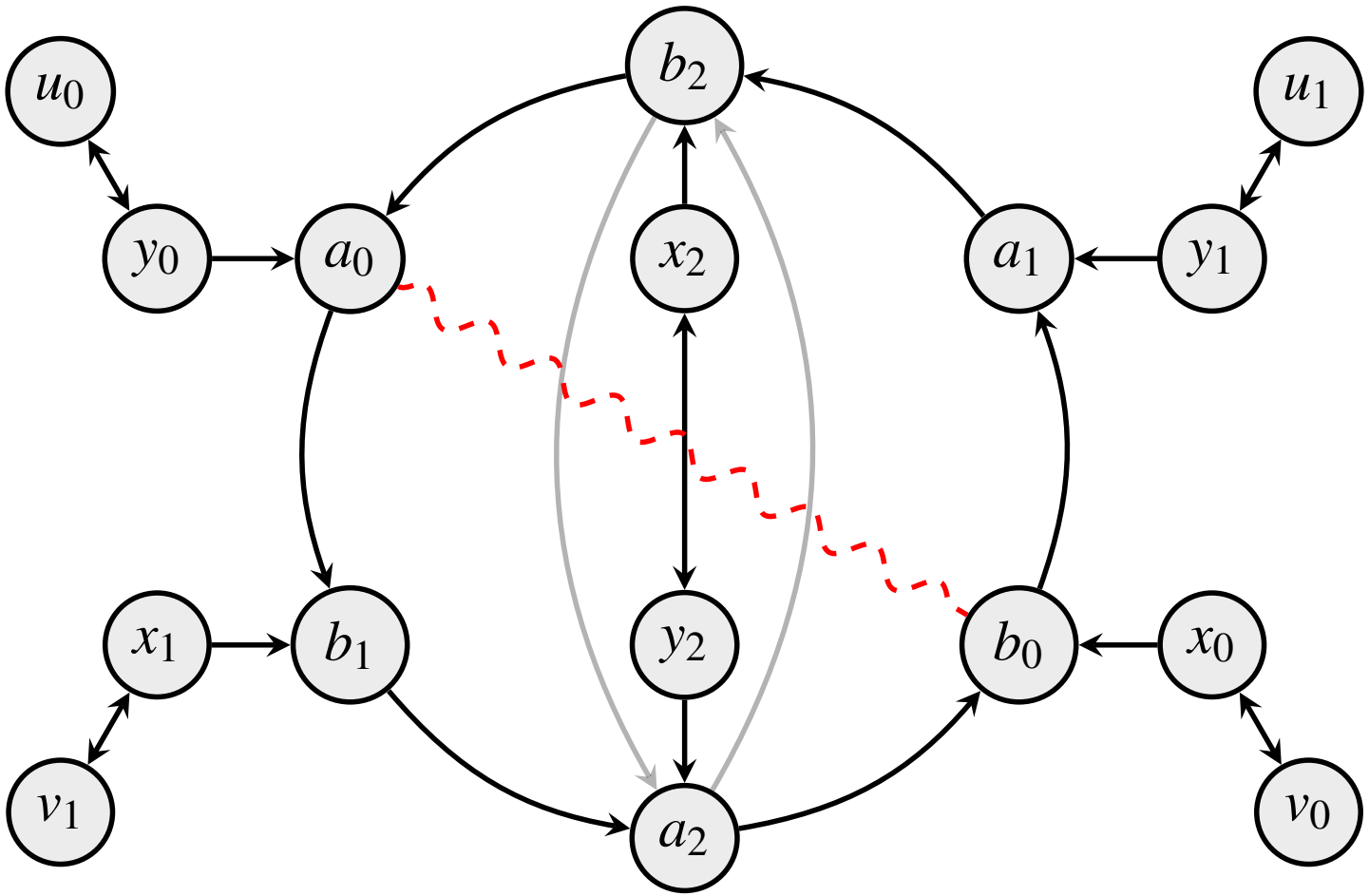



(a) Forcing Attack $(a, b)$

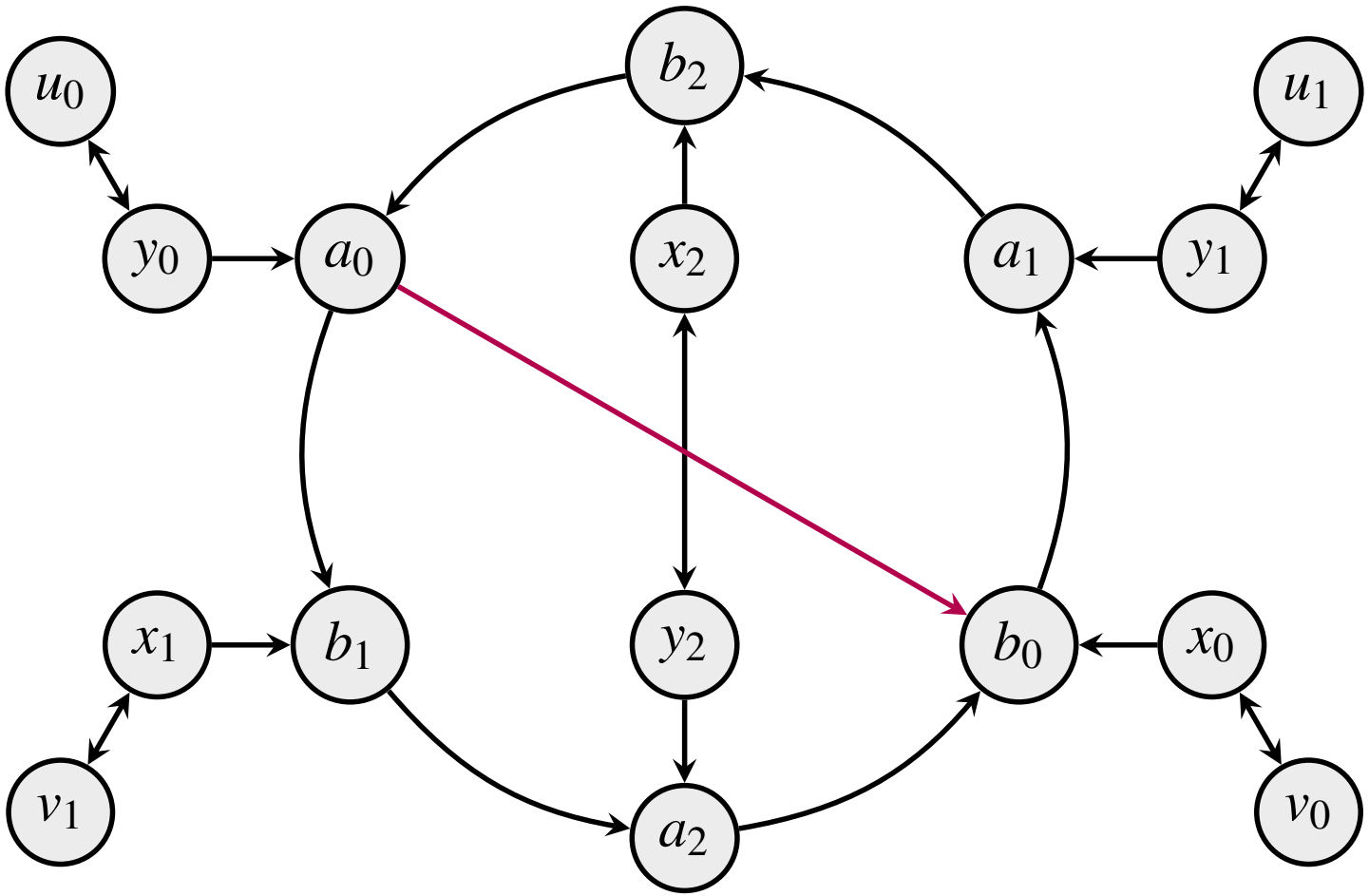



(b) Purging Attack $(c, b)$

# $A$-Purity

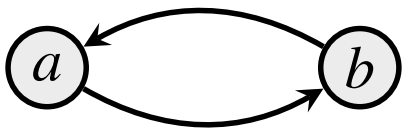


# $A$-Purity

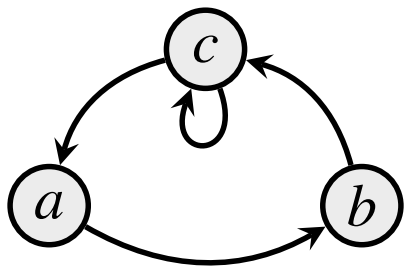


# Other Semantics

- Preferred and Semi-stable semantics have only symmetric necessary attacks $[a, b]$ where there are $S, T \in \mathbb{S}$ with $a \in S$, $b \in T$ and otherwise compatibilities $\{a, T \setminus \{b\}\}_{\mathbb{S}}$, $\{b, S \setminus \{a\}\}_{\mathbb{S}}$.
- Stage semantics has the same necessary conflicts as Stable, but without directions.
- Cf2 semantics probably has the same necessary conflicts as Stable, no necessary symmetric attacks but allows general pure conflicts.




(c) Symmetric Attack




(d) Directed Attack

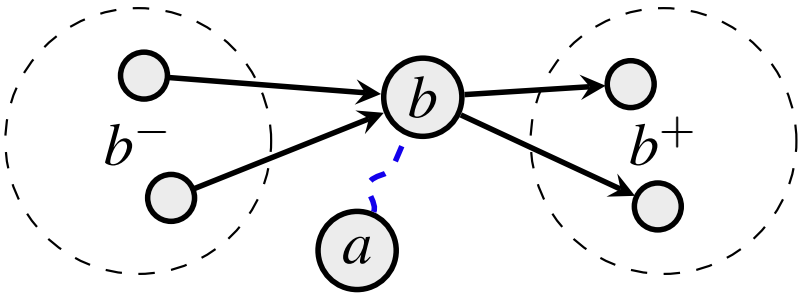
# Future Work, Open Questions

- Conditional Conflicts: exact characterizations for $A$-pure definitions, other conditions (arguments, attacks, extensions)
- Formal definition of attack-minimal AFs
- Other semantics, labellings, ...
- Instantiation-related questions; what does it mean to use such modifications?
- Other directions: Given some AF, which arguments necessarily are jointly acceptable? How can we detect semantic conflicts without computing all extensions?

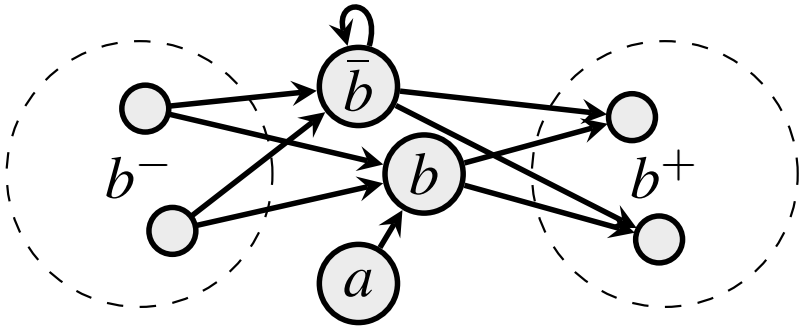
# References


- Baroni, P., Caminada, M., and Giacomin, M. (2011).
  An introduction to argumentation semantics.
  *Knowledge Eng. Review*, 26(4):365–410.
- Dung, P. M. (1995).
  On the Acceptability of Arguments and its Fundamental Role in Nonmonotonic Reasoning, Logic Programming and n-Person Games.
  *Artif. Intell.*, 77(2):321–358.
- Dunne, P. E., Dvořák, W., Linsbichler, T., and Woltran, S. (2015).
  Characteristics of multiple viewpoints in abstract argumentation.
  *Artif. Intell.*, 228:153–178.
- Linsbichler, T., Spanring, C., and Woltran, S. (2015).
  The Hidden Power of Abstract Argumentation Semantics.
  *The 2015 International Workshop on Theory and Applications of Formal Argument*.

# Preferred Modifications

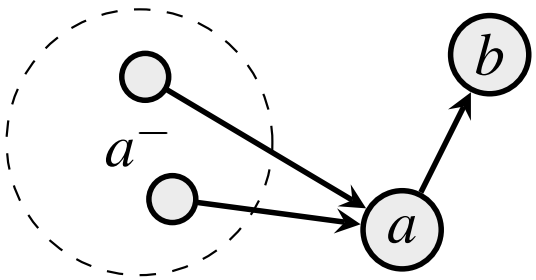



(e) Original AF, $[a, b]_{\mathbb{S}}$.




(f) Modified AF, $(a, b)_G$.

Figure : Forcing Attacks for Preferred Semantics.

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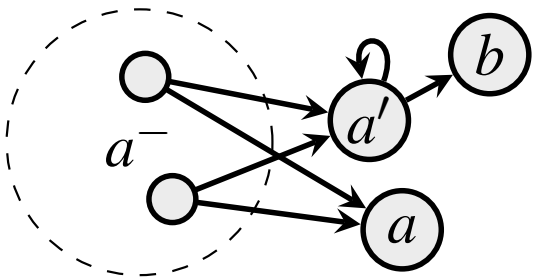
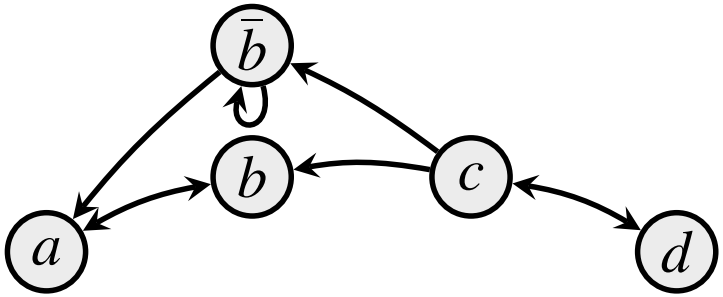



(b) Modified AF, $(a, b) \notin R_G$.

Figure : Purging Attacks for Preferred Semantics.

# Illustration of Preferred Modifications.

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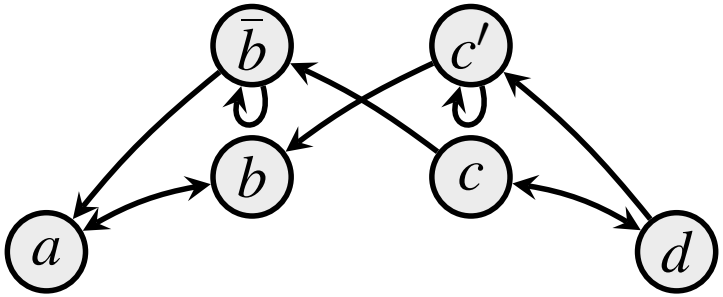
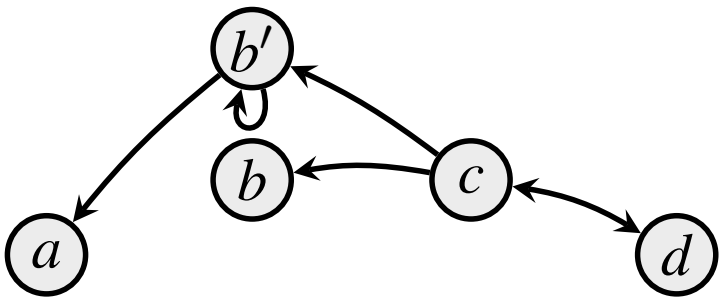
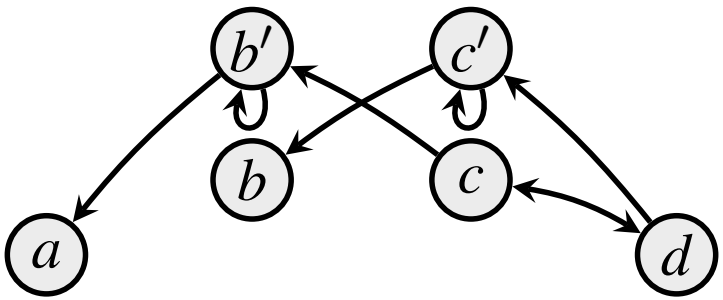



(b) Puring Attack $(c, b)$.

Figure : Analogy to Stable Illustration.




(a) Purging Attack $(a, b)$.




(b) Purging Attack $(c, b)$.

Figure : For an attack-minimal AF.