On the Instantiation of KBs in Abstract AFs

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Overview

- Paper accepted to CLIMA XIV session on argumentation.
- Motivating issues in instantiated AFs:
  - What are ''arguments'' and their relationships in AF terms?
  - How to address the Rationality Postulates?
  - How to simplify?
- Main idea:
  - translate KBs directly into AFs; no mediating 'argument' constructions.
  - 2 steps in analysis rather than 3.
- Some details of proposal and worked example.
- Three senses of ''argument'' (auxiliary issue).
- An ADF approach by Strass (2013) (comments).

Bit of Context

- Dungian arguments are abstract (*nodes*) in attack relations (*arcs*)
- Proposals to construct abstract argument from a KB - instantiated argumentation. ASPIC+, Logic-based, etc.
- Use 3 steps.
- Allow arguments with subarguments; unclarity about attacking subarguments; overgeneration.
- Issues about Rationality Postulates (ASPIC+):
  - Closure; Direct consistency; Indirect consistency.
  - Auxiliary definitions; restricted rebut (strict rules can only be rebutted where it is last rule of argument with a defeasible subargument).
- Unclear about *senses* of argument (Wyner et al. (2008, 2009)):
  - Argument: a single reasoning step from premises to claim.
  - Case: a train of arguments reasoning to a claim.
  - Debate: cases for and against a claim.

AFs that Wear the Logic on the Sleeves

- Conservative Dungian analysis: arcs and nodes; standard semantics; no auxiliary contributions to success of attacks.
- Address *Rationality Postulates* (consistency built in; closure by integrity constraint).
- Simplify steps: no need to pack/unpack 'arguments'; facilitates addition/removal/change in theories and AFs.
- Relate argument extensions to models of a theory.
- Account for partiality, e.g. get extensions of theories where there are premises that are not asserted.
- Clarify *senses* of argument (Wyner et al. (2008)).

Three Steps v. Two Steps

Knowledge Base → Argumentation Framework → Extensions of Arguments → Extensions of Conclusions

Step 1: construct arguments and attacks

Step 2: identify sets of accepted arguments

Step 3: identify sets of accepted conclusions

Caminada and Wu (2011)
'arguments' as complex premise-claim constructions

Knowledge Base → Argumentation Framework → Extensions of Arguments

Step 1: construct arguments and attacks

Step 2: identify sets of accepted arguments

Wyner, Bench-Capon, and Dunne (2013)
'arguments' as nodes in graph correlating to KB.

Given a Theory Base

Definition 3. *A* Theory Base, $\mathcal{T}$, *comprises a pair* $(\mathcal{L}, \mathcal{R})$ *in which*

$$\mathcal{L} = \{x_1, \ldots, x_n\} \cup \{\neg x_1, \ldots, \neg x_n\}$$

is a set of literals over a set of propositional variables $\{x_1, \ldots, x_n\}$. *We use* y_i *to denote an arbitrary literal from* $\{x_i, \neg x_i\}$.

We have a set of proper names *of rules* $\{r_1, r_2, \ldots, r_n\}$. *Rules are either strict* ($r \in \mathcal{R}_{str}$) *or defeasible* ($r \in \mathcal{R}_{dfs}$), *and* $\mathcal{R}_{str} \cap \mathcal{R}_{dfs} = \emptyset$. $\mathcal{R} = \mathcal{R}_{str} \cup \mathcal{R}_{dfs}$ *where*

$$\mathcal{R} = \{r_1, r_2, \ldots, r_n\}$$

in which $r \in \mathcal{R}$ *has a body,* $bd(r) \subseteq \mathcal{L}$, *and a head,* $hd(r) \in \mathcal{L}$.

Classical negation.
Heads can be positive or negative (not *Horn* clauses).

Derive Nodes (L) for an AF

Definition 5. *Let $\mathcal{T} = (\mathcal{L}, \mathcal{R})$ be a Theory Base with*

$$\begin{aligned} \mathcal{L} &= \{x_1, \ldots, x_n\} \cup \{\neg x_1, \ldots, \neg x_n\} \\ \mathcal{R} &= \mathcal{R}_{str} \cup \mathcal{R}_{dfs} \end{aligned}$$

The derived framework *from $\mathcal{T}$, is the* AF, $\langle \mathcal{L}^A_\mathcal{T}, \mathcal{R}^A_\mathcal{T} \rangle$ *in which,*

$$\begin{aligned} \mathcal{L}^A_\mathcal{T} = & \{ \mathsf{x}, \neg\mathsf{x} : x, \neg x \in \mathcal{L}\} \\ & \cup \{ \mathsf{r : bd(r) \rightarrow hd(r)} : r \in \mathcal{R}_{str}\} \\ & \cup \{ \mathsf{r : bd(r) \Rightarrow hd(r)} : r \in \mathcal{R}_{dfs}\} \end{aligned}$$

Furthermore,

$$\forall \mathsf{x} \in \mathcal{L}^A_\mathcal{T}, x \in \mathcal{L}, \text{ and}$$
$$\forall \mathsf{r} \in \mathcal{L}^A_\mathcal{T}, r \in \mathcal{R}$$

Have positive and negative literals.
As in the Theory Base, literals occur once in the AF.
Use elements of Theory Base as labels on AF nodes

Derive Attacks (R) for an AF

Definition 6. *In the* AF $\langle \mathcal{L}^A_T, \mathcal{R}^A_T \rangle$, $\mathcal{R}^A_T = \mathcal{R}^A_{ll} \cup \mathcal{R}^A_{lr} \cup \mathcal{R}^A_{rl}$ *where:*

$$\begin{aligned}
\mathcal{R}^A_{ll} &= \{\langle \mathbf{y}_i, \neg \mathbf{y}_i \rangle, \langle \neg \mathbf{y}_i, \mathbf{y}_i \rangle \ : \ 1 \leq i \leq n \\
&\quad \mathit{and}\ \mathbf{y}_i, \neg \mathbf{y}_i \in \mathcal{L}^A_T\} \\
\mathcal{R}^A_{lr} &= \{\langle \neg \mathbf{y}_i, \mathbf{r}_j \rangle \ : \ y_i \in bd(r_j)\ \mathit{and}\ \neg \mathbf{y}_i, \mathbf{r}_j \in \mathcal{L}^A_T\} \\
&\quad \cup \{\langle \neg \mathbf{y}_i, \mathbf{r}_j \rangle \ : \ r_j \in \mathcal{R}_{dfs}\ \mathit{and}\ hd(r_j) = y_i \\
&\quad \mathit{and}\ \neg \mathbf{y}_i \in \mathcal{L}^A_T\} \\
\mathcal{R}^A_{rl} &= \{\langle \mathbf{r}_j, \neg \mathbf{y}_i \rangle \ : \ hd(r_j) = y_i\ \mathit{and}\ \neg \mathbf{y}_i, \mathbf{r}_j \in \mathcal{L}^A_T\}
\end{aligned}$$

Positive and negative literals attack one another.
Negative literal of body attacks rule.
Negative literal of head of defeasible rule attacks rule.
Rule attacks negative literal of head.

Dungian Semantics with an Integrity Constraint

Standard Dungian Semantics.
As positive and negative literals attack one another,
no admissible extension can have both.

-- *Direct and Indirect Consistency Built In* --

Constraint 5 *Consider: a, an admissible set of the derived* AF $\langle \mathcal{L}^A_T, \mathcal{R}^A_T \rangle$*;* $\mathcal{A}$*, the set of admissible sets a; and* $\mathcal{R}_{str} \subseteq \mathcal{L}^A_T$*. For every* $r \in \mathcal{R}_{str}$ *and every* $a \in \mathcal{A}$*, if* $r \in a$ *and every* $bd(r) \in a$ *, then* $hd(r) \in a$*.*

Definition 7. *An admissible set of the derived* AF $\langle \mathcal{L}^A_T, \mathcal{R}^A_T \rangle$ *is a* Well-formed Admissible Set *(WFAS) iff it satisfies Constraint 5.*

Extensions are not homogeneous – contain literals and rules.

-- *Closure of Strict Rules* --

A Strict Rule – Theory Base and AF

Example 1. Let $\mathcal{T}_1$ be the pair with $(\mathcal{L}_1, \mathcal{R}_1)$, where

$$\begin{aligned} \mathcal{L}_1 &= \{x_1, x_2\} \cup \{\neg x_1, \neg x_2\} \\ \mathcal{R}_1 &= \{r_1\},\ where\ r_1\ has\ rule\ name\ r_1 : x_1 \rightarrow x_2 \end{aligned}$$

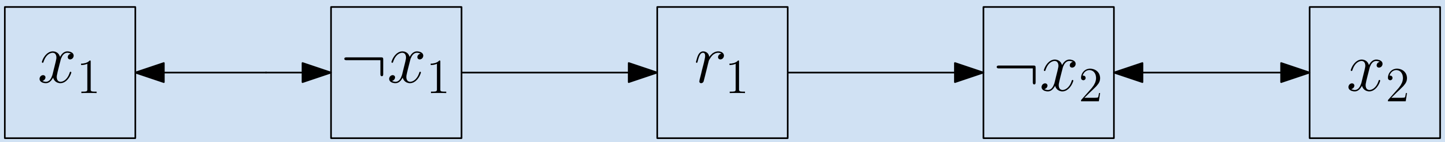
The *derived framework* from $\mathcal{T}_1$ is $\langle \mathcal{L}^A_{\mathcal{T}_1}, \mathcal{R}^A_{\mathcal{T}_1} \rangle$ in which,

$$\mathcal{L}^A_{\mathcal{T}_1} = \{x_1, x_2\} \cup \{\neg x_1, \neg x_2\} \cup \{r_1\}$$

and in which $\mathcal{R}^A_{\mathcal{T}_1}$ comprises the union of three disjoint sets:

$$\begin{aligned} \mathcal{R}^A_{ll} &= \{\langle x_1, \neg x_1\rangle, \langle \neg x_1, x_1\rangle, \langle x_2, \neg x_2\rangle, \langle \neg x_2, x_2\rangle\} \\ \mathcal{R}^A_{lr} &= \{\langle \neg x_1, r_1\rangle\} \\ \mathcal{R}^A_{rl} &= \{\langle r_1, \neg x_2\rangle\} \end{aligned}$$

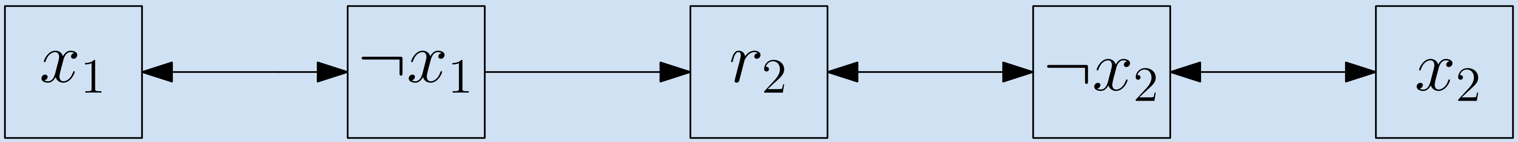
A Strict Rule – Graph and Extensions



$$\{x_1, r_1, x_2\}, \{\neg x_1, x_2\}, \{\neg x_1, \neg x_2\}$$

- Get extensions even where *we just have the rule* (unlike other approaches).
- Presence of rule in extensions is understood to mean that the rule has *applied*.
- With respect to literals, extensions correlate with models of the Theory Base.

A Defeasible Rule – Graph and Extensions



$$\{x_1, r_2, x_2\}, \{\neg x_1, x_2\}, \{\neg x_1, \neg x_2\}, \{x_1, \neg x_2\}$$

Where one has a Theory Base/AF with several strict and defeasible rules, may use the presence of rules in the extensions to decide which extension is chosen, e.g., choose the extension with the most defeasible rules.

Extensions with Partial Theories

- What to do with a theory that has no assertion for a premise of a rule?
- Cannot construct an argument in such a case in ASPIC:
  - base of definition of argument: body-less rules are arguments; a rule with premises is an argument where the premises are arguments.
- Not a problem here.
- Theory Base: -> x_1, r_1: x_1, x_3 -> x_2
- Extensions: $\{x_1, x_3, r_1, x_2\}, \{x_1, \neg x_3, x_2\}, \{x_1, \neg x_3, \neg x_2\}$
- Useful in reasoning with Dungian Semantics in partial theories.

To Problem Case – ASPIC Argument Construction

Definition 8. *(Argument) Suppose a* Theory Base, $\mathcal{T}$, *with strict and defeasible rules. An argument* A *is:*

$A_1, \ldots, A_n \longrightarrow \psi$ *if* $A_1, \ldots, A_n$, *with* $n \geq 0$, *are arguments such that there exists a strict rule* $\texttt{Conc}(A_1), \ldots, \texttt{Conc}(A_n) \rightarrow \psi$.

$\texttt{Prem}(A) = \texttt{Prem}(A_1) \cup \ldots \cup \texttt{Prem}(A_n)$,

$\texttt{Conc}(A) = \psi$,

$\texttt{Sub}(A) = \texttt{Sub}(A_1) \cup \ldots \cup \texttt{Sub}(A_n) \cup \{A\}$,

$\texttt{DefRules}(A) = \texttt{DefRules}(A_1) \cup \ldots \cup \texttt{DefRules}(A_n)$

$\texttt{TopRule}(A) = \texttt{Conc}(A_1), \ldots, \texttt{Conc}(A_n) \rightarrow \psi$

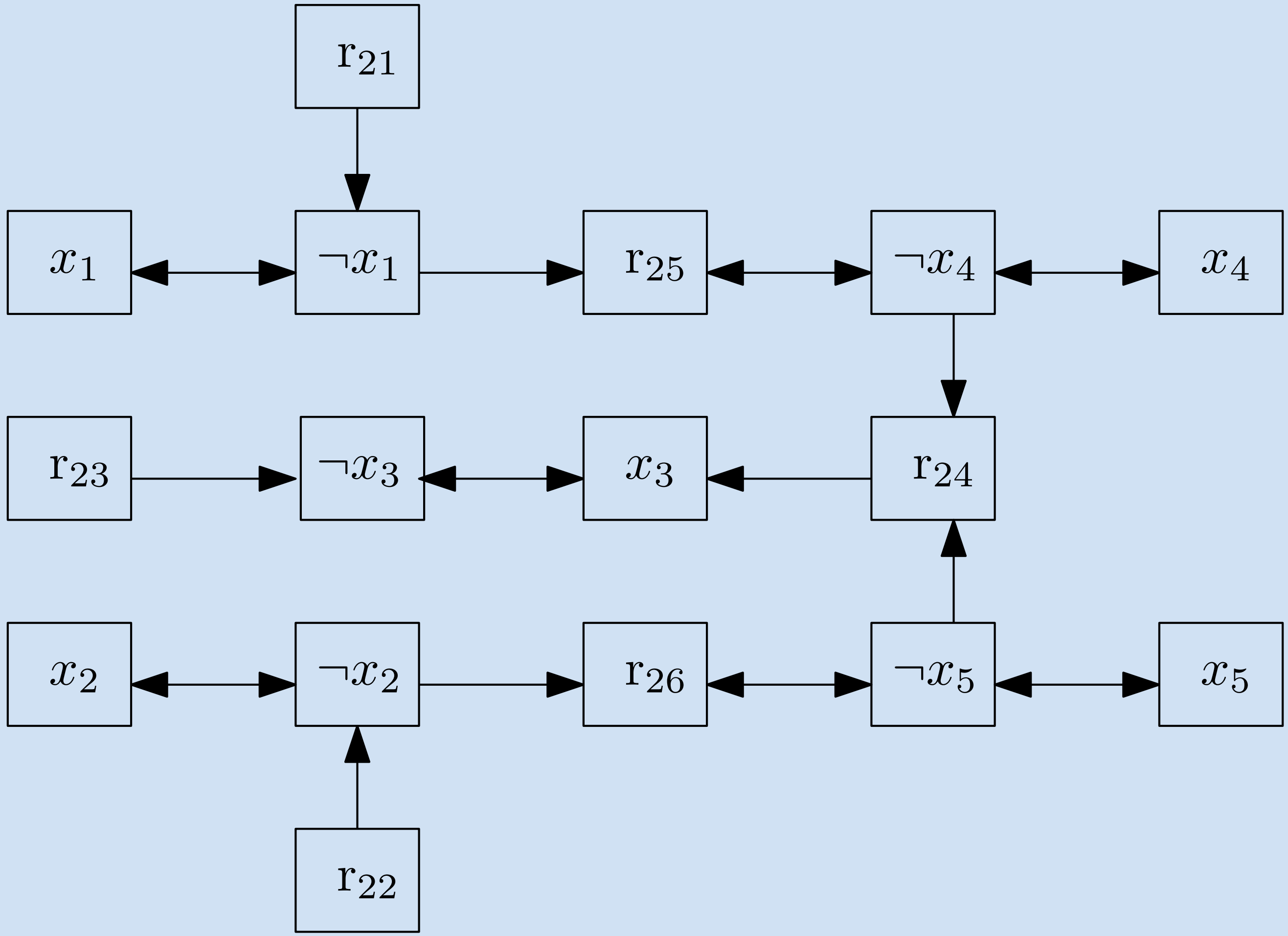
Problematic Example

Example 4. Let $\mathcal{T}_4$ be a Theory Base with the following rules:
$r_{21}: \rightarrow x_1$; $r_{22}: \rightarrow x_2$; $r_{23}: \rightarrow x_3$; $r_{24}: x_4, x_5 \rightarrow \neg x_3$; $r_{25}: x_1 \Rightarrow x_4$; $r_{26}: x_2 \Rightarrow x_5$.
We construct the following arguments:
A_1: $[[\rightarrow x_1] \Rightarrow x_4]$; A_2: $[[\rightarrow x_2] \Rightarrow x_5]$; A_3: $[\rightarrow x_3]$;
A_4: $[\rightarrow x_1]$; A_5: $[\rightarrow x_2]$;
A_6: $[[\rightarrow x_1] \Rightarrow x_4], [[\rightarrow x_2] \Rightarrow x_5] \rightarrow \neg x_3$.

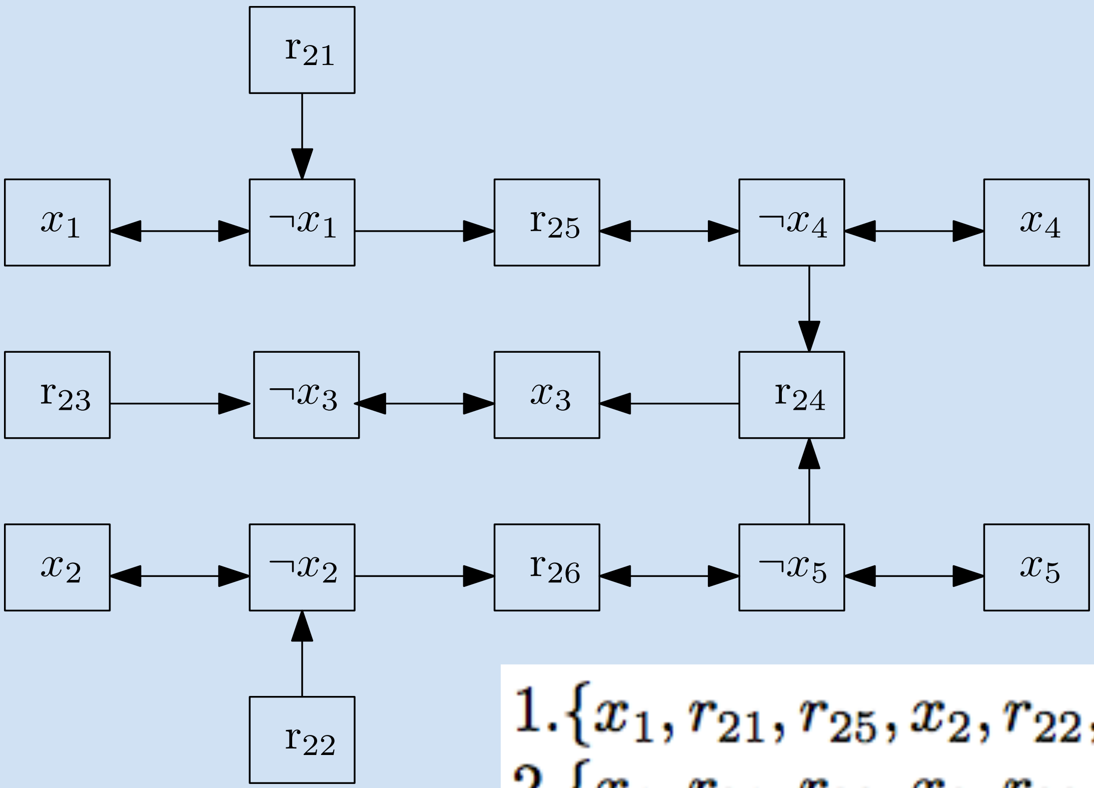
- An argument is strict if it has no defeasible subarguments.
- A strict argument can defeat a defeasible argument, but not vice versa.
- Defeat of a subargument is 'inherited' as defeat of the argument.

Problem: $-x_3$ should be a justified conclusion as the conclusion of a strict rule where all the premises are justified conclusions. Yet, A_6 is defeasible, while A_3 is strict, so A_3 defeats A_6, and we do not yield $-x_3$. Does not satisfy the intuition there should be closure of strict rules.

AF Derived from Theory Base



Extensions

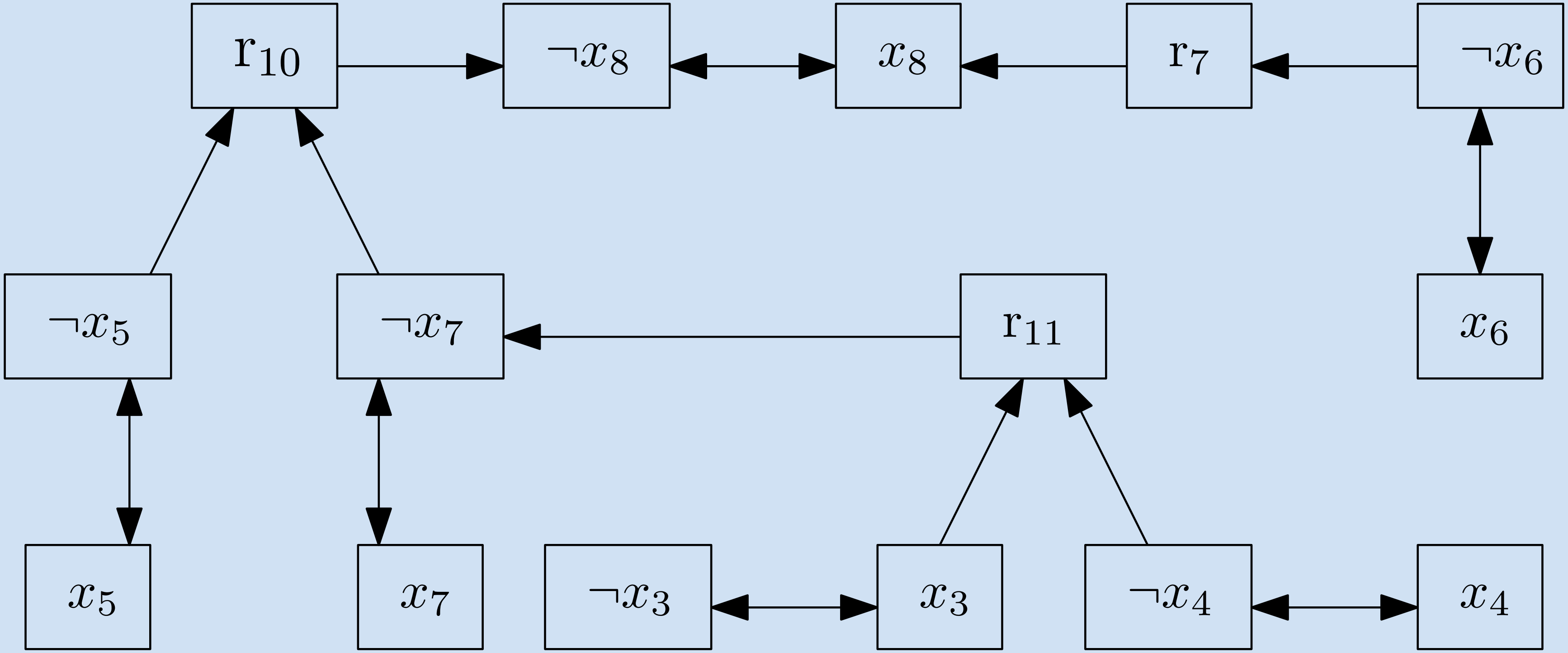


r_{24} does not apply

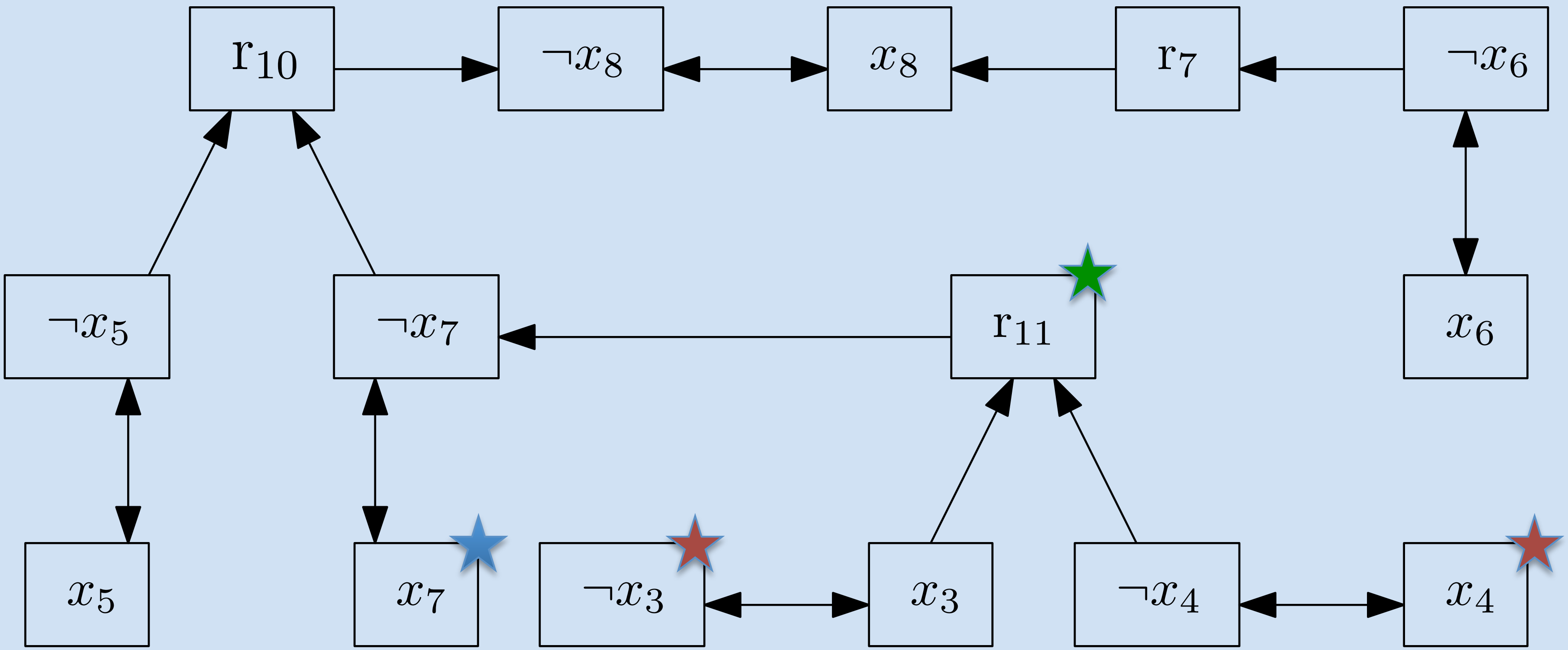
1. $\{x_1, r_{21}, r_{25}, x_2, r_{22}, x_3, x_4, r_{25}, \neg x_5\}$
2. $\{x_1, r_{21}, r_{23}, x_2, r_{22}, x_3, \neg x_4, x_5, r_{26}\}$
3. $\{x_1, r_{21}, r_{23}, x_2, r_{22}, x_3, \neg x_4, \neg x_5\}$
4. $\{x_1, r_{21}, r_{23}, r_{25}, x_2, r_{22}, r_{24}, r_{26}, x_4, x_5\}$

Not a Well-formed Admissible Set.

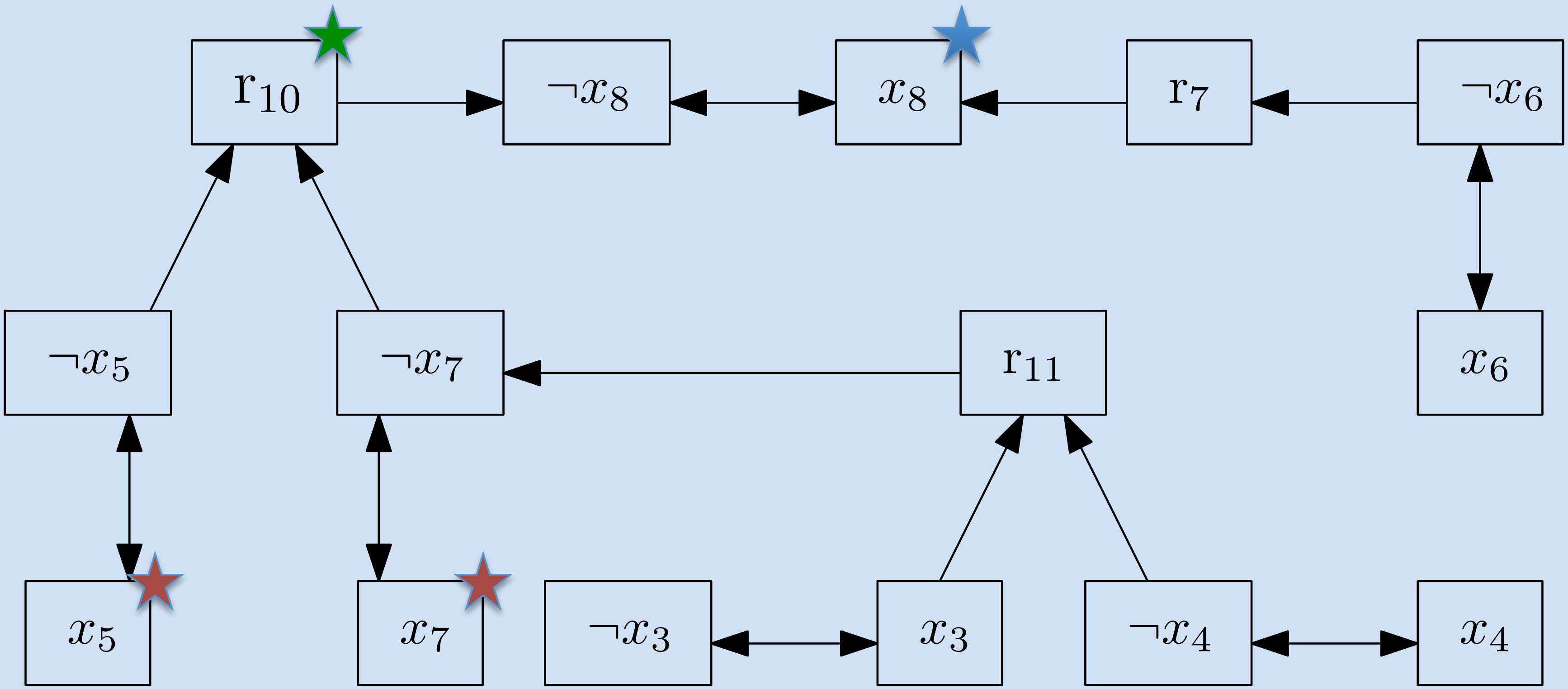
Arguments, Cases, Debates



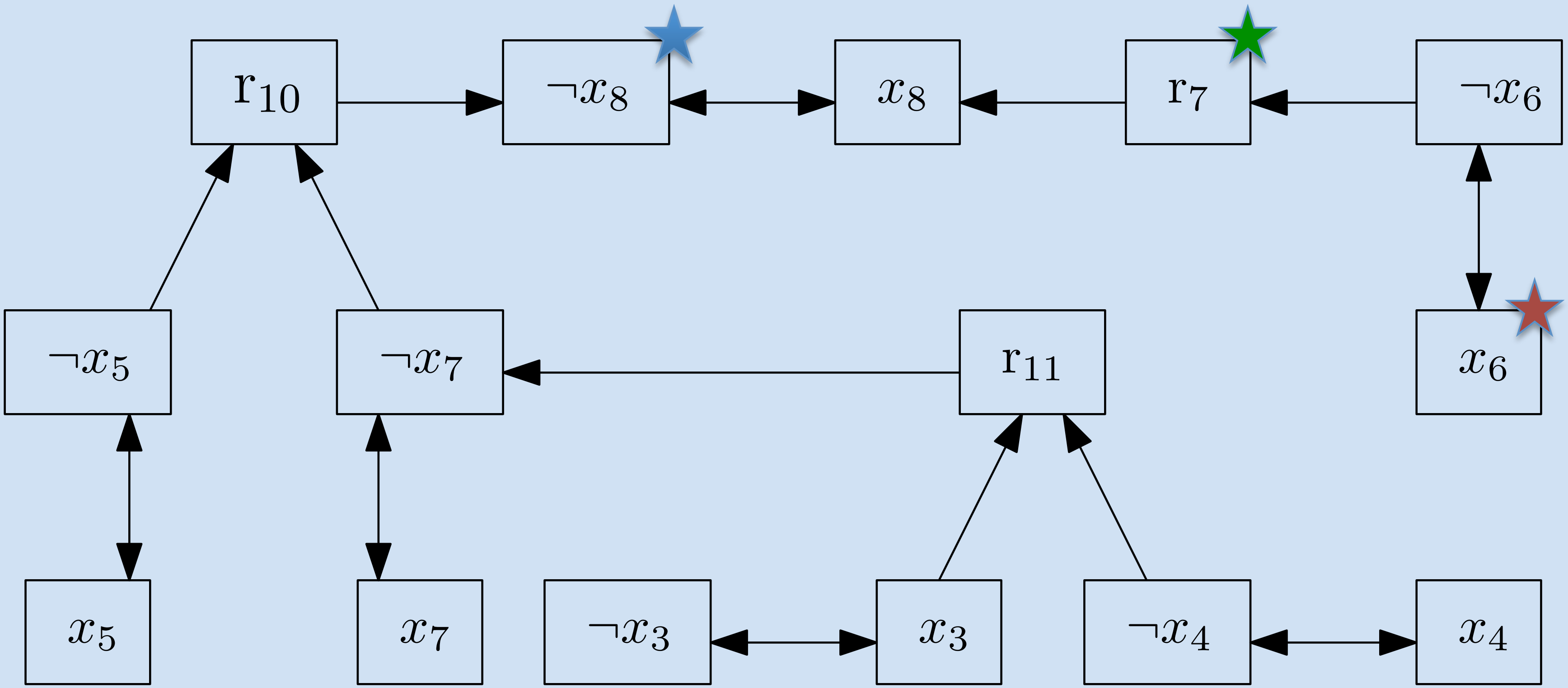
Argument 1 for x_7



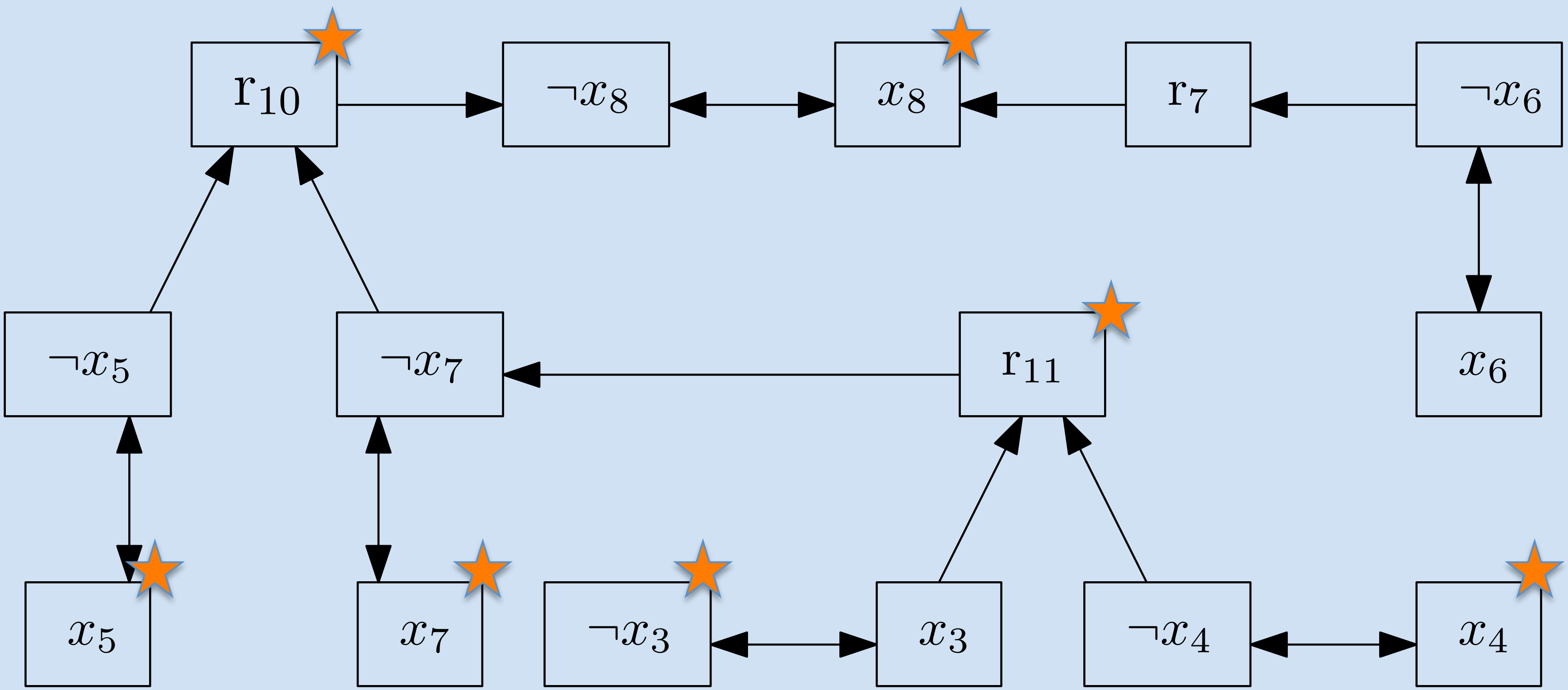
Argument 2 for x_8



Argument 3 against x_8

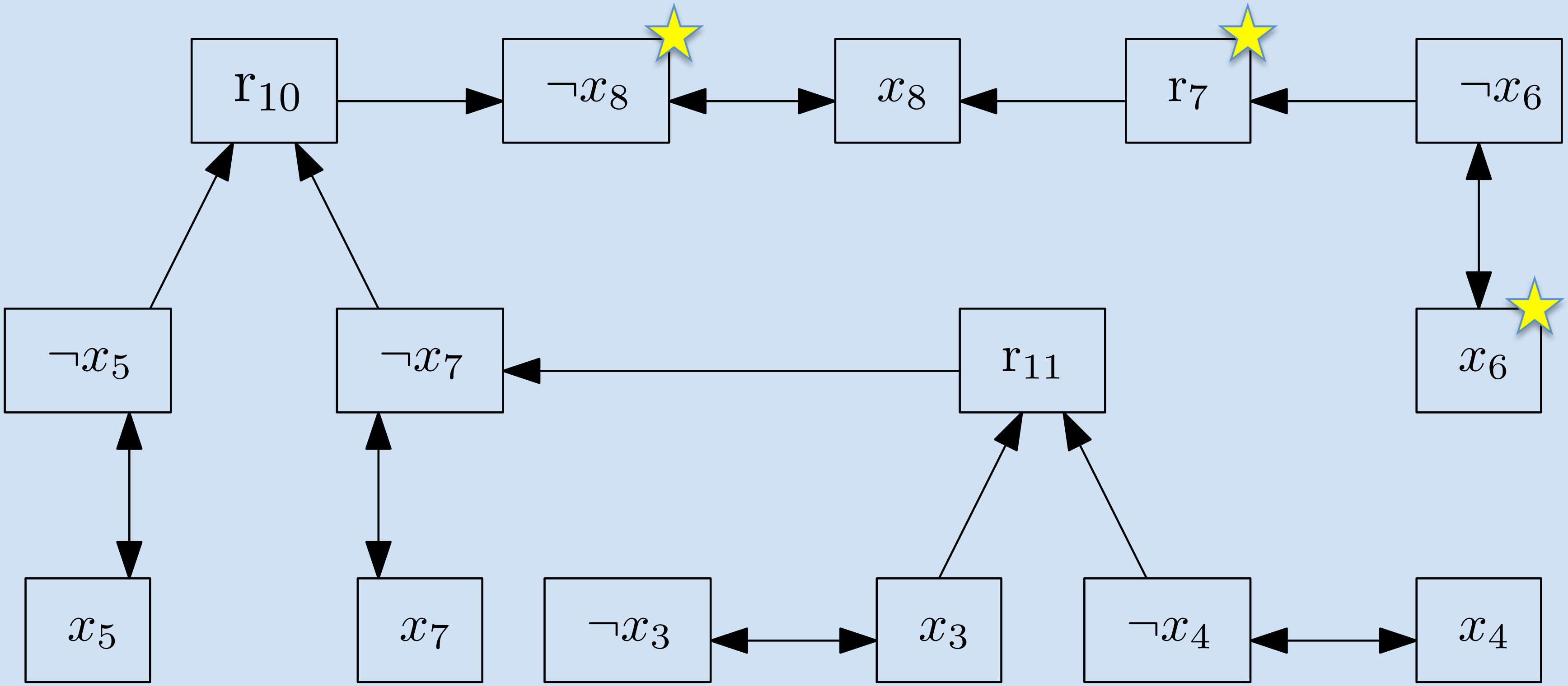


Case 1 for x_8

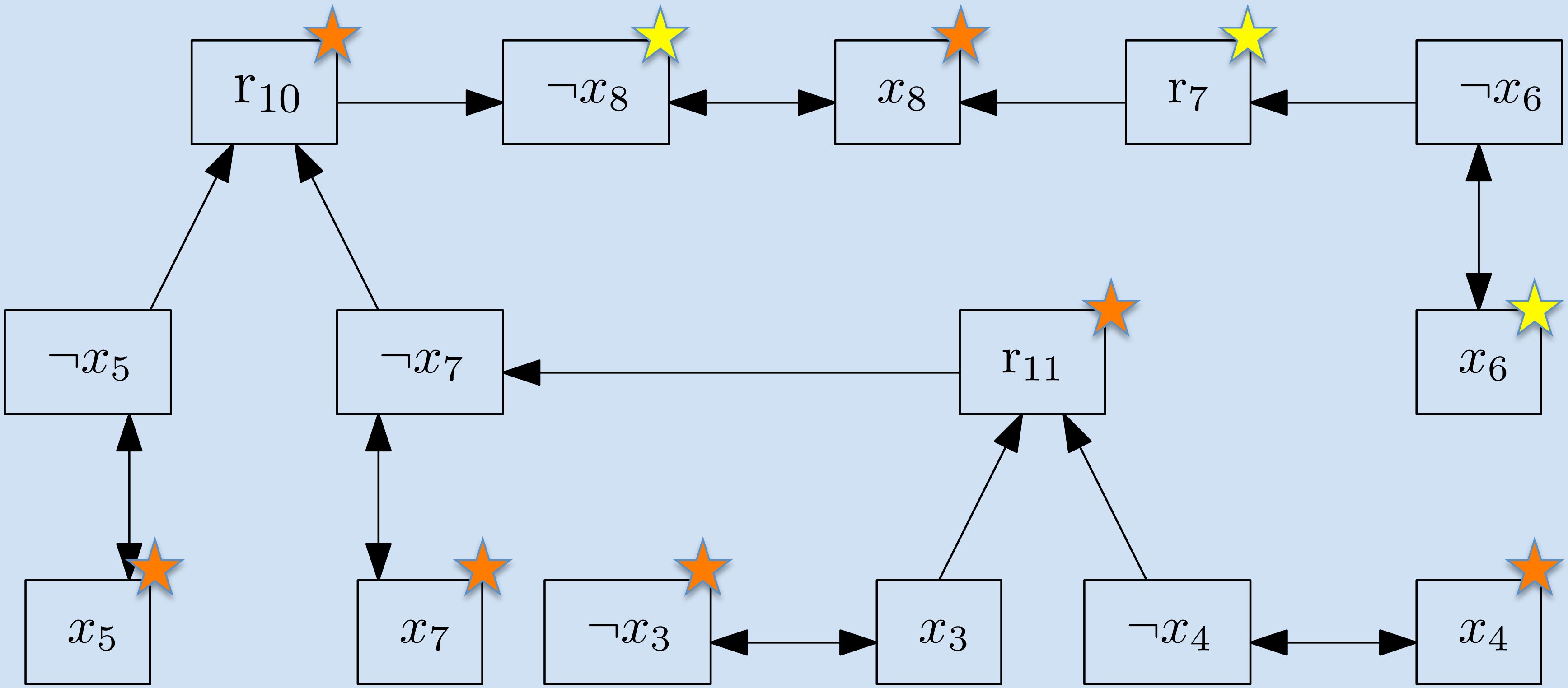


r_{10}
$\neg x_8$
x_8
r_7
$\neg x_6$
$\neg x_5$
$\neg x_7$
r_{11}
x_6
x_5
x_7
$\neg x_3$
x_3
$\neg x_4$
x_4

Case 2 against x_8



Debate for and against x_8

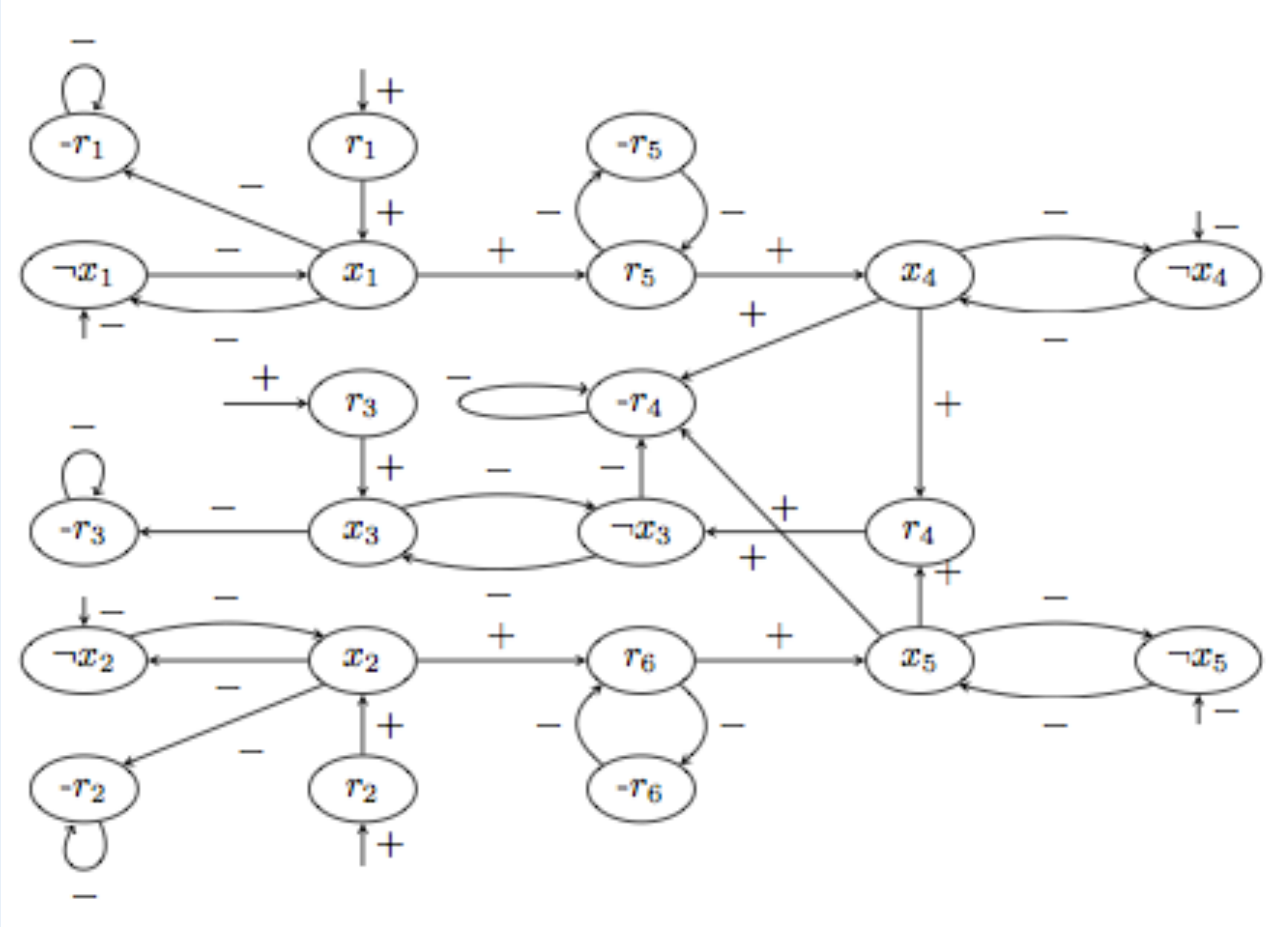


Abstract Dialectical Frameworks – Strass (2013)

- Points out that Wyner et al. (2009) allows the undesireable extension of worked example. Fixed in Wyner et al. (2013).
- Adapts the proposal to an ADF approach.
- ADF more *general* than AFs.
- ADF definitions – statements, links, and acceptance functions (determines when child is acceptable relative to parents).
- Has *attack* and *support*.
- Integrity constraint.
- Negation of literals (closed world) and of rules (inapplicable?).
- Same worked example.

Example in ADF

+ is support;
- is attack.



Acceptance Condition Functions, Then Evaluation

Example 3 (Continued). Definition 4 yields the following acceptance formulas.

$$\varphi_{x_1} = \neg[\neg x_1] \wedge [r_1] \qquad \varphi_{x_2} = \neg[\neg x_2] \wedge [r_2] \qquad \varphi_{x_3} = \neg[\neg x_3] \wedge [r_3]$$

$$\varphi_{x_4} = \neg[\neg x_4] \wedge [r_5] \qquad \varphi_{x_5} = \neg[\neg x_5] \wedge [r_6]$$

$$\varphi_{\neg x_1} = \bot \quad \varphi_{\neg x_2} = \bot \qquad \varphi_{\neg x_3} = \neg[x_3] \wedge [r_4] \qquad \varphi_{\neg x_4} = \bot \quad \varphi_{\neg x_5} = \bot$$

$$\varphi_{r_1} = \top \quad \varphi_{r_2} = \top \qquad \varphi_{r_3} = \top \qquad \varphi_{r_4} = [x_4] \wedge [x_5]$$

$$\varphi_{r_5} = [x_1] \wedge \neg[\neg x_4] \wedge \neg[\text{-}r_5] \qquad \varphi_{r_6} = [x_2] \wedge \neg[\neg x_5] \wedge \neg[\text{-}r_6]$$

$$\varphi_{\text{-}r_1} = \neg[x_1] \wedge \neg[\text{-}r_1] \qquad \varphi_{\text{-}r_2} = \neg[x_2] \wedge \neg[\text{-}r_2] \qquad \varphi_{\text{-}r_3} = \neg[x_3] \wedge \neg[\text{-}r_3]$$

$$\varphi_{\text{-}r_4} = [x_4] \wedge [x_5] \wedge \neg[\neg x_3] \wedge \neg[\text{-}r_4] \qquad \varphi_{\text{-}r_5} = \neg[r_5] \quad \varphi_{\text{-}r_6} = \neg[r_6]$$

An *outie approach* in which successful 'attack' or 'support' is mediated by a separate component. Others – preferences and values. Very powerful and (too?) expressive.

V.

An *innie approach* in which Dungian attack is all.

Questions on ADF Approach

- While a more *general* can be an advantage, an approach should be *best fit for purpose*.
- Supports (difference between premise and 'other reasons'?).
- Self-support, where a literal only has itself in its acceptance function (means what in classical logic?).
- Rule negation (OK, but this way? Could be 'ab' as in Wyner et al. (2009)).
- Represent 'senses of argument'?
- Main difference is in acceptance conditions, which could be used in a variety of ways to augment the graph.

Future Work

- Back to basics to reconstruct theory from ground up more systematically – models, proofs, complexity....
- Further examples.
- Add auxiliary reasoning, e.g. preferences and values.
- Compare further to ADFs.
- Link to paper:
  - http://wyner.info/LanguageLogicLawSoftware/?p=1858

Thanks for your attention!

- Appreciation to Federico Cerutti for discussions.
- Questions?
- Contacts:

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