A dynamic approach for combining abstract argumentation semantics

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Motivations

- Increasing number of semantics: 16 different semantics described in the Handbook of Formal Argumentation.
- Diversity is good, but how to choose?
- Principle-based approaches help, but sometimes no semantics fits perfectly.

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We propose a formal framework for dynamically combining argumentation semantics.

Update semantics

Direct Semantics

From unlabelled to fully labelled frameworks in a single step.

Update semantics

We decompose this relation into a more fine-grained one, while respecting the principles of:

- Monotonic precision increase
- Reachable fixpoints are fully labelled

$$LAF_1 \longrightarrow LAF_2 \longrightarrow \cdots \longrightarrow LAF_f \circlearrowleft$$

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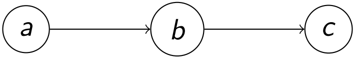
We say that an update semantics *gives rise to* a direct semantics iff the reachable fixpoints correspond exactly to the direct labellings.

Preliminaries

Abstract Argumentation Framework

A pair (A, R):

- A: a set of *abstract* arguments;
- $R \subseteq A \times A$: a relation of *attack* between arguments.



Labellings

Labels

Assign a single label to each argument:

- in for accepted
- out for rejected
- undec for undecided

Semantics

Admissibility

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Labelling-based abstract argumentation semantics

Attach a label to every argument

- Complete: admissible + contains all arguments it defends
- Grounded: Complete + minimal *in*
- Preferred: Complete + maximal *in*

A concrete update semantics

The step_grounded semantics

Procedure:

1. Look for unlabelled arguments with all attackers out, make them in and anything they attack out;
2. Otherwise, label all remaining arguments undec.

A concrete update semantics

The step_grounded semantics

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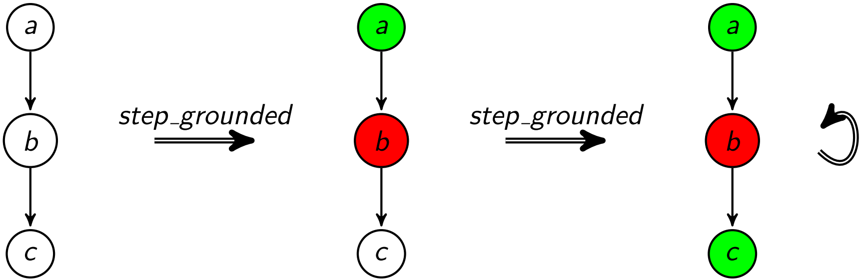
Theorem 1

step_grounded is an update semantics which gives rise to the grounded semantics.

Example



Towards a step_preferred semantics

Minimal admissible sets

- Admissible;
- Non-empty;
- Unlabelled;
- Minimally so.

Second update semantics

The step_preferred semantics

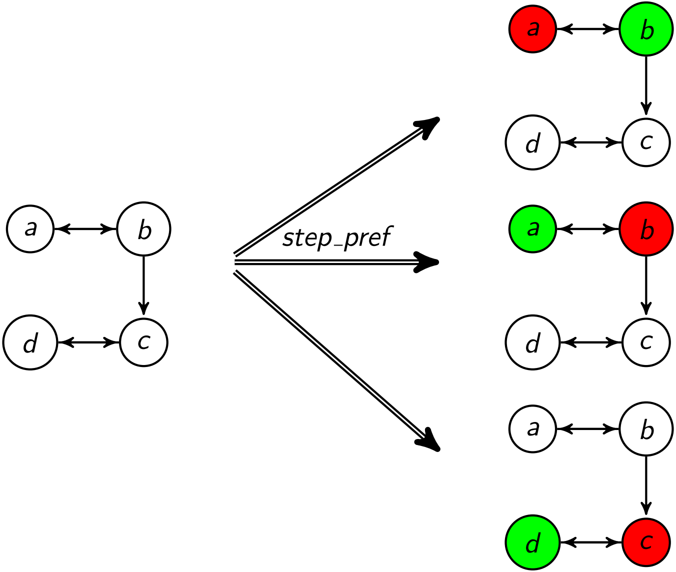
Procedure:

1. Look for unlabelled arguments with all attackers out, make them in and anything they attack out;
2. Else, look for minimal admissible sets of arguments, label those in and anything they attack out;
3. Otherwise, label all remaining arguments undec.

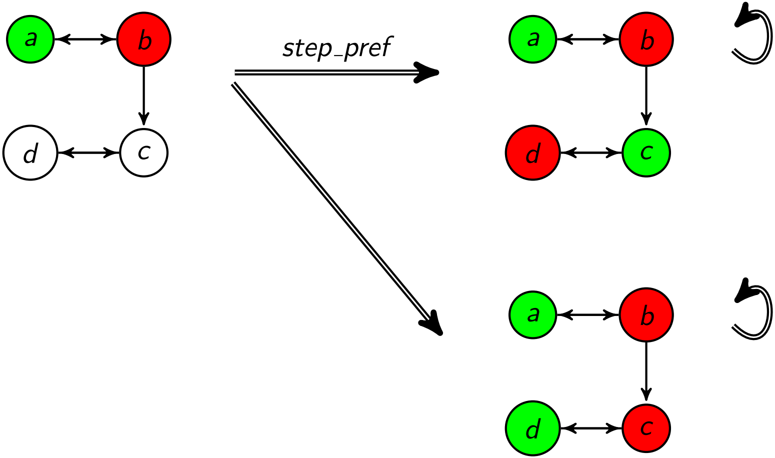
Theorem 2

step_preferred is an update semantics which gives rise to the preferred semantics.

Example



Example



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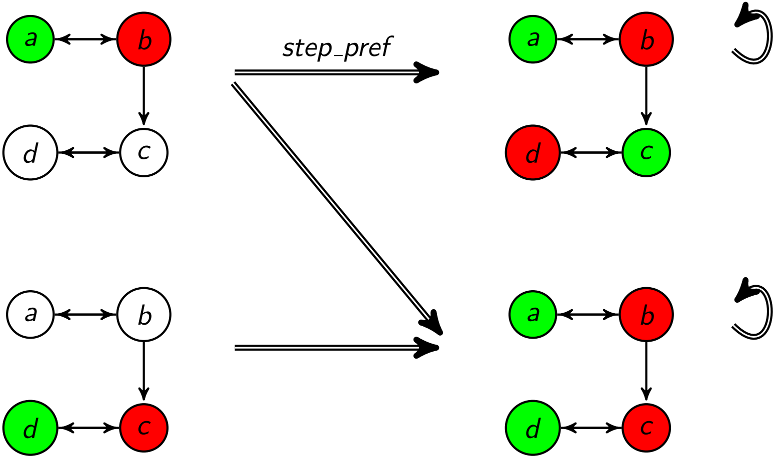
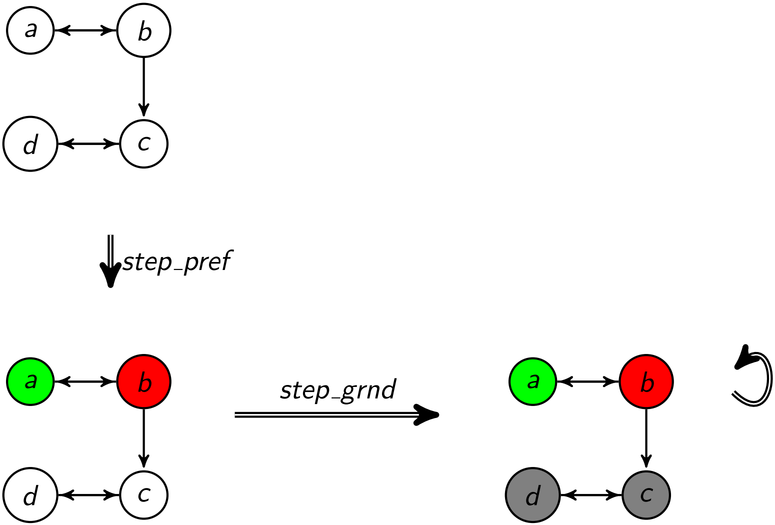


Composition of update semantics

Theorem 3

step_grounded ∪ *step_preferred* is an update semantics which gives rise to the complete semantics.

Example



A semantic approach

Precision ordering over the partially-labelled frameworks

$(\langle A, R\rangle, Lab) \geq_p (\langle A', R'\rangle, Lab')$ iff:

- $\langle A, R\rangle = \langle A', R'\rangle$;
- $\forall a \in A$, if $Lab(a')$ is defined, then $Lab(a) = Lab(a')$.

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The most fine-grained update semantics

For a given direct semantics *dir*, we define mfg_{dir} as the transitive reduction of $\geq_p$ restricted to the paths from initial frameworks to the corresponding final ones returned by *dir*.

Combining most fine-grained updates

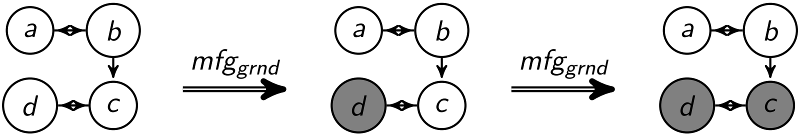
Combination operation

Given u_1 and u_2, we define $u_1 \uplus u_2$.
We also allow for changes to be imported into a framework F from a similar framework F_2, if the framework can be partitioned into $S, I, M \subseteq A$:

1. I is already fully labelled;
2. there is no conflict between S and M;
3. F and F_2 agree on $S \cup I$;
4. the update happens in S;
5. the current label of $I \cup M$ is reachable by $u_1 \uplus u_2$.

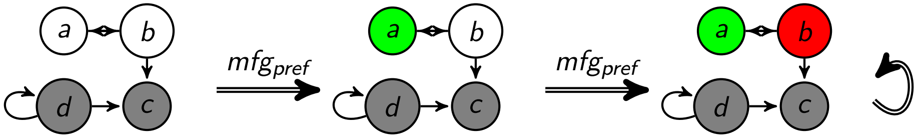
Example

F:



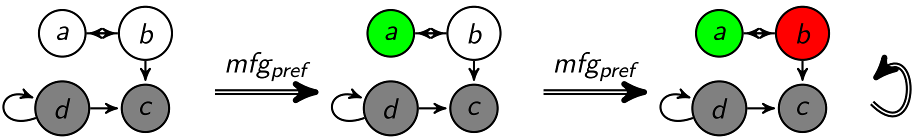
Example continued

F_2:



Example continued

F_2:



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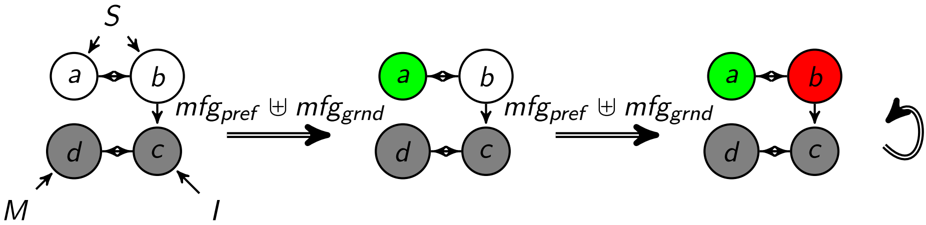

Conclusions and future work

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- Decomposed some direct semantics into fine-grained version.
- Combined preferred and grounded to get complete in two different ways. What does this mean for direct semantics?

Future work:

- Define update semantics based on algorithms, such as SCC-recursiveness.
- Examine the results of other combinations of update semantics.
- How fine-grained do you need to be in order to get interesting combinations of updates?
- A model closer to learning-oriented reasoning?

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Thank you!