A DIAMOND for Argumentation

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Motivation

- Dung's abstract argumentation frameworks (AFs) are widely used in argumentation
- They are often criticized for the limitation to simple attacks between arguments
- Abstract Dialectical Frameworks (ADFs) generalize Dung's AFs and allow for arbitrary relations between one argument and a set of *parent* arguments
- DIAMOND (**DIA**lectical **MO**dels e**N**co**D**ing) is a tool for argumentation researchers to compute extensions of ADFs

Abstract Dialectical Frameworks

Definition. An **abstract dialectical framework** is a tuple $D = (S, L, C)$ where

- S is a set of statements (positions, nodes),
- $L \subseteq S \times S$ is a set of links,
- $C = \{C_s\}_{s \in S}$ is a set of total functions $C_s : 2^{par(s)} \to \{\mathbf{t}, \mathbf{f}\}$. C_s is called acceptance condition of s.

Acceptance conditions can be represented as propositional formulae.

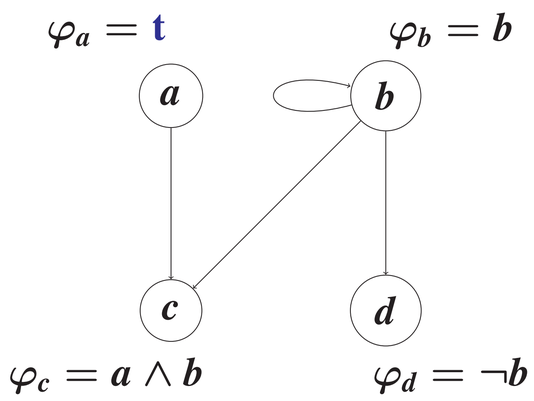

Figure : Example of an ADF

- Semantics are based on three-valued logic
- $\mathbf{t}$, $\mathbf{f}$, and $\mathbf{u}$ are partially ordered by $\leq_i$ s.t. $\mathbf{u} <_i \mathbf{f}$ and $\mathbf{u} <_i \mathbf{t}$
- **Consensus**-Operator, which assigns $\mathbf{t} \sqcap \mathbf{t} = \mathbf{t}$, $\mathbf{f} \sqcap \mathbf{f} = \mathbf{f}$, and returns $\mathbf{u}$ otherwise.

Definition. Let D be an ADF and v be a three-valued interpretation over S. Then the interpretation $\Gamma_D(v)$ is given by $s \mapsto \sqcap \{w(\varphi_s) \mid w \in [v]_2\}$. Furthermore v is

- **admissible** iff $v \leq_i \Gamma_D(v)$;
- **complete** iff $\Gamma_D(v) = v$, that is, v is a fixpoint of Γ_D;
- **grounded** iff v is the $\leq_i$-least fixpoint of Γ_D.

A two-valued interpretation v is a **model of** D iff $\Gamma_D(v) = v$; it is a **stable model** of $D = (S, L, C)$ iff v is a model of D and E_v equals the grounded extension of the reduced ADF $D^v = (E_v, L^v, C^v)$, where $L^v = L \cap (E_v \times E_v)$ and for $s \in E_v$ we set $\varphi_s^v = \varphi_s[r/\mathbf{f} \,:\, v(r) = \mathbf{f}]$.

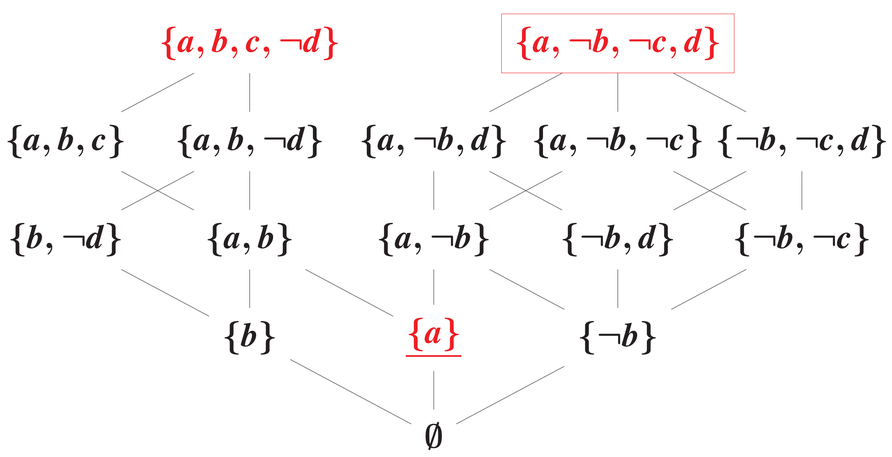

Figure : admissible, complete, grounded, model, and stable model semantics

DIAMOND

- Collection of Answer Set Programming Encodings, utilizing the **Potassco** solvers
- Provides ECL^{i}PS^e scripts for input format conversions from **prioritized ADFs** and **propositional formula ADFs** to the **acceptance function** representation
- Command-line interface realized with Python

Instance Representation

An ADF is represented by the predicates

- `s/1`
- `ci/1`
- `co/1`
- `l/2`
- `ci/3`
- `co/3`

where s and l represent the statements and links. ci (resp. co) represents under which accepted parents the acceptance function maps to $\mathbf{t}$ (resp. $\mathbf{f}$).

Example

```
s(a).  s(b).  s(c).  s(d).
l(a,c).  l(b,b).  l(b,c).  l(b,d).
ci(a).  co(b).  ci(b,1,b).
co(c).  co(c,1,a).  co(c,2,b).  ci(c,3,a).  ci(c,3,b).
ci(d).  co(d,1,b).
```

Implementation Details

- Γ_D will be computed at `step(I)`, based on the three valued interpretation, represented by the predicates `in(X,I)` and `out(X,I)`
- Γ_D's result is modeled by `valid(X,I)`, `unsat(X,I)`, and `fp(I)`
- Admissible and complete models can be realized with a Guess & Check approach

```
step(0).                    :- in(S,0), out(S,0).
in(S,0):s(S).               :- in(S), not valid(S,0).
out(S,0):s(S).              :- out(S), not unsat(S,0).
```

- The computation of the grounded model needs to construct an ordering for iteration untill the fixpoint is reached

```
max(I) :- I:=s(S). step(0).
in(S,I+1) :- valid(S,I).
out(S,I+1) :- unsat(S,I).
step(I+1) :- step(I), not max(I).
```

- Stable models combine the Guess & Check approach and the grounded model fixpoint-computation

References

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