Updates of argumentation frameworks

Ján Šefránek
Comenius University, Bratislava, Slovakia,
sefranek@ii.fmph.uniba.sk

Goals

- introduction of updates into assumption-based frameworks (Bondarenko et al., 1997)

- exploring an inertia of an admissible set after an update of an abstract argumentation framework

assumption-based fwk

argumentation framework

deductive system

knowledge base

assumption-based fwk

argumentation framework

deductive system

knowledge base – **logic program**

assumption-based fwk

argumentation framework

deductive system – **bottom-up evaluation**

knowledge base – logic program

EVOLVING assumption-based fwk

argumentation framework – assumptions + **UPDATED** attacks

deductive system - bottom-up evaluation

EVOLVING knowledge base – **UPDATED** logic program

Dynamic argumentation semantics

- Assumption-based framework
- Preferential conflicts solving
- Updating
- Evaluation

Assumption-based framework

a language of an extended logic program is assumed

assumption = a default literal = argument

Δ – a set of assumptions,
$\Delta^{\rightsquigarrow P}$ – the set of all (objective) literals derivable from Δ using P

an argument $not\ A$ **attacks** an argument $not\ B$ w.r.t. a program P iff there is $B \in \{not\ A\}^{\leadsto P}$

we have an abstract argumentation framework: arguments + attacks

Δ **attacks** Δ' w.r.t. P if there is $L \in \Delta^{\leadsto P}$ s.t. $not\ L \in \Delta'$

Preferential conflicts solving

two types of conflicts in $\langle P, U \rangle$:

1. let P be $a \leftarrow$ and U be $\neg a \leftarrow$, Δ be $\emptyset$,

then $\Delta^{\leadsto^{P \cup U}} = \{a, \neg a\}$;

rebuttal

2. $P = \{$obedient $\leftarrow$ punish$\}$,

$U = \{$punish $\leftarrow$ not obedient$\}$

if $\Delta = \{not$ obedient$\}$

then $\Delta^{\leadsto^{P \cup U}} = \{$punish, obedient$\}$;

undercutting

Definition: A **solution** of a conflict C w.r.t. a set of arguments Δ is a minimal set of rules R s.t. $\Delta^{\leadsto (P \cup U) \setminus R}$ does not contain C

$\Delta_{cf}^{\leadsto R}$: a *conflict-free* set of conclusions of Δ

a *maximal* conflict-free set of conclusions of Δ

(the principle of minimal change is satisfied)

$\langle P, U\rangle$ – information of U is more preferred

preferences on rules

$r_1 \prec r_2$ iff $r_2 \in U$ and $r_1 \in P$

Definition: Suppose that $R_1, R_2 \subseteq P \cup U$ and both $\Delta_{cf}^{\rightsquigarrow R_1}$, $\Delta_{cf}^{\rightsquigarrow R_2}$ are conflict-free sets of conclusions of Δ.

If $\exists r_1 \in R_1 \setminus R_2 \; \exists r_2 \in R_2 \setminus R_1 \; r_2 \prec r_1$ and $\neg\exists r_3 \in R_2 \setminus R_1 \; \exists r_4 \in R_1 \setminus R_2 \; r_4 \prec r_3$ then $\Delta_{cf}^{\rightsquigarrow R_1}$ is **more preferred** than $\Delta_{cf}^{\rightsquigarrow R_2}$.

Updating

some restrictions on P, U and $\triangle$ are reasonable; it is not sufficient only to solve conflicts w.r.t. a preference relation in order to realize an update

first, if P is inconsistent, then we will accept that there is no dynamic answer set of $\langle P, U\rangle$

second, If $AS(U) = \emptyset$, there is no dynamic answer set of $\langle P, U\rangle$

The third decision: **Inertia of the current state**

turning back at the semantic roots of updates is needed; a free selection of an interpretation checked by a fixpoint condition in approaches based on the causal rejection principle should be somehow restricted

it is not reasonable to solve conflicts in $\Delta^{\rightsquigarrow P \cup U}$ for an arbitrary Δ

Example: Let be

$$P = \{d \leftarrow not\ n \qquad U = \{s \leftarrow s\}$$
$$n \leftarrow not\ d$$
$$s \leftarrow n, not\ c\}$$
$$\neg s \leftarrow$$

$\{s, \neg s\} \subseteq \{not\ d, not\ c\}^{\rightsquigarrow P \cup U}$
$\neg s \in \emptyset^{\rightsquigarrow P \cup U}$

we do not accept solutions of conflicts based on non-minimal sets of assumptions (Occam's razor)

Δ **rebuts** Ω w.r.t. R, if there is $L \in \mathcal{O}$ s.t. $L \in \Delta^{\rightsquigarrow R}$ and $\neg L \in \Omega^{\rightsquigarrow R}$

if $\Delta \subset \Omega$, then Δ is more preferred than Ω

Definition: let Δ be more preferred than Ω, Δ **defeats** Ω w.r.t. R iff (Δ attacks or rebuts Ω w.r.t. R). $\Box$

a **reasonability criterion**: it is not reasonable to accept the set of objective literals, dependent on defeated sets of arguments

Principle of the inertia of the current state

Let Δ be a set of arguments and $\langle P, U \rangle$ a sequence of programs. Let $\Delta \cup \Delta^{\leadsto P \cup U}$ be an answer set of P and also of $P \cup U$.

Then no set of arguments Ω, defeated by Δ, may generate an update of P by U.

$\Delta^{\leadsto R}_{cf+pref}$: a *preferred* set of conclusions

Definition: A **cautious solution** of a conflict $C = \{A, \neg A\}$ dependent on Δ is a solution R which satisfies:

if $L \in \Delta^{\leadsto R}_{cf+pref}$ then there is no Ω, a proper subset of Δ and a set of rules R' s.t. $\neg L \in \Omega^{\leadsto R'}_{cf+pref}$

Definition: Let P be consistent and U be coherent. A **dynamic view** on $\langle P, U \rangle$ is a set of literals $\Delta \cup \Delta^{\stackrel{R}{\leadsto}}_{cf+pref}$ s.t.

- $R \subseteq P \cup U$, R is a cautious solution of all conflicts in $P \cup U$ w.r.t. Δ,
- $\Delta^{\stackrel{R}{\leadsto}}_{cf+pref}$ is a maximal preferred conflict-free set of conclusions of Δ,

dynamic answer sets – total interpretations – **completed** sets of assumptions

two uses of Occam's razor and two corresponding notions: cautious solution and minimal active set of assumptions

Example: $P = \{a \leftarrow; b \leftarrow a\}$, $U = \{\neg a \leftarrow not\ b\}$, $\Delta_2 = \emptyset$. $\Delta_2^{\rightsquigarrow P \cup U} = \{a, b\}$ a completion of Δ_2: $S^- = \{not\ \neg a, not\ \neg b\}$.

$\Delta_1 = \{not\ b\}$; $\{a, \neg a\} \subseteq \Delta_1^{\rightsquigarrow P \cup U}$, $R = (P \cup U) \setminus \{a \leftarrow\}$, $\Delta_1^{\rightsquigarrow R} = \{\neg a\}$, the corresponding total interpretation is $\{not\ b, not\ \neg b, not\ a\} \cup \{\neg a\}$

Δ_1, Δ_2: **active sets of arguments** used in derivation of $\{a, b\}$ and $\{\neg a\}$, respectively; completions of Δ_1 and Δ_2 are needed only to obtain total interpretations

$\Delta_1 = \{not\ b\} \supset \Delta_2 = \emptyset$;

only minimal active sets of arguments (Δ_2 in this example) are interesting from our point of view

Definition: $\Delta \cup \Delta^{\rightsquigarrow R}$ – a total interpretation; Ω – a minimal subset of Δ s.t. $\Delta^{\rightsquigarrow R} = \Omega^{\rightsquigarrow R}$; then Ω is a *minimal active set of arguments* supporting $\Delta^{\rightsquigarrow R}$.

Definition: $\Sigma_D(\langle P, U\rangle)$ – the set of all dynamic answer sets of $\langle P, U\rangle$; if P has no model or U is incoherent then $\Sigma_D(\langle P, U\rangle) = \emptyset$.

Definition, cont'd: Otherwise, suppose that $S = \Delta \cup \Delta^{\leadsto R}_{cf + pref}$ is a dynamic view on $\langle P, U \rangle$ and it is a total interpretation;

then S is a **dynamic answer set** of $\langle P, U \rangle$ iff for Ω, a minimal active set of arguments supporting $\Delta^{\leadsto R}_{cf + pref}$, holds that no its proper subset is a minimal active set of arguments supporting a dynamic view on $\langle P, U \rangle$.

Evaluation

Observation: if $\Delta \cup \Delta^{\leadsto R}_{cf+pref}$ is a dynamic view on $\langle P, U\rangle$, then Δ is a conflict-free set of arguments

Remark: Suppose that Δ generates a dynamic view w.r.t. $R \subseteq P \cup U$. Then Δ is not necessary an admissible set of arguments.

Example

$$P = \{b \leftarrow not\ a\} \qquad U = \{d \leftarrow b$$
$$a \leftarrow not\ c\}$$

$\Delta = \{not\ \ a\}$ generates a dynamic view $\{not\ \ a, b, d\}$ on $\langle P, U\rangle$. However, Δ does not counterattack the attack of the argument $not\ c$ against Δ.

Proposition: If $\Delta \cup \Delta^{\rightsquigarrow R}_{cf+pref}$ is a dynamic answer set of $\langle P, U \rangle$ then Δ is a stable extension of $\mathcal{Q}$

Remark: If Δ is a stable extension of $\mathcal{Q}$, it may not generate a dynamic answer set of $\langle P, U \rangle$.

Remind Example about a tautological "update".

Proposition Let $\langle P, U \rangle$ be a sequence of logic programs over the language $\mathcal{L}$. Then there is a logic program Q over the language $\mathcal{L}$ s.t. $AS(Q) = \Sigma_D(\langle P, U \rangle)$.

Consequence $P \cup U$ – a program over $\mathcal{L}$, $\mathcal{D} \subset \mathcal{L}$ be the set of arguments. . If Q represents $\langle P, U \rangle$, then each argument of Q is a member of $\mathcal{D}$.

Proposition: Let $AS(P) \neq \emptyset \neq AS(U)$. Then $\Sigma_D(\langle P, U \rangle) \neq \emptyset$.

consequence: If there is a conflict-free set of assumptions w.r.t. a program P and a conflict-free set of assumptions w.r.t. U, then there is a conflict-free set of assumptions w.r.t. Q, where $AS(Q) = \Sigma_D(\langle P, U \rangle)$. $\Box$

Remark: an arbitrary argumentation semantics can be specified for an assumption-based framework over an evolving knowledge base

how to make this conception of updates more general; $T \cup A \vdash L$ is defined in an assumption-based framework over a deductive system

a translation: replace each occurrence of $L \in \Delta^{\leadsto^P}$ by $T \cup A \vdash L$

Rational ideologies

some sets of arguments are for human or artificial reasoner often more preferred

a problem of an inertia of sets of arguments after an update of an abstract argumentation framework

sets of strongly believed arguments are represented by admissible sets an update of an argumentation framework is given and a rational reasoner wants to check, whether a set of strongly believed arguments is justified also after the update

Definition: Let $AF_o = (AR_o, \alpha_o)$ and $AF_u = (AR_u, \alpha_u)$ be given. Then $(AR_o \cup AR_u, \alpha_o \cup \alpha_u)$ is called the **expansion** of AF_o by AF_u. It is also said hat AF_o is **updated** by AF_u.

representation of an argumentation framework by a logic program, an admissible set of AF_o is selected, a goal: to find such admissible set of the expansion, that a minimal number of “old” arguments is rejected

a procedure processes the representation of the update by a logic program;

a conservative stance – some arguments may be rejected, but no new arguments can be accepted; an alternative, less conservative

The following property is inspired by Cayrol et al.

Definition: An update of an argumentation framework AF_o by an argumentation framework AF_u satisfies a property of **selective monotony**, if at least one admissible set of AF_o is also an admissible set of the expansion of AF_o by AF_u.

Observation Let S be an admissible set of AF_o and $AF_u = (A_u, \alpha_u)$ be an update of AF_o.

If for each $(b, a) \in \alpha_u$, where $a \in S$, holds that there is $c \in S$ s.t. $(c, b) \in \alpha_o \cup \alpha_u$ then the update satisfies the *selective monotony* property.