Measuring minimal change in argument premise revision

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Overview

- Belief revision theory
- The ASPIC+ framework for argumentation
- Measuring minimal change
- Example
- Current & future work

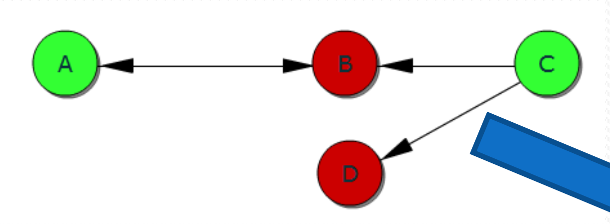
Belief revision

- Agent (human or software) needs to change its beliefs
- How…?
- Most prominent theory: AGM theory
- Set of postulates that describe valid revisions, contractions and expansions of belief sets
- Guided by “minimal change” through an entrenchment ordering
- Entrenchment is not purely logical; other factors are taken into consideration (but logical consequences are still important)

ASPIC+ framework

- Prakken 2010
- Extension to "original" ASPIC framework (Amgoud et. Al. 2006)
- Instantiates Dung (1995)'s abstract approach to argumentation by adding structure…
- Main concept – Argumentation System (AS) containing:
  - Set of rules
  - Preference ordering over rules
  - Contrariness relation
  - Knowledge base
- From AS derive Argumentation Theory (AT) from which, in turn, an abstract framework can be derived

ASPIC+ framework

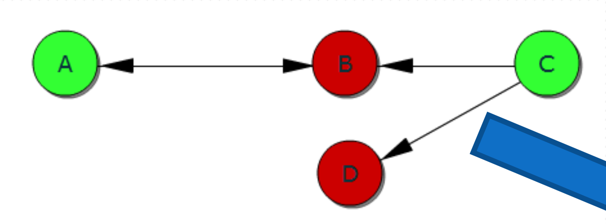


A: (a1,a2=>A)
B: (b1=>B)
C: (c)
D: (d1,d2,d3->D)

Removing abstract argument is easy: we can just remove it at examine the effects

But when the arguments have structure we need to decide what PREMISES to remove…how?

ASPIC+ framework



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Apply belief revision techniques

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Measuring minimal change

- Factors in minimal change:
  - Lost arguments (removing a shared premise)
  - Lost acceptability (removing a defender)
  - Gained acceptability (removing an attacker)
- Capture these through three functions…

Measuring minimal change

- Lost arguments – Argument Drop Function:

$$\Delta_A(D) = \{A \mid A \in \bigcup E(AT_{AS}), A \notin AS \backslash D)\}$$

- Lost acceptability – Acceptability Drop Function:

$$\Delta_S(D) = \{A \mid A \in \bigcup E(AT_{AS}), A \notin \bigcup E(AT_{AS \backslash D}), A \in AS \backslash D\}$$

- Gained acceptability – Acceptability Gain Function:

$$\Lambda_S(D) = \{A \mid A \notin \bigcup E(AT_{AS}), A \in \bigcup E(AT_{AS \backslash D})\}$$

Measuring minimal change

- Three different measures; to simply combine (e.g. union the output of the functions) loses context
- Want to leave things open – e.g. Preferences over the sets, adding new measures,…
- So express as a vector. For some subset D of K:

$$\Upsilon(D) = \begin{pmatrix} \Delta_A(D) \\ \Delta_S(D) \\ \Lambda_S(D) \end{pmatrix}$$

Measuring minimal change

- Can still obtain a numerical measure to realise an entrenchment ordering:

$$\Upsilon'(D) = \begin{pmatrix} \mid \Delta_A(D) \mid \\ \mid \Delta_S(D) \mid \\ \mid \Lambda_S(D) \mid \end{pmatrix}$$

Thus, if for some $D_1 \subseteq \mathcal{K}$ and $D_2 \subseteq \mathcal{K}$, $\mid \Upsilon'(D_1) \mid < \mid \Upsilon'(D_2) \mid$, then we have an entrenchment ordering, $<_e$ where $D_1 <_e D_2$ (that is, the set D_2 is *more* entrenched than the set D_1).

Example

- $\mathcal{K} = \{p, q, t, v, x\}$ such that $t < q$ and $v < s$;
- $\mathcal{R}_d = \{p, q \Rightarrow r; p \Rightarrow s; t \Rightarrow u; v \Rightarrow w\}$;
- $q \in \overline{t}$, $s \in \overline{v}$ and $w \in \overline{x}$.

Arguments:

- $\langle\{p, q\}; p, q \Rightarrow r; r\rangle$
- $\langle\{p\}; p \Rightarrow s; s\rangle$
- $\langle\{t\}; t \Rightarrow u; u\rangle$
- $\langle\{v\}; v \Rightarrow w; w\rangle$

Want to remove the argument for "r"

One complete extension in $AT_{\mathcal{AS}}$: $\{p, q, r, s, x\}$.

Example

	Δ_A	Δ_S	Λ_S
p	$\{r, s\}$	$\{x\}$	$\{v, w\}$
q	$\{r\}$	$\{\}$	$\{t, u\}$

These yield the following vectors for p and q:

$$\Upsilon(\{p\}) = \begin{pmatrix} \{r, s\} \\ \{x\} \\ \{v, w\} \end{pmatrix} \qquad \Upsilon'(\{p\}) = \begin{pmatrix} 2 \\ 1 \\ 2 \end{pmatrix} \Rightarrow \sqrt{9} = 3$$

$$\Upsilon(\{q\}) = \begin{pmatrix} \{r\} \\ \{\} \\ \{t, u\} \end{pmatrix} \qquad \Upsilon'(\{q\}) = \begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix} \Rightarrow \sqrt{5} \approx 2.24$$

Thus, using structural + semantic considerations, {q} < {p}, so q is given up

Current & future work

- Forms the core of wider research into argument revision + its applications
- Further measures of “minimal”:
  - Acceptability semantics
  - Preferences – input and output
  - Strategic considerations
- Postulates for argument revision – describe valid revisions/contractions/expansions of argument systems
- Evaluation!
- Applications:
  - One main one – inter-agent dialogues
  - Has sub-applications, i.e. specific uses in dialogue

Conclusions

- Presented a method towards measuring minimal change in argument revision
- Assesses the impact on an argumentation system when removing a premise, in terms of:
  - Loss of arguments
  - Loss of acceptability of remaining arguments
  - Arguments gaining acceptability
- Only an initial step – but forms the core of wider work on argument revision

Questions?

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