

Selected Research Issues & Conclusions

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Overview

- We conclude with a brief (personal) review of several research questions.
- These outline some very general themes which appear to have been largely neglected or not pursued in as much depth as (arguably) merited.

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Infinite Argumentation Structures I

- The nature of argumentation is “*open-ended*” and “conclusions” defeasible given appropriate “*new*” information.
- The AFs implicitly associated with ABFs (given the logical theory $\langle L, R \rangle$ underpinning these) involve infinitely many arguments.
- In fact, Dung’s original paper derives some core properties of infinite AFs: e.g. *existence* of preferred extensions; *uniqueness* of grounded extension in *finitary* AFs etc.

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Infinite Argumentation Structures II

- Some analysis of infinite structures is also presented w.r.t. ideal semantics in Dung et al. (2007). Although not explicitly stated (assuming Axiom of Choice) it can be proved that *every* AF has a unique ideal extension.
- Apart from Verheij's construction of infinite AFs without semi-stable extensions there has been little analysis of such frameworks.

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Infinite Argumentation Structures III

- For example,
 - a. Methods for *representing* infinite AFs and their computational properties.
 - b. Conditions (e.g. finitary, acyclic, tree) on infinite AFs and *existence of extensions, coincident semantics* etc.
 - c. "*compactness*" properties.

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Merging and Updating I

- Given a collection of AFs
 $\langle H_1, H_2, H_3, \dots, H_r \rangle$
what defines a "sensible" form of an AF, H ,
"*aggregating*" all of these?
- The issue is especially relevant to MAS contexts where several agents may have differing views of the relevant AF.
- Coste-Marquis et al. (AIJ, 171:730-753, 2007) is one of the few detailed studies of this issue. There has, however, been very little work undertaken that builds on this treatment.

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Merging and Updating II

- Closely related to the question of how to *merge* frameworks is the issue of *dynamically updating* information, i.e. given $\langle X, A \rangle$ suppose a “*new*” argument y is added to X that attacks some subset S of X and is attacked in turn by another subset T .
- Are there “better” methods for constructing, say, the set of preferred extensions than *recomputing* these?
- Are there efficient means for determining arguments whose *status w.r.t. a semantics changes*?
- Again these issues have largely been neglected in existing research.

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Beyond Courcelle’s Theorem I

- Courcelle’s Theorem gives mechanisms for translating a form of second order logic expression, Φ , into *algorithms* recognising structures corresponding to *models* of Φ .
- For structures arising in graphs with *bounded treewidth* these algorithms run in *linear time*.
- As noted in the previous section a number of notionally “hard” problems in AF semantics yield linear time algorithms via this approach.

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Beyond Courcelle’s Theorem II

- Unfortunately, the resulting algorithms are typically unhelpful: constant factors qualifying linear run-time being *extremely large*.
- The results, however, show that, *in principle*, efficient algorithmic solutions to hard computational questions in AFs *are* possible.
- Problem: develop *practical/FPT* methods for AF based decision problems (building on the fact that efficient methods *do* exist)

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Game-theoretic treatments

- Dung's original paper mentions argumentation semantics as an interpretation of game-theoretic models.
- While some investigation of argumentation as an n -player game has been carried out, e.g. Rahwan & Larson (2009), Riveret et al. (COMMA 2008) it is, perhaps, unclear whether significant benefits result.

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Open Problems I

- Is there a constant k s.t. given an AF $\langle X, A \rangle$ a *propositional* formula, $\Phi(X)$, with the following properties *always* exists?

$$|\Phi(X)| \leq |X|^k$$

$\Phi[S]$ holds if and only if $S \in E_{PR}(\langle X, A \rangle)$

- If so, how hard is it to construct such a formula from $\langle X, A \rangle$?

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Open Problems II – novel semantics

- Are semi-stable extensions *guaranteed* to exist in *finitary* AFs?
- Is it possible to translate the exact bounds for semi-stable CA and SA (from Dvorak and Woltran, 2010) from AFs into DL and AEL settings of ABFs? (LP setting is “easy”).
- Obtain exact complexity bounds on ideal semantics for AEL settings of ABFs (Dunne, 2009 fails to hold for this case).

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Conclusion

- Argumentation continues to be an important topic within the field of AI.
- While we have focused on recent developments in one formal model, there are many active areas –
 - Dialogue and proof-theoretic methods
 - Argument extraction and synthesis
 - Argument visualisation
 - Interchange formats
- In total, the field is likely to continue to be active for the foreseeable future.

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