FAKULTÄT FÜR !NFORMATIK
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Diplomarbeitspräsentation

dbai
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Tree-Decomposition based Algorithms for Abstract Argumentation Frameworks

Masterstudium:
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Motivation

Overview

- Argumentation Frameworks (AFs) important reseach field in Artificial Intelligence
- Selection of 'appropriate' arguments from AF defined by a semantics
- Many different semantics
- Selection oftentimes computationally hard (intractable)

→ Identify tractable fragments
For AFs: Tree-Width, defined on Tree Decompositions

Goal

- Development of novel algorithms for stable, complete and admissible semantics, following up the work of Dvořák et.al. [1]
- Based on Tree Decompositions, tractable
- Evaluation of different types of Tree Decompositions

Basic Definitions

Argumentation Framework [2]
Pair $F = (A, R)$ where A is a set of arguments and $R \subseteq A \times A$ is the attack relation.

Tree Decomposition [3]
Tree where each node has a bag that contains a set of vertices from the original graph such that:

- every vertex in at least one bag
- connected vertices together in bag
- nodes containing a vertex are connected upwards the tree.

Admissible Semantics [2]
Set S admissible if conflict-free and each argument in S is defended.

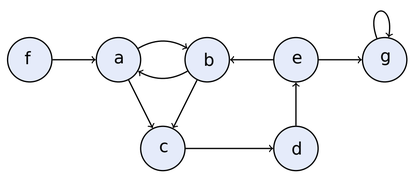
Stable Semantics [2]
Set S stable if conflict-free and each argument not in S is attacked by S.

Complete Semantics [2]
Set S complete if admissible and each defended argument is in S.

Approach for Algorithms based on Tree Decompositions

Preparation

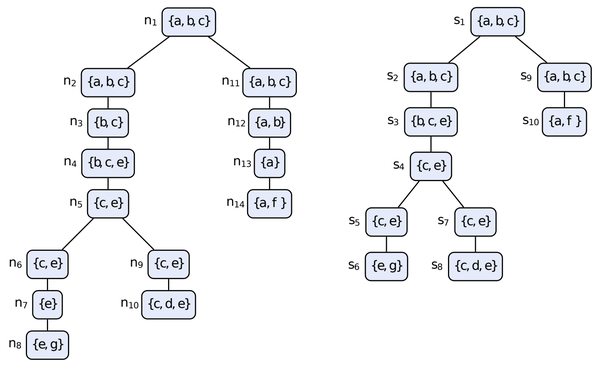
Input Instance: Argumentation Framework



Example Argumentation Framework

Obtain Tree Decomposition

- Makes use of heuristics (finding decomposition of minimal width itself intractable)
- Handled by an existing purpose-built framework
- Either normalized or semi-normalized
  - Semi-norm contains less nodes
  - Several arguments introduced or removed in one node
  - Branch node the same



Tree Decomposition:
Normalized (left), Semi-normalized (right)

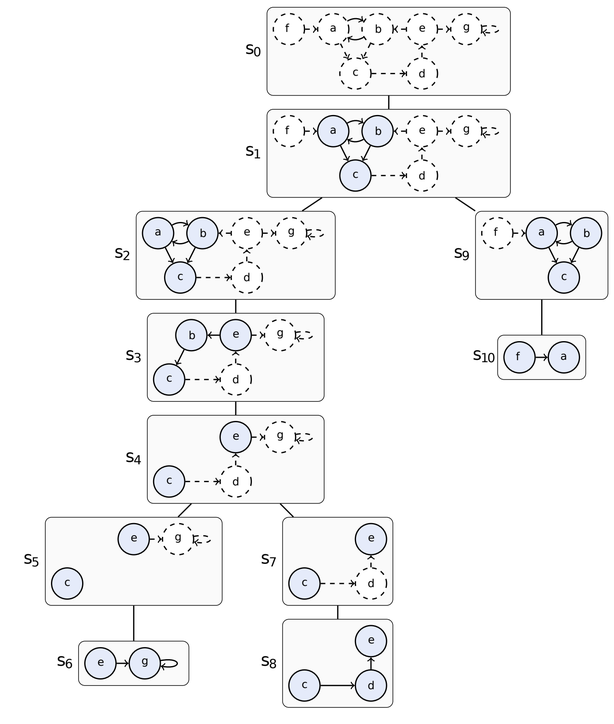
Computation

Traverse tree in bottom-up order

- Use information about vertices in current bag and colorings of vertices in the sub-tree

Restricted Sets: Contain arguments that that were completely considered in the sub-tree of a node, arguments fulfill properties of semantics

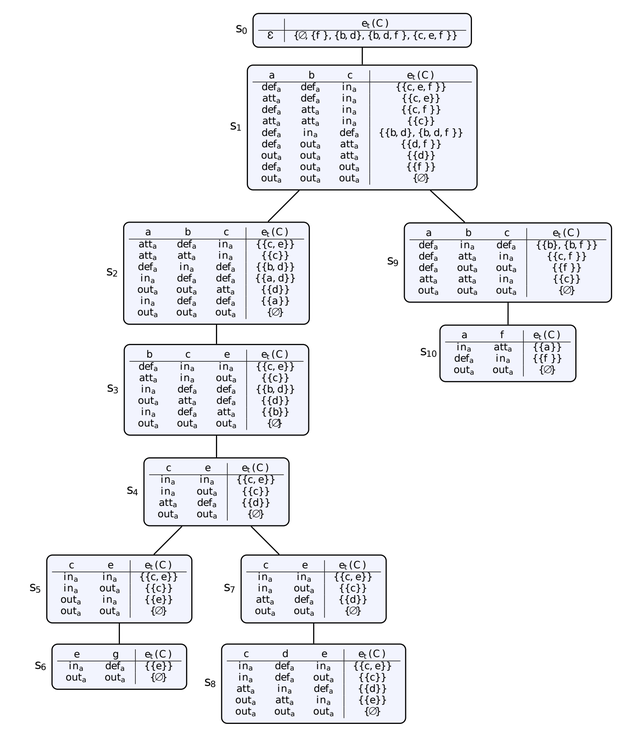
Colorings: Defined on restricted sets
Encode information about relations by assigning colors to each argument of current node



Semi-normalized Tree Decomposition with Sub-Frameworks

V-Colorings: Defined solely on current vertices and colorings of child-node, not on restricted sets

→ Fixed-parameter tractability achieved



Semi-normalized Tree Decomposition with V-Colorings for Admissible Semantics

Result Delivery

- At root node all arguments have been handled
- Restricted sets correspond to extensions of AF

→ Computation in $f(tw) \cdot n^{O(1)}$

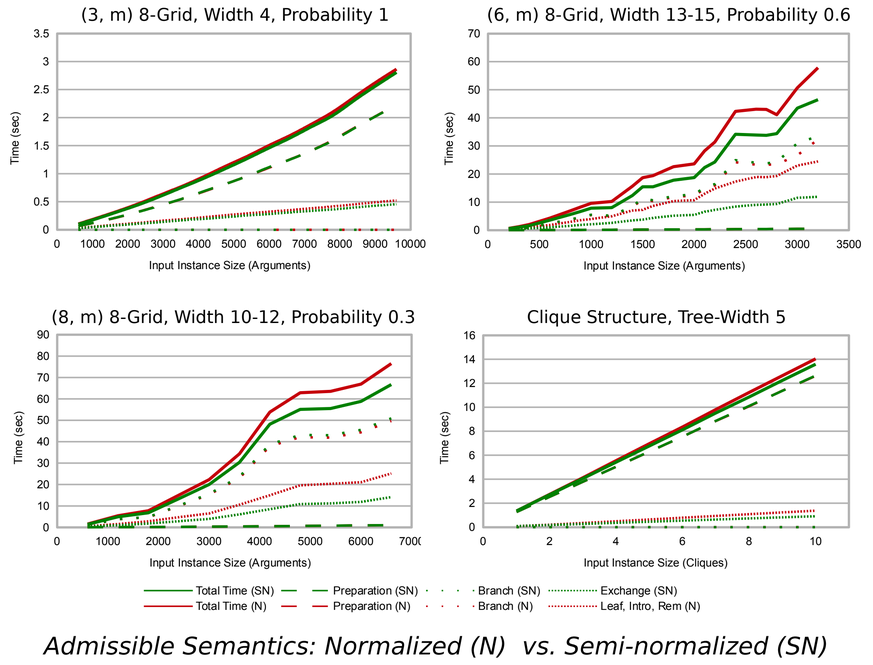
Experimental Results

Test Setup

- Comparison of already existing algorithm for admissible semantics on normalized tree decomposition [1] to novel on semi-normalization
- Different test instance types (Grid, Clique)
- Different width and edge probability

Analysis of Benchmarks

- Semi-normalized implementation out-performs normalized in every test case
- Relative performance gain significant (up to 50%)
- Absolute performance gain depends on cost for preparation and branch node evaluation
- In general: Less edges, performance gain more significant



Admissible Semantics: Normalized (N) vs. Semi-normalized (SN)

Conclusion

Contributions

- Novel algorithms for stable and complete semantics based on normalized tree decompositions
- Novel algorithm for admissible semantics based on semi-normalized tree decompositions
- Implementations and correctness proofs of the algorithms
- Experimental results show that algorithm on semi-normalized tree decompositions outperforms the existing one

Future Work

- Provide algorithms for further semantics based on tree decompositions
- Analysis of run-time on non-normalized tree decompositions
- Detailed complexity analysis

[1] Dvořák, W., Pichler R., and Woltran, S. - Towards fixed-parameter tractable algorithms for argumentation. In KR 2010, 2010.
[2] Dung, P.M. - On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. Artificial Intelligence, 77(2):321 – 357, 1995.
[3] Robertson, N. and Seymour, P. - Graph minors. III. Planar tree-width. Journal of Combinatorial Theory, Series B, 36(1):49 – 64, 1984.

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