μ–TOKSIA

An Efficient Abstract Argumentation Reasoner

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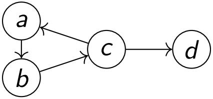
Motivation

Argumentation in AI

- Active and vibrant area of modern AI research
- Central KR formalism for reasoning in abstract argumentation: **argumentation frameworks** (AFs) [Dung, 1995]



Systems for Reasoning in Abstract Argumentation

- Reasoning tasks such as argument acceptance often **NP-hard**
- Several **direct** and **declarative approaches**
- ICCMA: biennial competition for evaluation of **AF solvers**
  - declarative approaches based on **SAT** and ASP most successful

μ–TOKSIA: SAT-based AF Solver

Ranked #1 on **every track** in ICCMA'19

Supported Reasoning Tasks

Supports all tasks in ICCMA'19:

- credulous and skeptical acceptance of an argument,
- finding a single extension or enumerating all extensions, and

"dynamic track": AF + sequence of changes [Niskanen and Järvisalo, 2020]

Incremental SAT Solving

- SAT solver instantiated only once during a single execution, keeping its state between iterative calls [Eén and Sörensson, 2003]
- Key implementation-level aspect: making efficient use of the **assumptions interface**

μ–TOKSIA: Algorithms

Basis: SAT encodings for complete and stable [Besnard and Doutre, 2004]

- **Grounded** extension computed via unit propagation on the encoding for complete semantics [Lagniez et al., 2015]
- **Complete** semantics: credulous acceptance via a single SAT call, extension enumeration by iteratively blocking solutions
- **Stable** semantics: similarly as complete, but in addition precompute and assume the grounded extension
- **Preferred**, **semi-stable**, and **stage** semantics: reimplementation of algorithms in CEGARTIX (without "shortcuts") [Dvorák et al., 2014]
- **Ideal** extension: SAT-based procedure
  1. compute the union of complete extensions via iterative SAT calls
  2. do not consider arguments attacked by this union via assumptions
  3. subset-maximize a complete extension within this set via SAT calls

μ–TOKSIA: Implementation and Benchmarks

Implementation

Available online under **open-source** MIT license:
`https://bitbucket.org/andreasniskanen/mu-toksia`

- Implemented in **C++** using STL data structures: no dependencies apart from a SAT solver
- Includes interfaces to GLUCOSE and CRYPTOMINISAT
- Generic **SAT solver interface**: plug in a SAT solver of your choice!

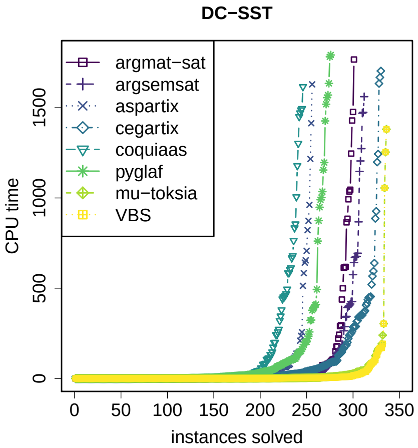
Benchmarks

- **ICCMA'17 AFs**: considerably more difficult than ICCMA'19
- **NP-hard** credulous and skeptical **acceptance** tasks
- Compare to the top-performing solvers in ICCMA'17 and ICCMA'19

Experimental Evaluation

On all reasoning tasks except for stable semantics:

- Ranked #1 in terms of solved instances
- Ranked #1 in terms of contribution to Virtual Best Solver (VBS)



Conclusions

Paper Summary

Description of SAT-based AF solver μ–TOKSIA

- Algorithms and optimizations, overview of implementation
- Empirical evaluation (beyond ICCMA'19): state-of-the-art approach
- Available online in open source:

  `https://bitbucket.org/andreasniskanen/mu-toksia`

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