ArgoSMTe: SMT-LIB 2.0 compliant expression library

Milan Banković
milan@matf.bg.ac.rs

Department of Computer Science
Faculty of Mathematics
University of Belgrade, Serbia

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Outline

SMT solving

SMT problem:

- is a problem of deciding whether a first order formula is satisfiable with respect to some given background theory
- is solved using the procedures called SMT solvers
- a great number of different SMT solvers exist

Issues:

- external incompatibility: solvers use different input languages, produce different outputs
- internal incompatibility: solvers have incompatible implementations of expressions (terms and formulae)
- interface incompatibility: solvers have incompatible Application Programming Interfaces (APIs)
- thus, cooperation within the community is made difficult

SMT-LIB 2.0

SMT-LIB is an international effort in:

- providing a standard language for rigorous descriptions of first-order theories used in SMT
- providing a standard language for SMT solvers' input and output
- providing a large library of benchmarks for testing SMT solvers

History and Credits

- Developed since 2003.
- Version 1.1 (2005)
- Version 1.2 (2006) supported by most SMT solvers
- Version 2.0 (2010) still not fully supported by some solvers
- Joint work of three work groups led by Cesare Tinelli, Clark Barrett, and Aaron Stump

Motivation

Why expression library is important?

- Implementation of expressions is usually the first step in development of SMT solver
- The component that is most dependant on the input language
- Must be flexible enough to support all the standard features
- Must be extensible, to allow further development of the solver

Unresolved issues:

- Expression implementations in SMT solvers do not fully support the standard
- Intermixing codebases between SMT solvers in not possible
- Tools that use SMT solvers must implement support for different SMT solvers API's

Motivation

The solution is:

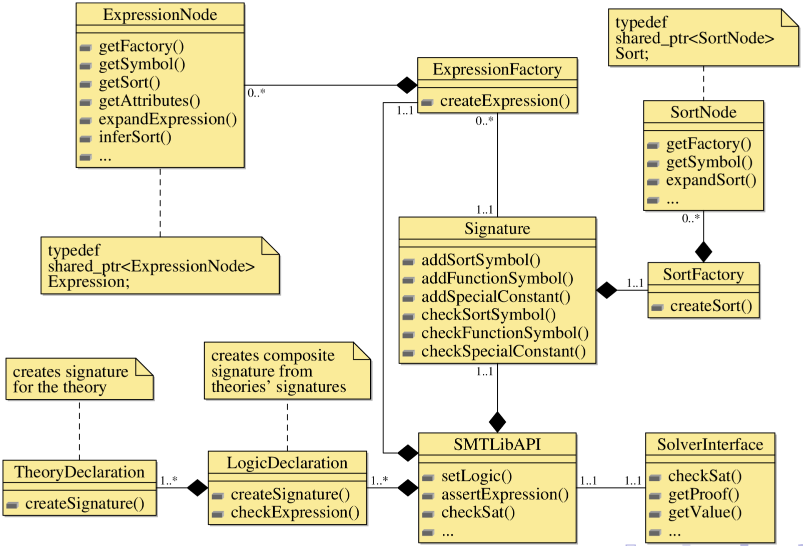
- Standardization and specification of SMT expression library that fully supports all the features of SMT-LIB 2.0
- Providing a reference implementation of such library specification
- It should include all parts that are common to all SMT solvers (sorts, expressions, signatures, syntax checking, definitions of standard theories and logics, API, parser)
- It should provide an easy and uniform way to communicate with the decision procedures that are developed on top of the library

ArgoSMTe library

ArgoSMTe features:

- developed in standard C++ (GNU/Linux, g++)
- developed using well-known design patterns of object oriented programming
- easy to use, develop, understand, extend
- is a free software (GNU/GPL licensed)
- strong adherence to the SMT-LIB 2.0 standard

Overall structure of ArgoSMTe



Low level

At the low level:

- Basic types: special constants, symbols, variables
- Expressions: common subexpression sharing
- Sorts: also have expression-like structure
- Shared pointers are used as handles to sorts and expressions
- Signatures: store declarations of sort and function symbols
- Signature combination and expansion
- Well-sortedness checking and sort inference

Intermediate level

At the intermediate level:

- Theory declarations: simple way to define signatures for standard theories
- Logic declarations: define signatures for standard logics
- Makes the library easy to use, in case of standard logics and theories
- Support for future extensions of the standard

High level

At the high level:

- Standard API: the operation of the solver can be completely driven by invoking API methods
- Parser: can read commands from SMT-LIB 2.0 scripts instead of calling API methods programmatically
- API class fully implements commands that do not need solver (set-option, set-logic, declare-fun, declare-sort, etc.)
- Solver interface: defines standard interface to connect with the solver's code (i.e. to invoke the decision procedure, when needed)

Conclusions

Instead of conclusions:

A simple demonstration: EUF theory solver

The library is available at:

`http://www.matf.bg.ac.rs/~milan/software/argosmte/`

THANK YOU