Dynamic Semantic Resolution

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Overview

- Background
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Automated theorem provers (ATP) are computer programs capable of artificial reasoning.

Theoretically, ATP are capable of solving any problem expressed in a formal logic.

Important in the design and verification of logic circuits and computer programs.
Propositional logic and first order logic

A literal can be thought of as a statement that is true or false. i.e. $p, not q, \exists x f(x)\ldots$

A clause is the disjunction of a set of literals. i.e. $p \mid q \mid r, \exists x f(x) \mid \forall y g(y)\ldots$

Resolution is a rule of inference leading to a refutation.

\[
\begin{array}{c|c|c}
A \lor B \lor D & C \lor \neg A \lor E \\
\hline
B \lor D \lor C \lor E
\end{array}
\]
Motivation

Syntactic method VS Semantic method

Search space using binary resolution

Search space using semantic resolution

(Graph retrieved from http://users.cecs.anu.edu.au/~jks/Semantic_Resolution_All.html)
The inputs to the inference are one clause called the nucleus and an arbitrary number of other clauses (not necessarily all different) called satellites.

The semantic constraint is that all satellites and the hyper-resolvent must be false in the guiding model.
Good Model?

Good guiding model VS Bad guiding model

(Graph retrieved from http://users.cecs.anu.edu.au/~jks/Semantic_Resolution_All.html)
Dynamic Semantic Resolution (DSR)

- Dynamic semantic resolution (DSR) uses a changing model to guide the theorem prover.
- The model is developed as the proof search progresses so that the guidance provided is closely adapted to the search’s development.
The main idea of DSR’s algorithm is to build a single semantic resolution inference from a number of semantically constrained binary resolution steps.

The semantic constraint is that all satellites and the hyper-resolvent must be false in the guiding model.
Algorithm

Graph representation of the main loop
The program is written is python and integrate two pre-existing program.

ATP : prover9
It is written by William McCune and modified by John Slaney.
Model generator: Finder
It is written by John Slaney)

Our implementation call each program in turn, analyzing the output from one and generate input for the other.
Implementation

Data flow of the program
Future work

- One extension to integrate DSR directly into prover9.
- Research on how to find good model
- More data and further testing are required.
- Many models may be used at same time to guide the search.
Conclusion

Advantages:
- DSR has shown its potential to reduce the search space when using a good model.
- DSR makes ATP smarter by using semantic information.

Disadvantages:
- DSR is incomplete in general for hyper-resolution
- How to define and find to a good model is still an open question
Reference List.


Thank you!

Any Questions?