Implementing Tableaux Using Binary Decision Diagrams

Initial Seminar

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A Trivial but Real Example

Attempting to change "Advanced Options" for TeXstudio:

Informal modal logic description:

- A wise friend \textit{necessarily} tells the truth (doesn’t lie)
- A wise friend \textit{necessarily} tells not truth (does lie)
- A wise friend \textit{possibly} tells the truth (doesn’t lie)
Practical Applications

Medicine:
  ▶ Galen Common Reference Model

Hardware verification:
  ▶ Pentium FDIV bug

Software Engineering:
  ▶ Program Synthesis and Proof-as-Programs
  ▶ Curry-Howard Correspondence

Mathematics:
  ▶ Computer-aided proofs
  ▶ Four Colour Theorem
Can we implement more efficient theorem provers?

Proof Complexity:
- Time needed to reason about larger systems grows exponentially
- Careful to avoid cycles

Implementing Tableaux using Binary Decision Diagrams:
- Reasoning using modal logic
- Method of semantic tableaux: a well established proof procedure
- Binary Decision Diagrams (BDDs) used to produce highly efficient model checkers: McMillian [1992]
Approach

Preliminaries:
- Modal logic, semantic tableaux methods

Review:
- BDD characteristics, successful applications
- Semantic tableaux provers: current state and approaches

Research:
- Hypothesise methodology for finding efficient provers
- Design and implementation of tableaux provers for basic normal modal logics using BDDs as the underlying data structure
- Measure and assess efficiency and performance
Motivations:

- Important economic and societal applications
- Practical exposure to designing and implementing performant software
- Knuth [2008] considers BDDs "one of the only really fundamental data structures to come out in the last twenty-five years"
- Deeper understanding of logic and exposure to research work