




A SAT-based Approach For Solving The Modal Logic S5-Satisfiability Problem



Thomas Caridroit, Jean-Marie Lagniez,
Daniel Le Berre, Tiago de Lima and Valentin Montmirail

CRIL, Université d'Artois and CNRS, France

{caridroit, lagniez, leberre, delima, montmirail}@cril.fr  UNIVERSITÉ D'ARTOIS

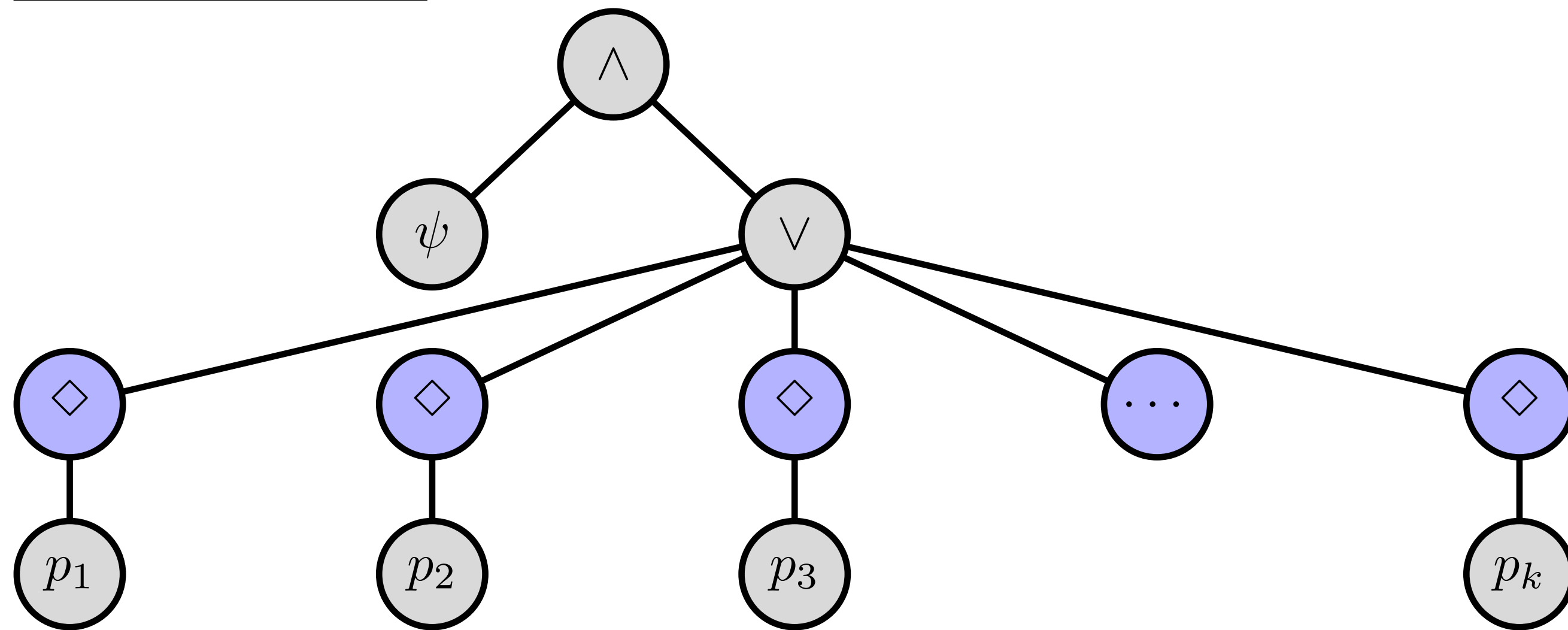
MOTIVATION AND CONTRIBUTIONS

- A SAT-based approach for solving the modal logic S5-satisfiability problem, which is **NP-complete**
- Naive translation leads to huge CNF: How to reduce them ?
 - Syntactic property: diamond degree used as an upper-bound for generating a SAT encoding for the S5-satisfiability
 - A lightweight caching system which allows us to further reduce the size of the propositional formula
- We implemented a generic SAT-based approach within the modal logic S5 solver S52SAT (C++, using Glucose SAT solver as backend)

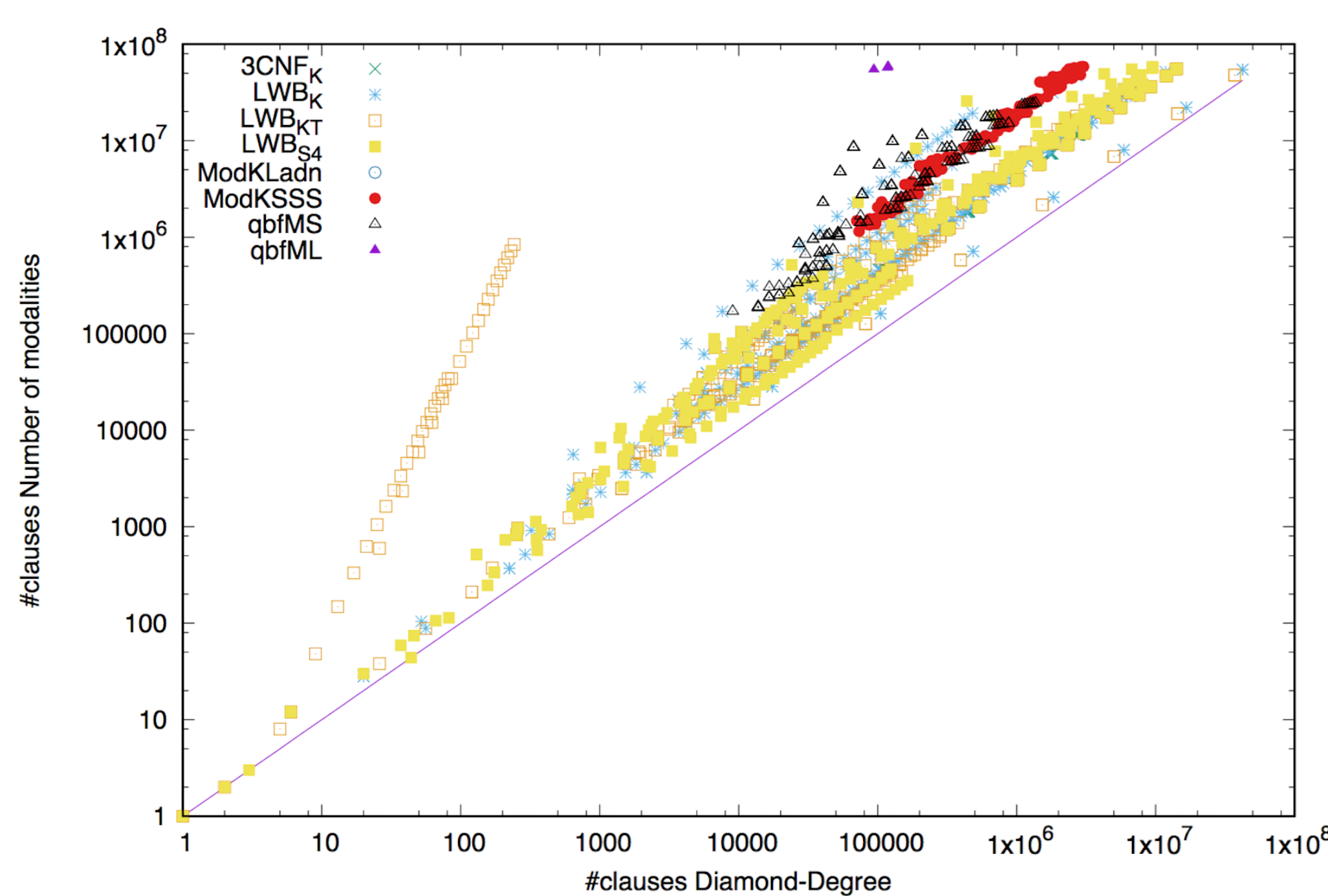
DIAMOND DEGREE

- New upper bound on the number of required worlds (thus #clauses)
- Strictly better than the number of modalities (nm)

Pathological case:

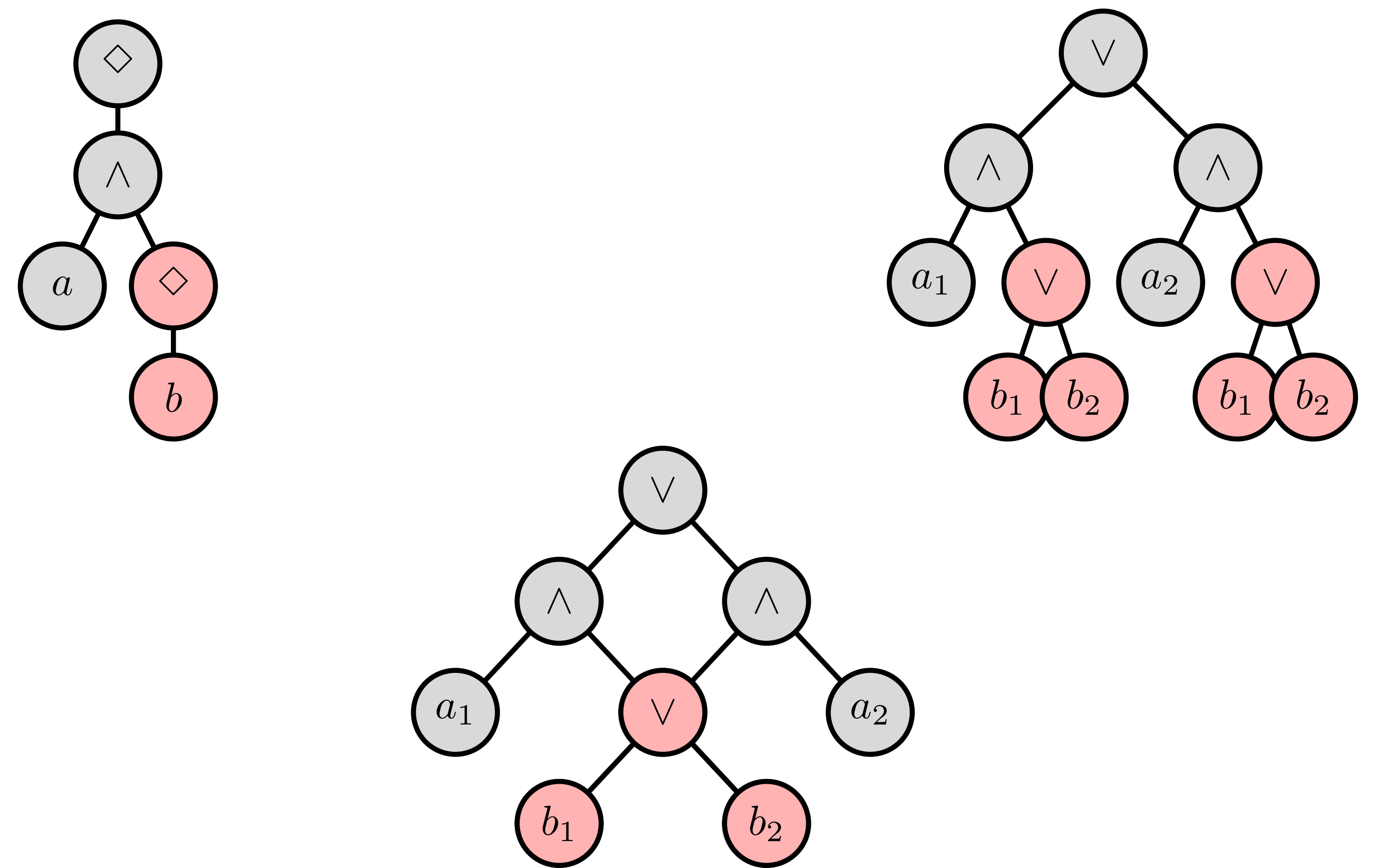


- $nm(\varphi)$ equals k
- $dd(\varphi)$ equals 1
- We just need to satisfy 'one' diamond, not all of them, so we need only one world
- The entire formula needs only $dd(\varphi) + 1$ worlds, to avoid conflict with the actual world

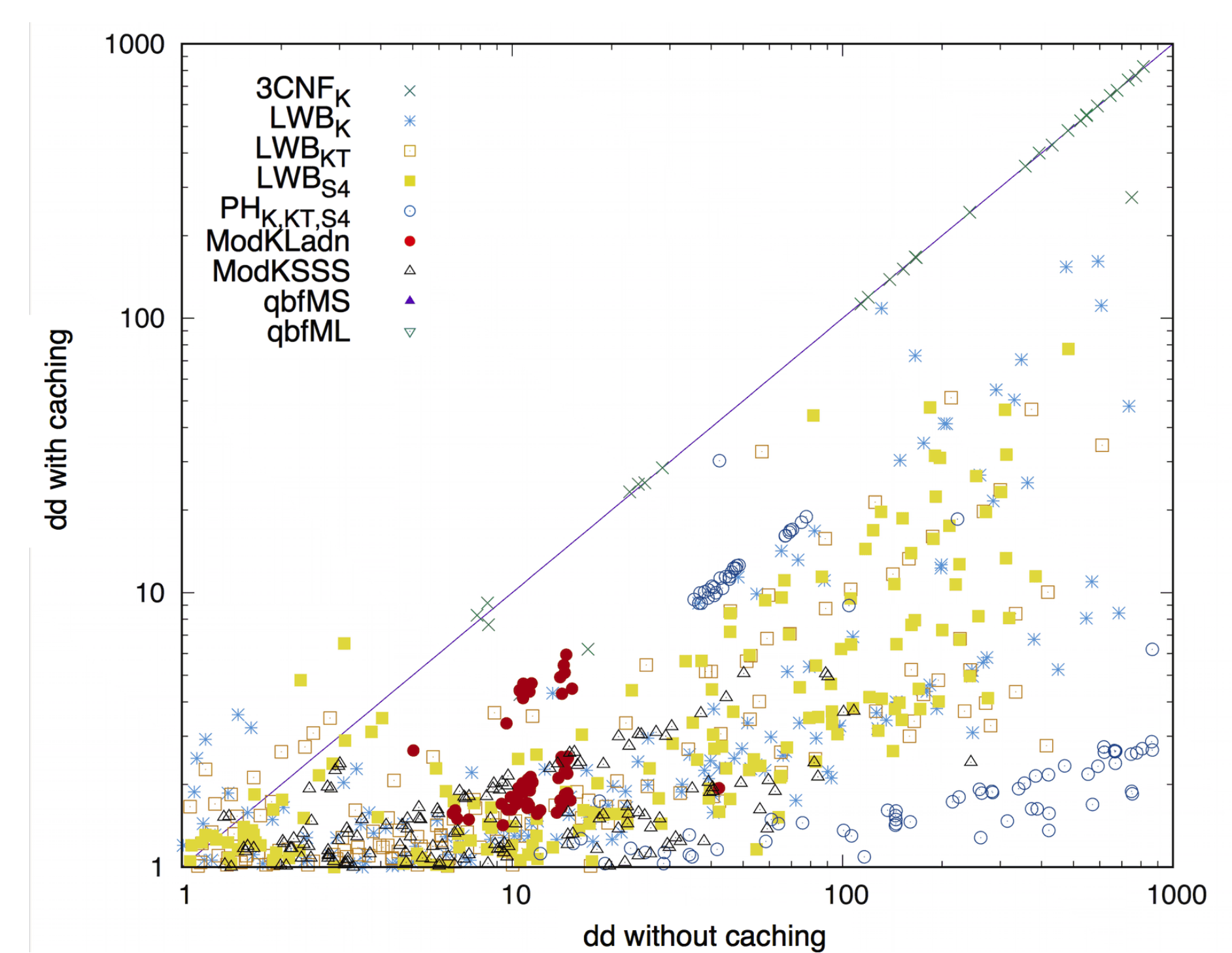


LIGHTWEIGHT CACHING

- In Modal Logic S5: translation of modal terms can be re-used

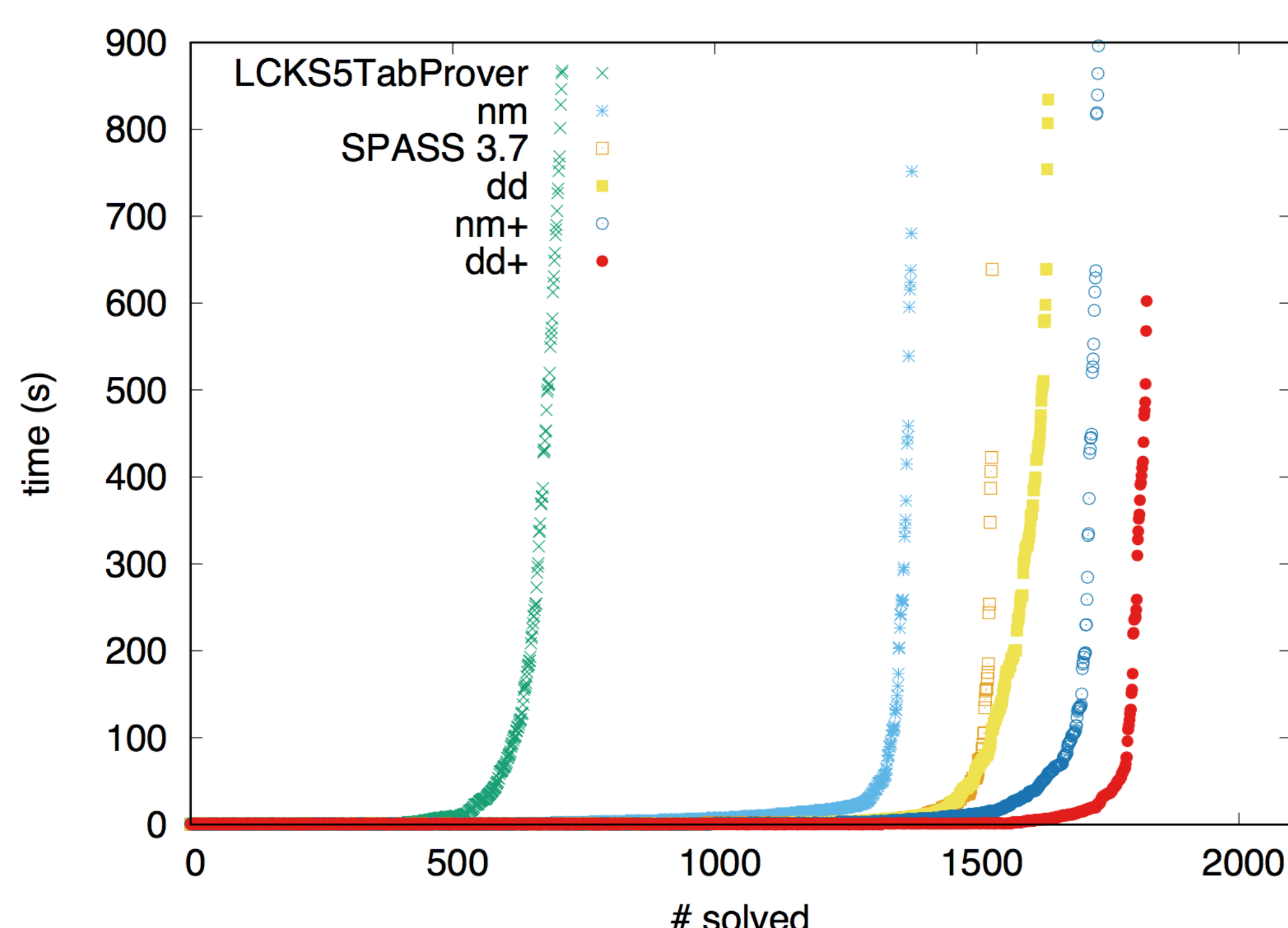


- Using a DAG instead of a Tree → more efficient translation to CNF



It may not cache all possible formulas, but it only requires a flag

EXPERIMENTAL RESULTS



CentOS 6.0, bi-proc. XEON, 4 cores, 3.3 GHz, 8GB, 900 seconds.

EXPERIMENTAL SETTINGS

- 4 different configurations of S52SAT: nm vs dd , with (+) or without caching
- Against LCKS5TabProver and SPASS3.7, the current state-of-the-art in S5-satisfiability solving

CONCLUSION AND FUTURE WORK

- Efficient in practice versus state-of-the-art solvers
- Reasoning toolbox ready for solving NP-complete problems which requires S5 expressiveness
- Can provide a preprocessing step for solving the satisfiability of others modal logics (e.g K, KT, S4)

