

Examination Automated Reasoning

Code 2IMF25, November 8, 2019, 13.30 - 16.30

This examination consists of 5 problems each having the same weight. The final result for this course will be the average of the result for the practical assignment and the result for this examination, as long as both results are at least 5.

Problem 1.

Consider the CNF consisting of the following nine clauses

- | | | |
|----------------------------|-----------------------|---------------------|
| (1) $\neg r \vee \neg s$ | (4) $p \vee q \vee t$ | (7) $\neg s \vee q$ |
| (2) $\neg p \vee \neg q$ | (5) $s \vee r \vee t$ | (8) $p \vee s$ |
| (3) $q \vee \neg r \vee s$ | (6) $r \vee \neg t$ | (9) $p \vee r$ |

- Prove that this CNF is unsatisfiable by using the four rules UnitPropagate, Decide, Fail and Backtrack; make clear at every step which clause was used and what is the corresponding list M of literals.
- In case it is possible to keep the CNF unsatisfiable after removing one clause, argue which clause should be removed to do so.

Problem 2.

Construct the ROBDD of the pseudo boolean constraint $p + 2q + 3r + 4s \leq 5$ with respect to the order $p < q < r < s$.

Problem 3.

- Argue why the CTL formulas $E[\phi U (\neg\phi)]$ and $\neg AG\phi$ are equivalent, or why they are not.
- Let u, v, x, y be variables. Let σ be the most general unifier of $f(x, x, y)$ and $f(g(u), v, f(u, v, v))$. Compute $\sigma(y)$.

Problem 4.

Answer the following questions in at most ten lines each.

- Explain what it means that satisfiability of predicate logic is undecidable.
- Explain how the basic simplex algorithm to find an optimal value starting from a basic solution, can be used to check feasibility of any set of linear inequalities.
- Explain what is meant by Skolemization, and how it plays a role in resolution.

Problem 5.

The term rewriting system R is defined to consist of the rules

$$\begin{aligned} f(g(x)) &\rightarrow h(x, x), \\ h(f(x), g(x)) &\rightarrow x, \\ g(x) &\rightarrow x. \end{aligned}$$

- Prove that R is terminating.
- Give all non-trivial critical pairs of R .
- Determine whether R is confluent.