IA085: Satisfiability and Automated Reasoning

Seminar 5

Exercise 1 *If you didn't write the bounded model checking exercise using incremental* SMT *calls, rewrite it as such. Finish the k-induction exercise from the last seminar.*

Exercise 2 *You know the problem of Satisfiability Modulo Theories (*SMT*), where the task is to compute any model of the given formula. There is a related problem of Optimization Modulo Theories (*OMT*), where the task is to compute for a given formula φ and a term t a model that* minimizes *the value of t.*

For example, given a formula

$$\varphi \quad = \quad (x = 0 \land y \geq 10) \lor (x = 2 \land y \geq 5)$$

over LIA *and a term $t = x + y$, the solution of optimization modulo theories problem would be a model $\mu(x = 2), \mu(y = 5)$.*

Design an algorithm that solves the OMT *problem using potentially multiple queries to an* SMT *solver and implement it in* `pySMT`.

Exercise 3 *Use the congruence closure algorithm to determine which of the following conjunctions of* UF*-literals are satisfiable. Also identify some of the implied equalities and disequalities.*

1. $x = y \land f(x) \neq f(y)$,
2. $f(x) \neq x \land f^2(x) = x \land f^4(x) = x$,
3. $f(x) \neq x \land f^3(x) = x \land f^5(x) = x$.

Exercise 4 *Use the algorithm from the lecture to determine which of the following conjunctions of literals in difference logic over integers are satisfiable. Also identify some of the implied inequalities.*

1. $x - y = 5 \land z - y \leq 3 \land x - z < 4$,
2. $a - b \leq 3 \land c - b \leq 10 \land d - a \leq 1 \land a - d \leq 5 \land c - a \leq 1 \land d - c \geq 3 \land d - b \geq 2$.