Universität Koblenz-Landau

FB 4 Informatik

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Exercises for "Decision Procedures for Verification"
Exercise sheet 9

Exercise 9.1: (*2 P*)
Check the satisfiability of the following ground formula using the algorithm based on congruence closure presented in the lecture.

- $\phi = h(c,e) \approx d \wedge g(d) \approx e \wedge g(h(c,g(d))) \not\approx e.$

You will be able to solve the following exercises after the lecture on Monday, 9. 01. 2023.

Exercise 9.2: (*6 P*)
Check the satisfiability of the following formulae in positive difference logic w.r.t. $\mathbb{Q}$; in case of satisfiability find a satisfying assignment.

(1) $x - y \leq 3 \ \wedge \ y - z \leq 2 \ \wedge \ x - z \leq 1 \ \wedge \ x - u \leq -3.$
(2) $x - y \leq 3 \ \wedge \ y - z \leq 2 \ \wedge \ x - z \leq 1 \ \wedge \ x - u \leq -3 \ \wedge u - x \leq 1.$
(3) $x - y \leq 3 \ \wedge \ y - z \leq 2 \ \wedge \ x - z \leq 1 \ \wedge \ x - u \leq -3 \ \wedge \ u - z \leq 3 \ \wedge \ z - x \leq 1.$

Exercise 9.3: (*4 P*)

(I) Check the satisfiability of the following conjunctions in difference logic w.r.t. $\mathbb{Z}$; in case of satisfiability find a satisfying assignment.
(1) $x - y < 4 \ \wedge \ y - z \leq 2 \ \wedge \ z - x < -3 \ \wedge \ x - u \leq -3.$
(2) $x - y < 4 \ \wedge \ y - z \leq 2 \ \wedge \ z - x \leq -5 \ \wedge \ x - u < -3 \ \wedge u - x \leq 4.$
(3) $x - y < 4 \ \wedge \ y - z \leq 2 \ \wedge \ z - x < -5 \ \wedge \ x - u < -3 \ \wedge u - x \leq 4.$

(II) Check the satisfiability of the following formulae in difference logic w.r.t. $\mathbb{Q}$; in case of satisfiability find a satisfying assignment.
(1) $x - y < 4 \ \wedge \ y - z \leq 2 \ \wedge \ z - x < -5 \ \wedge \ x - u \leq -3.$
(2) $x - y < 4 \ \wedge \ y - z \leq 2 \ \wedge \ z - x \leq -6 \ \wedge \ x - u \leq -4 \ \wedge u - x \leq 4.$
(3) $x - y < 4 \ \wedge \ y - z \leq 2 \ \wedge \ z - x \leq -7 \ \wedge \ x - u < -3 \ \wedge u - x \leq 4.$

Hint: It is sufficient to check the existence of negative cycles in the associated graphs by looking at the graphs; in this assignment you do not have to use the Bellman-Ford algorithm for this.

Please submit your solution until Wednesday, January 11, 2023 at 16:00. Joint solutions prepared by up to three persons are allowed. Please do not forget to write your name on your solution.

Submission possibilities:

- Use the directory Homework 9 in OLAT.