CS 270 Assignment 5 (Correctness of Conjunctive Normal Form algorithm)

Due Fri Dec. 8 at 11:59pm.

This assignment is a follow up to assignment 3, where you implemented functions (cnf) to convert a boolean expression to conjunctive normal form (CNF) and to check that a boolean expression is in conjunctive normal form (is-cnf?). In this assignment you will prove that your function cnf is correct using equational reasoning and induction. In particular, you are to prove

1. (bool-eval (cnf expr) env) = (bool-eval expr env) where expr is a boolean expression and env contains values for all variables in expr
2. (is-cnf? (cnf expr)) where expr is a boolean expression

Proofs of (1) and (2) use structural induction over boolean expressions and require several lemmas which are given as additional questions. See the lecture on Disjunctive Normal Form for analogous proofs. You may assume

1. (is-nnf? (nnf expr))
2. (bool-eval (nnf expr) env) = (bool-eval expr env)

which were proven in the lecture on Disjunctive Normal Form.

If you did not successfully implement cnf and is-cnf? solutions will be made available after the due date of assignment 3.

1) [5 points] In lieu of a readme file, please provide a brief summary of any difficulties you encountered and how much time it took you to complete the assignment.

2) [15 points] Lemma 1 (and (is-cnf? expr1) (is-cnf? expr2)) $\rightarrow$ (is-cnf? (list 'and expr1 expr2)))

3) [15 points] Lemma 2 (and (is-cnf? expr1) (is-cnf? expr2)) $\rightarrow$ (is-cnf? (distrib-orand expr1 expr2))

4) [15 points] Lemma 3 (bool-eval (list 'or expr1 expr2) env) = (bool-eval (distrib-orand exp1 exp2) env)

5) [25 points] (is-cnf? (cnf expr)) = #t

6) [25 points] (bool-eval (cnf expr) env) = (bool-eval expr env) for an arbitrary env containing values for all of the variables occurring in expr.

Assignments should be submitted to BBLearn and should be submitted as a pdf file. Handwritten solutions will not be accepted. You may use Microsoft word, LaTeX or any word processing program for your homework so long as the output is converted to pdf. There are 6 problems with specified point values. Make sure you clearly indicate your base case and inductive hypothesis in your inductive proofs. You should also state the reasoning used in the steps of your proof as was done in the examples from class.