Formal Models SS 2016: Assignment 10

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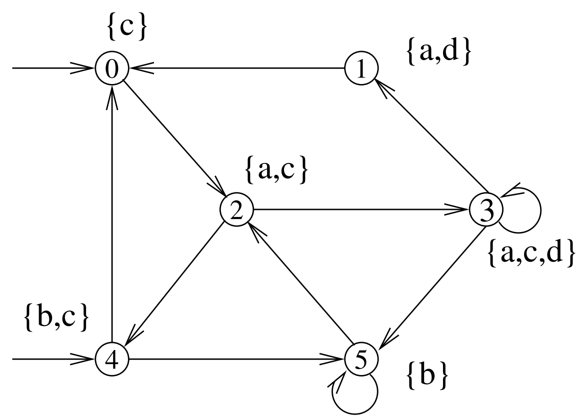
Exercise 37
Given Kripke structure K as shown below. For the following infinite traces π of K and LTL formulae f, determine whether $\pi \models f$ or not.



1. $\pi := (0,2,4)^\omega$ and $f := c\ \mathbf{G}(\mathbf{U}\ b)$
2. $\pi := (0,2,4)^\omega$ and $f := d\ \mathbf{U}\ c$
3. $\pi := (2,3,5)^\omega$ and $f := \mathbf{G}(b \to \mathbf{X}\neg b)$
4. $\pi := 0,2,(3)^\omega$ and $f := \mathbf{FG}\ d$

Which of the following CTL formulas hold in K?

1. $\mathbf{AG}\ (\neg a \to c)$
2. $\mathbf{E}\ ((c \vee d)\ \mathbf{U}\ b)$
3. $\mathbf{AG}\ ((c \wedge d) \to \mathbf{EX}\ a)$
4. $\mathbf{EF}\ ((a \wedge \neg c) \to \mathbf{EX}\ c)$

Exercise 38
Given the propositional formula $(\neg a \vee b) \wedge (\neg b \vee c) \wedge (\neg c \vee d) \wedge (\neg d \vee a)$. Find a quantifier prefix over variables a, b, c, d containing both universal and existential quantification such that the resulting QBF is true. Now find another quantifier prefix such the resulting QBF is false.

Exercise 39

- Given $F = \forall u_1 \exists e_1 \forall u_2 \exists e_2 \forall u_3 \exists e_3 \forall u_4.(u_1 \lor e_2) \land (\neg e_2 \lor \neg u_1) \land (e_1 \lor \neg e_3) \land (u_3) \land (\neg u_2 \lor \neg e_1 \lor u_4) \land (e_2)$
  Determine the unit literals of F. Eliminate the unit literals by BCP.

- Given $F = \forall u_1 \exists e_1 \forall u_2 \exists e_2, e_3 \forall u_3.(u_1 \lor \neg e_1 \lor \neg u_3) \land (\neg e_1 \lor e_2) \land (e_1 \lor e_3) \land (\neg e_3 \lor u_2 \lor \neg u_3) \land (u_1 \lor \neg e_1)$
  Determine the pure literals of F. Remove the pure literals in a satisfiability preserving manner.

- Given $F = \forall u_1 \exists e_1 \forall u_2 \forall u_3 \exists e_2 \exists e_3 \forall u_4 \exists e_4.(e_3 \lor \neg e_2 \lor u_3) \land (u_4 \lor u_3 \lor e_3) \land (\neg e_3 \lor u_4 \lor e_4) \land (e_1 \lor u_1 \lor \neg u_2)$
  Apply universal reduction to F.

Exercise 40
Given the formula

$$\exists x \exists y \exists z \forall a \forall b \forall c((a \lor b \lor c \lor x \lor \neg y) \land (x \lor y \lor a \lor \neg b) \land (z \lor b) \land (\neg y \lor b) \land (\neg y \lor \neg b \lor \neg x))$$

Find an equivalent QBF which is as small as possible. Show which simplification rule you applied.