



**Tutorials for Verification**  
**Exercise sheet 11**

**Exercise 1: Equivalences CTL and LTL**

(a) Show that no two of the following CTL formulas are equivalent and that none is equivalent to the LTL formula  $\diamond(a \wedge \bigcirc a)$ :

(i)  $\forall \diamond(a \wedge \exists \bigcirc a)$       (ii)  $\exists \diamond(a \wedge \forall \bigcirc a)$       (iii)  $\exists \diamond(a \wedge \exists \bigcirc a)$

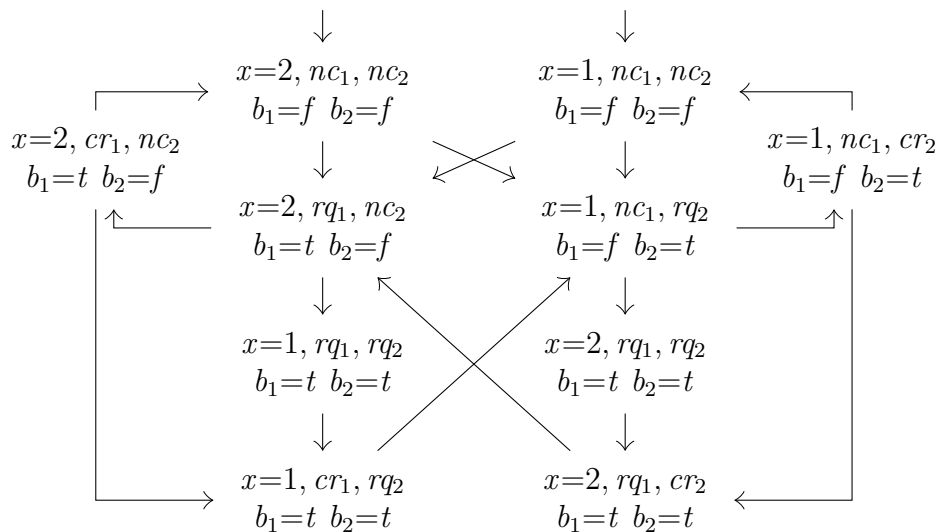
(b) Show that no two of the following CTL formulas are equivalent and that none is equivalent to the LTL formula  $\diamond \square a$ :

(i)  $\forall \diamond \exists \square a$       (ii)  $\exists \diamond \forall \square a$       (iii)  $\exists \diamond \exists \square a$

**Exercise 2: CTL model-checking**

Consider Petersen's mutual exclusion algorithm. The goal is to check the formula

$$nonstarv = \forall \square (rq_1 \rightarrow \forall (rq_1 \cup cr_1))$$



- (a) Convert the formula  $nonstarv$  in existential normal form (ENF).
- (b) Apply the algorithm from the lecture to check for which states of the transition system the above formula holds.

**Exercise 3: Proving that an LTL formula has no equivalent CTL counterpart**

Without using unproven claims from the lecture, show that there is no equivalent CTL formula for the LTL formula  $\diamond \square a$ .

Hint: a possible solution is to look at the theorem 6.3.5 in the script and fill in the gaps.