

## Automated Verification

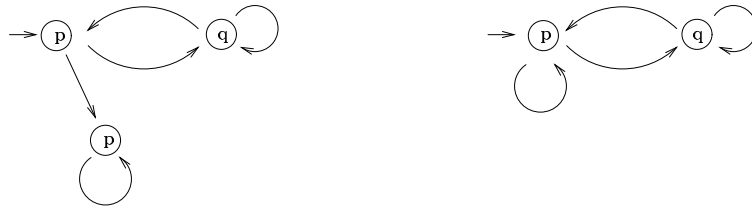
### Assignment 4

(Due on Thu 6th April 2006)

1. Give state-labeled transition systems  $M$  and a state  $s$  in  $M$ , where the following CTL formulas are (a) satisfied and (b) not satisfied.

- (a)  $\text{EFAX}p$
- (b)  $\text{AFE}(p \text{ U } q)$

2. Give LTL and CTL formulas that distinguish the start states of the following transition systems:



3. Show that there are no LTL formulas which are expressively equivalent to the CTL formulas below. Recall that an LTL formula  $\alpha$  and a CTL formula  $\varphi$  are expressively equivalent if they define the same set of (transition system, state) pairs. An LTL formula  $\alpha$  defines the set of all  $(M, q)$  such that all infinite paths starting at  $q$  in  $M$  satisfy  $\alpha$ . Similarly a CTL formula  $\varphi$  defines the set of  $(M, q)$  such that  $\varphi$  is satisfied in state  $q$  in  $M$ .

- (a)  $\text{EFAX}p$
- (b)  $\text{EFAGEF}p$

4. Find transition systems which distinguish the following pairs of CTL\* formulas:

- (a)  $\text{AFG}p$  and  $\text{AFAG}p$
- (b)  $\text{AGF}p$  and  $\text{AGEF}p$ .

5. Use the CTL\* model checking algorithm to label all states in the transition system for the microwave oven example (page 39 of *Model Checking*) which satisfy the formula  $\text{A}(\text{G}\neg\text{heat} \vee \text{F}\neg\text{error})$ .