Problems and Exercises
"Model Checking", SS06
Part 1

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1 CTL and LTL Specifications

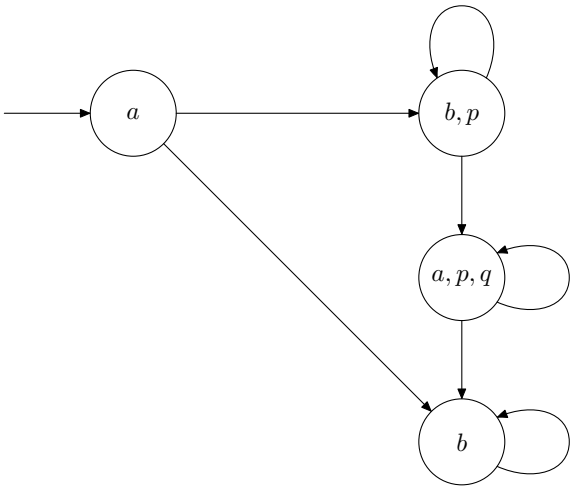

Figure 1: Kripke structure.

1. On the Kripke structure in Figure 1, label the states according to the following specifications:

   (a) **EF**a.

   (b) **AG**a.

(c) $\mathbf{E}a\mathbf{U}b$.

(d) $\mathbf{AG}(p \rightarrow q)$.

(e) $(a \vee q) \rightarrow \mathbf{EX}b$.

2. Let p, q be atomic properties of systems. Express the following specifications in CTL as simply as possible: (There can sometimes be several possible solutions.)

   (a) p can never happen.

   (b) p holds at least twice in the future (i.e., at two different points in time).

   (c) Whenever p holds, then q cannot hold any more.

   (d) Either p holds in one step, or it will never hold.

   (e) If it is possible to reach p at all, then p must be reachable infinitely often.

3. Are the following formulas true, false, or neither ?

   (a) $(\mathbf{AG}p) \rightarrow (\mathbf{AG}\neg p)$.

   (b) $(\mathbf{AG}p) \rightarrow (\mathbf{AG}p)$.

   (c) $(p \wedge \neg p) \leftarrow (q \wedge \neg p)$.

   (d) $(p \wedge \neg p) \rightarrow$ false.

   (e) $(\mathbf{AX}p) \rightarrow (\mathbf{EF}p)$.

4. Represent the following CTL formulas using only **EX**, **EU**, **EG**:

   (a) $\mathbf{EF}(s \wedge \neg r)$

   (b) $\mathbf{AG}(r \rightarrow \mathbf{AF}ack)$

   (c) $\mathbf{AGEF}r$

5. **** Find a Kripke structure K, s such that $K, s \models \mathbf{AFG}p$ but $K, s \not\models \mathbf{AFAG}p$.