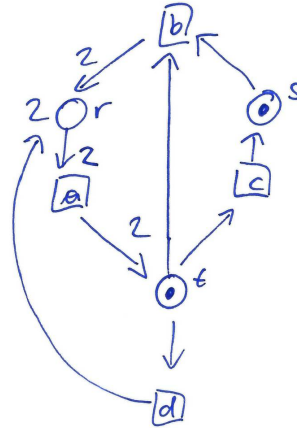


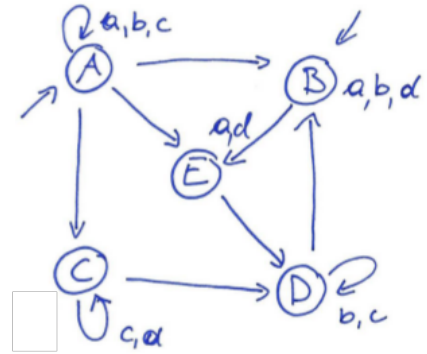
# Exercises

1.) Show the LTS for the following PTN. How many markings are possible in theory?



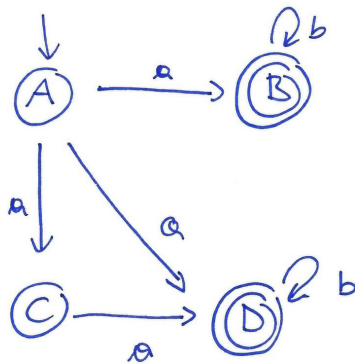
2.) Consider the Kripke structure on the right. Which entailments hold?

1.  $A \models A(cUa)$
2.  $A \models EGd$
3.  $B \models EFAG(b \wedge c)$
4.  $C^\omega \models (cUd)$
5.  $C^\omega \models (cUa)$
6.  $(B, E, D)^\omega \models G(a \rightarrow Xb)$

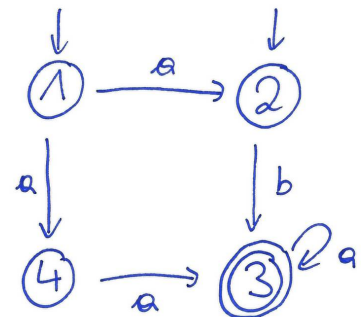


3.) Given automata  $A_1$  and  $A_2$  below. (1) Show the power automaton of  $A_1$ . (2) Show the product automaton of  $A_2$  and the power automaton of  $A_1$ .

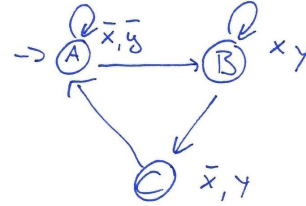
$A_1$



$A_2$



4.) Given the Kripke structure on the right. Formulate a SAT encoding asking if  $G(x \vee \bar{y})$  is violated after two steps.



5.) Given the (buggy) transition function  $x' \leftrightarrow y, y' \leftrightarrow z, z' \leftrightarrow 1$ . Formulate a SAT encoding asking if  $F(\neg x \wedge \neg y \wedge \neg z)$  is violated after three steps starting from initial state  $(\neg x \wedge \neg y \wedge z)$ .

6.) Argue if ACTL formulas  $AX(\neg p \vee A[pUq])$  and  $AXp \vee AX\neg q$  have an equivalent LTL formula.

7.) Do the following HML/CTL formulas hold w.r.t.  $A_1$  from 3.) (ignore the final states)?

1.  $A \models AG([a]\langle b \rangle 1)$
2.  $A \models EX([a][b][a]1 \vee \langle a \rangle 1)$
3.  $B \models A(\langle a \rangle 1U \langle b \rangle 1)$

8.) Interpret  $A_1$  from above as LTS. Transform  $A_1$  to a Kripke structure.

9.) Make  $A_1$  from above deterministic by using the the Oracle construction (both versions).

10.) What are the truth values of the following QBFs. Justify your answer.

- $\forall a \exists b \forall c \exists d. ((c \vee \neg b) \wedge (b \vee d \vee c) \wedge (\neg b \vee \neg c \vee \neg a) \wedge (\neg d \vee \neg b \vee a))$
- $\forall a \exists b \forall c \exists d. ((c \vee \neg b) \wedge (b \vee d \vee c) \wedge (\neg b \vee \neg c \vee \neg a) \wedge (\neg d \vee \neg b \vee a) \wedge (b \vee a))$

11.) Process Algebra

Given the the PA system  $P = Q || R$ , with  $Q = s.a.Q$ , and  $R = s.R + s.b.s.R$ . Draw the LTS defined by  $P$ .