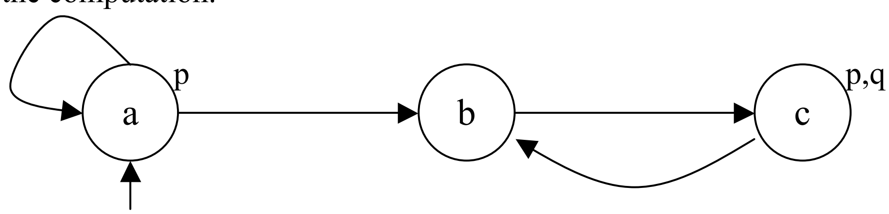
Exercise 2

CTL and CTL Modelchecking

1) Write the following formulas using only the basic operators and show the parse tree for it.
(a) $AG(AF\ p \rightarrow AF\ q)$
(b) $AF(p \vee AG\ q)$

2) For the Kripke structure depicted below.
(a) Explain why $K \models EG\ p$ does or does not hold by referring to the semantics of CTL.
(b) Explain why $K \models AG\ EF\ p$ does or does not hold by referring to the semantics of CTL.
(c) Find the set of states satisfying AG EF p by computing the appropriate fix-points. Show the iterates of the computation.



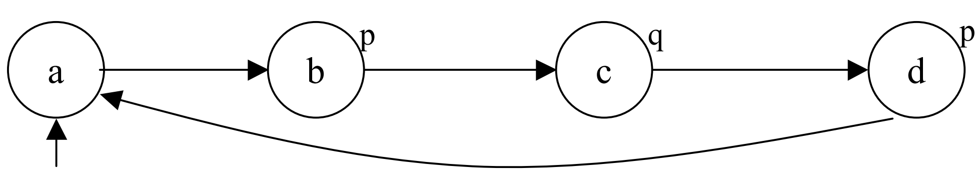
3) Which of the following identities holds? For the equalities that are not valid, show counterexamples (i.e., give a Kripke structure that shows that equality is not valid). For those that are valid, argue why they are so.

(a) $EF(p \vee q) = EF\ p \vee EF\ q$
(b) $EF(p \wedge q) = EF\ p \wedge EF\ q$
(c) $EG(p \vee q) = EG\ p \vee EG\ q$
(d) $EG(p \wedge q) = EG\ p \wedge EG\ q$
(e) $AG((p \wedge q) = AG\ p \wedge AG\ q$

4) Show that $EG\ p = \nu Z.\ p \wedge EX\ Z$.

5) Prove that $EG\ p = EG\ EG\ p$.

6) For the Kripke structure depicted below find the set of states satisfying E p U q by computing the appropriate fix-point. Show the iterates of the computation.



<u>Bonus</u>: When computing E p U q convergence is reached when two successive iterates are identical. Prove that the following conditions are also sufficient to signal convergence to the fix-point: (a) $Z_i=S$, (b) $Z_i= p \vee q$, (c) $Z_i \geq p$.