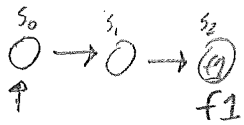
Joseph Blodgett
CS 386
HW 8

1) Assuming of Param

- $[\,](f \to \langle\rangle g) \leftrightarrow f\,U(g \vee !f)$ $\boxed{\text{false}}$ → $f, f, \neg f$ matches $f\,U(g \vee !f)$ but there is no g.

- $X(\langle\rangle f1) \leftrightarrow (X f1)$ $\boxed{\text{false}}$



s_0 meets $X(\langle\rangle f1)$ but not $X f1$.

- $(f\,U g)\,U g \leftrightarrow f\,U g$ $\boxed{\text{true}}$ by idempotentcy.

$f\,U g = \exists n \geq 0 : (\pi[n] \models g \wedge \forall\, 0 \leq k < n : \pi[k] \models f$

$(f\,U g)\,U g =$

$\exists n \geq 0 : (\pi[n] \models g \wedge 0 \leq k < n : \pi[k] \models (\exists n \geq 0 : (\pi[n] \models g \wedge \forall\, 0 \leq k < n : \pi[k] \models f))$

$A \wedge A \wedge B = A \wedge B$

$\exists n \geq 0 : (\pi[n] \models g \wedge \forall\, 0 \leq k < n : \pi[k] \models \pi[n] \models g \wedge \forall\, 0 \leq k < n : \pi[k] \models f)$

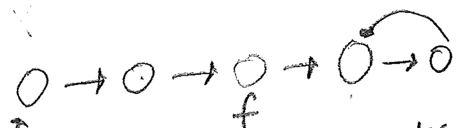
$\exists n \geq 0 : (\pi[n] \models g \wedge \forall\, 0 \leq k < n : \pi[k] \models f)$

which is $f\,U g$.

- $[\,](f \wedge X(\langle\rangle f)) \leftrightarrow [\,]f$ $\boxed{\text{true}}$ $[\,](f \wedge X(\langle\rangle f)) == \underline{[\,]f} \wedge [\,]X(\langle\rangle f))$

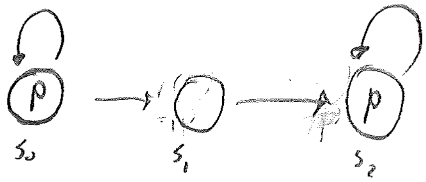
$\leftrightarrow [\,]f$

- $\langle\rangle(f \wedge X([\,]f)) \leftrightarrow \langle\rangle f$ False



meets $\langle\rangle f$ but not $\langle\rangle(f \wedge X([\,]f))$

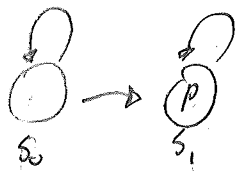
2) $A(F(A(G(p)))) >_{strength} F(G(p))$



- Satisfies LTL FGp but not in CTL $AFAGp$.
- The path that cycles on s_0 has the potential path to hit s_1, thus violating $\overset{AF}{A}G_p$, ^{CTL} but LTL treats any path that goes via s_1 to s_2 to be ... separately.
- thus if we want to say once p, all paths lead to p, use CTL.

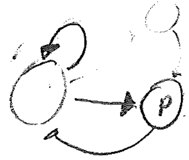
-if any possible path satisfies AFAGp, then all paths will satisfy FGp, thus all structures that satisfy the CTL will satisfy the LTL.

3) $GF_p \overset{strength}{>} AG(EF_p)$.



- Satisfies $AG(EFP)$ but not GF_p because the $s_0 \to s_1$ path will always exist $AG(EF_p)$ is always satisfied on the path that loops s_0, when $s_0, s_0, s_0, \ldots$ does not satisfy GF_p.
- Any structure that all paths Globally meet FP will have at least one Path that meets it, thus all structures that meet the LTL will satisfy the CTL formula.

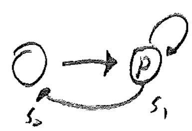
4) $\underset{CTL^*}{E(G(F\,p))} \not\equiv \overset{CTL}{E(G(EF\,p))}$



Satisfies $E(G(EF_p))$ but not $E(G(F_p))$ as There is no path that leads to always F_p (as you can get caught in a loop is s_0) but that path always exists, thus

$E(G(F_p)) > E(G(EF_p))$

$EG(F_p)) \not\equiv E(G(AF_p))$



Satisfies $EG(F_p)$ but not $E(G(AF_p))$ because there exists a path where Globally Future p, but because there Exists an escape from the loop on s_1, AF_p can never be Globally satisfied.

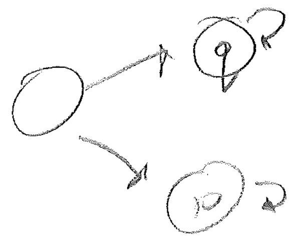
thus

$E(G(AF_p)) > EG(F_p)$

5) $EF_p \,||\, EF_q == EF(p||q)$

Yes they are equivalent, all we're asking is that there is a p or a q, which both formulas query properly

6) $AF_p \,||\, AF_q \;!= AF(p||q)$ No



← satisfies $AF(p||q)$ but not $(AF_p \,||\, AF_q)$ as we're asserting p or q existing on all paths with $AF_p \,||\, AF_q$ but not with $AF(p||q)$