Model Satisfaction

Given:

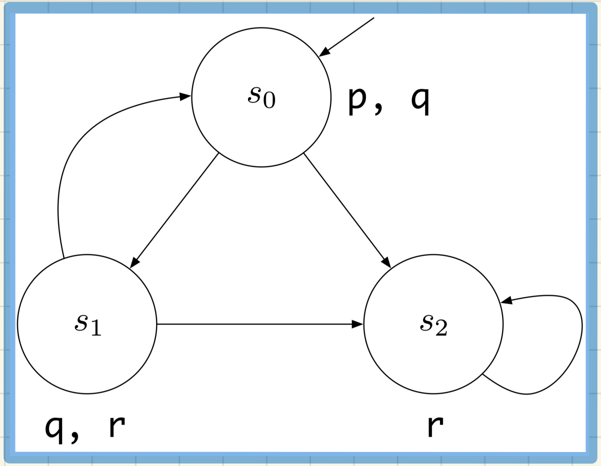
- Model $M = (S, \longrightarrow, L)$
- State $s \in S$
- LTL Formula ϕ

$M, s \vDash \phi$ **iff** for every path π of M starting at s, $\pi \vDash \phi$.

Formulation (over **all** paths)

How to prove vs. disprove $M, s \vDash \phi$?

Model vs. Path Satisfaction: Exercises (1.2)



$s \models p \Leftrightarrow$ all π starting at s, $\pi \models p$

$s_0 \models \top$

$s_0 \not\models \bot$

$s_0 \models p \land q$

$s_0 \models p \lor q$

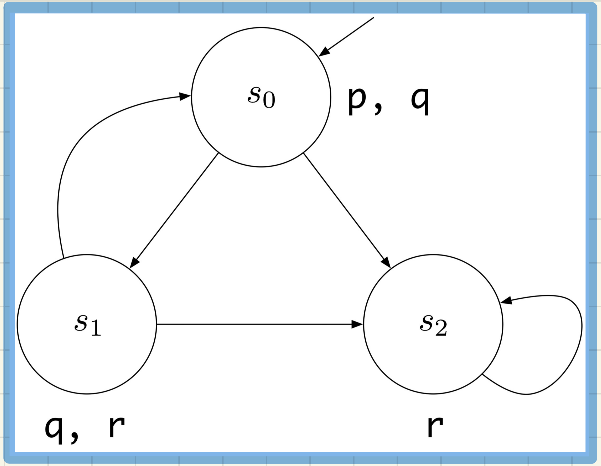
$s_0 \models p \Rightarrow q$

$s_0 \models r$

$s_0 \models r \Rightarrow p \land q \land r$

Exercise: What if we change the LHS to s_1?

Model vs. Path Satisfaction: Exercises (2.1)



Recall: $\pi \models \mathbf{X}\ \phi \Leftrightarrow \pi^2 \models \phi$

Say: $\pi = s_0 \longrightarrow s_1 \longrightarrow s_2 \longrightarrow s_2 \longrightarrow \ldots$

$\pi \models \mathbf{X}\ \top$

$\pi \not\models \mathbf{X}\ \bot$

$\pi \models \mathbf{X}\ (q \land r)$

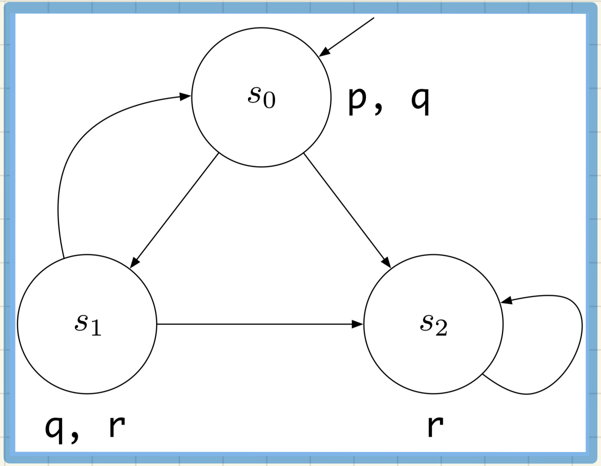
$\pi \models \mathbf{X}\ q \land r$

$\pi \models \mathbf{X}\ (q \Rightarrow r)$

$\pi \models \mathbf{X}\ q \Rightarrow r$

Exercise: What if we change the LHS to π^2?

Model vs. Path Satisfaction: Exercises (2.2)



$s \models \phi \Leftrightarrow$ all π starting at s, $\pi \models \phi$

$s_0 \models \mathbf{X} \top$

$s_0 \not\models \mathbf{X} \bot$

$s_0 \models \mathbf{X} (q \wedge r)$

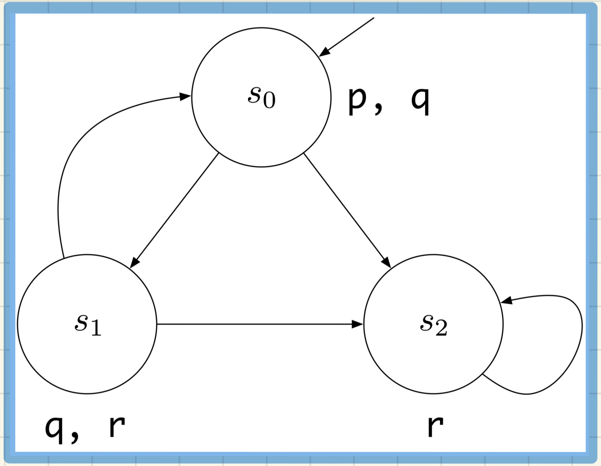
$s_0 \models \mathbf{X} q \wedge r$

$s_0 \models \mathbf{X} (q \Rightarrow r)$

$s_0 \models \mathbf{X} q \Rightarrow r$

Exercise: What if we change the LHS to s_1?

Model vs. Path Satisfaction: Exercises (3.1)



$\pi \models G\ \phi \iff \forall i \bullet i \geq 1 \Rightarrow \pi^i \models \phi$

Say: $\pi = s_0 \rightarrow s_1 \rightarrow s_2 \rightarrow s_2 \rightarrow \ldots$

$\pi \models G\ \top$

$\pi \not\models G\ \bot$

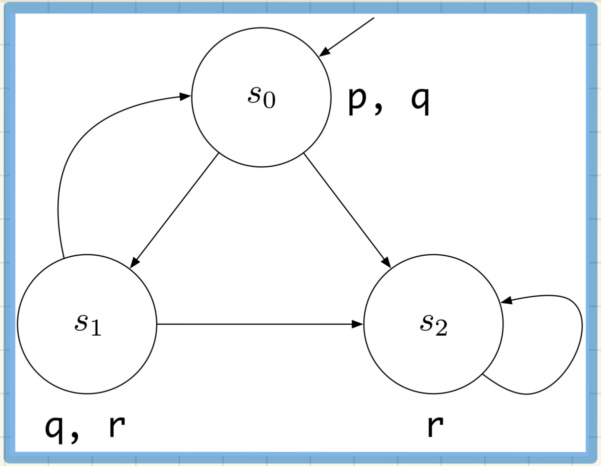
$\pi \models G\ \neg(p \land r)$

$\pi \models G\ r$

$\pi \models G\ r$

Exercise: What if we change the LHS to π^2?

Model vs. Path Satisfaction: Exercises (3.2)



$s \models \phi \Leftrightarrow$ all π starting at s, $\pi \models \phi$

$s_0 \models \mathbf{G}\ \top$

$s_0 \not\models \mathbf{G}\ \bot$

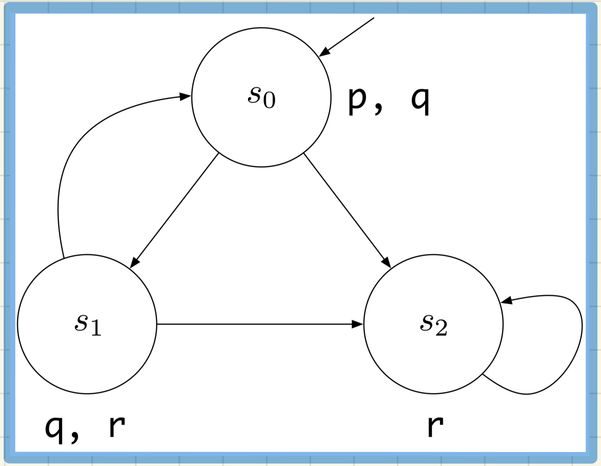
$s_0 \models \mathbf{G}\ \neg(p \land r)$

$s_0 \models \mathbf{G}\ r$

$s_2 \models \mathbf{G}\ r$

Exercise: What if we change the LHS to s_1?

Model vs. Path Satisfaction: Exercises (4.1)



$\pi \models \mathbf{F}\ \phi \Leftrightarrow \exists i \bullet i \geq 1 \land \pi^i \models \phi$

Say: $\pi = s_0 \rightarrow s_1 \rightarrow s_2 \rightarrow s_2 \rightarrow \ldots$

$\pi \models \mathbf{F}\ \top$

$\pi \not\models \mathbf{F}\ \bot$

$\pi \models \mathbf{F}\ \neg(p \land r)$

$\pi \models \mathbf{F}\ r$

$\pi \models \mathbf{F}\ (q \land r)$

Exercise: What if we change the LHS to π^2?