CSC410

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Step 3: model checking against an LTL/CTL property

For LTL, you would need to know/learn about automata on infinite words ....

CTL Model Checking

CTL Expansion Laws

$$\begin{aligned}
\exists(\Phi \,\mathsf{U}\, \Psi) &\equiv \Psi \lor (\Phi \land \exists\bigcirc \exists(\Phi \,\mathsf{U}\, \Psi)) \\
\exists\Diamond\Phi &\equiv \Phi \lor \exists\bigcirc \exists\Diamond\Phi \\
\exists\Box\Phi &\equiv \Phi \land \exists\bigcirc \exists\Box\Phi
\end{aligned}$$

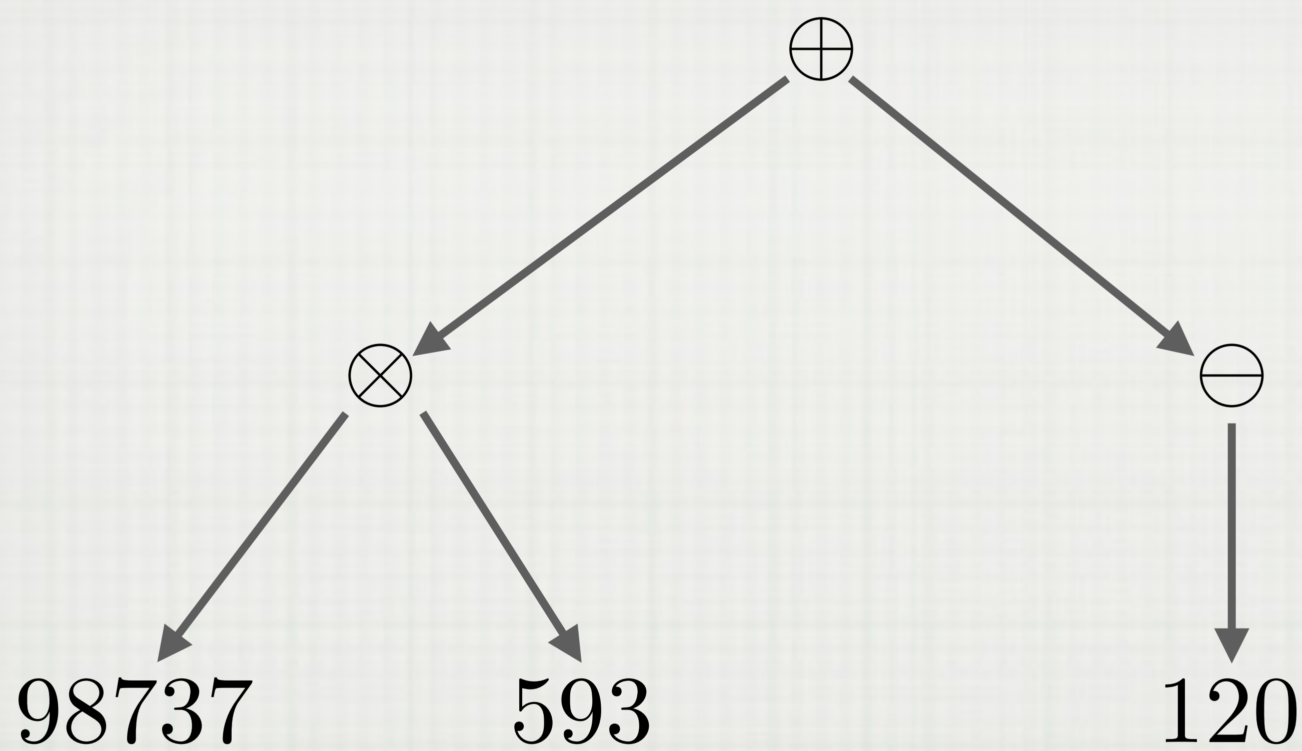
Lemma. Until is the least solution to the expansion law.

The following equation has many solutions:

$$F \equiv \Psi \lor (\Phi \land \exists\bigcirc F)$$

Until is the smallest set that satisfies this equation.

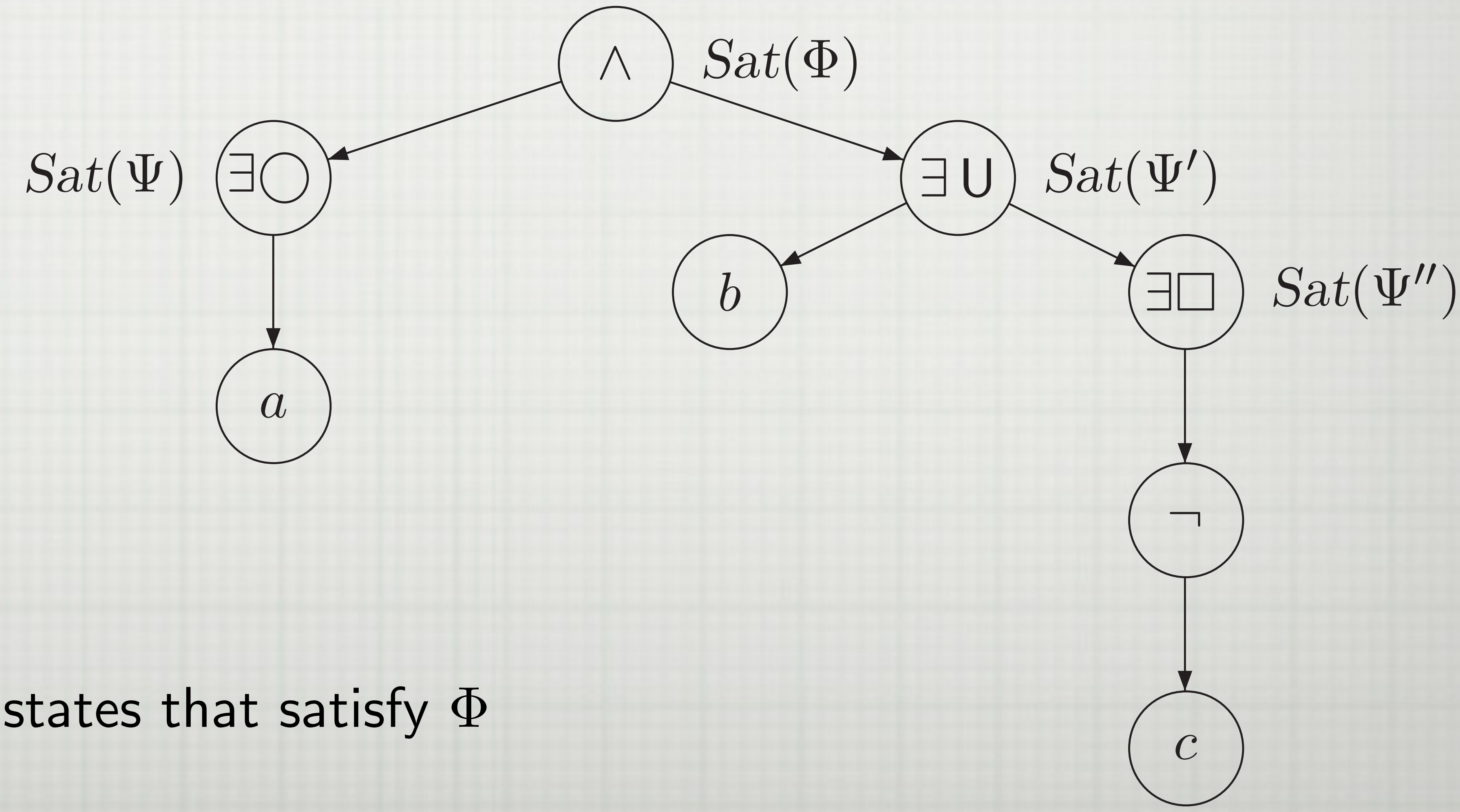
Idea



$$(98737 \otimes 593) \oplus (\ominus 120)$$

Idea

$$\Phi \;=\; \underbrace{\exists\bigcirc a}_{\Psi} \;\wedge\; \underbrace{\exists(b\,\mathsf{U}\,\underbrace{\exists\Box\neg c}_{\Psi''})}_{\Psi'}$$



$Sat(\Phi)$: set of all states that satisfy Φ

Let's invent the algorithm together ....

Watch the white board lecture!

Recursive Rules for ENF

(a) $Sat(true) = S$,

(b) $Sat(a) \;=\; \{\, s \in S \mid a \in L(s) \,\}$, *for any* $a \in AP$,

(c) $Sat(\Phi \wedge \Psi) \;=\; Sat(\Phi) \,\cap\, Sat(\Psi)$,

(d) $Sat(\neg\Phi) \;=\; S \setminus Sat(\Phi)$,

(e) $Sat(\exists\bigcirc\,\Phi) \;=\; \{\, s \in S \mid Post(s) \cap Sat(\Phi) \neq \varnothing \,\}$,

(f) $Sat(\exists(\Phi \,\mathsf{U}\, \Psi))$ *is the smallest subset* T *of* S, *such that*

(1) $Sat(\Psi) \subseteq T$ *and* (2) $s \in Sat(\Phi)$ *and* $Post(s) \cap T \neq \varnothing$ *implies* $s \in T$,

(g) $Sat(\exists\Box\,\Phi)$ *is the largest subset* T *of* S, *such that*

(3) $T \subseteq Sat(\Phi)$ *and* (4) $s \in T$ *implies* $Post(s) \cap T \neq \varnothing$.

Final words on Model Checking ...