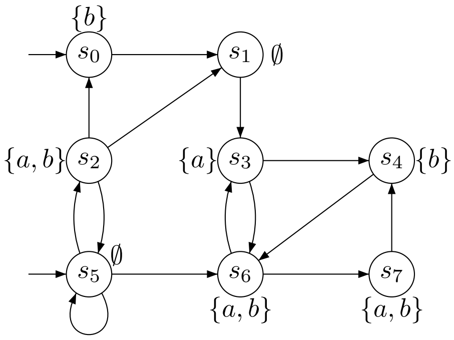
Exercise 1 (CTL-star): (3 points)

Consider the CTL*-formula (over $AP = \{a, b\}$)

$$\Phi = \forall\Diamond\Box\exists\bigcirc(a \mathsf{U} \exists\Box b)$$

and the transition system TS outlined below:



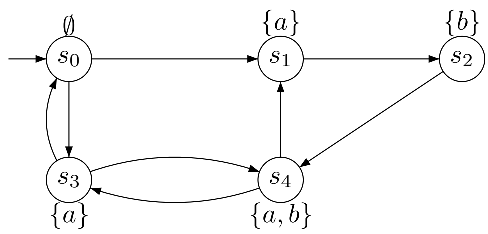
Apply the CTL* Model Checking Algorithm to compute $Sat(\Phi)$ and decide whether $TS \models \Phi$.
Hint: You may infer the satisfaction sets for LTL formulas directly.

Exercise 2 (Fair-CTL Model Checking): (3 points)

Consider the CTL-formula $\Phi = \forall\Box(a \rightarrow \forall\Diamond(b \wedge \neg a))$ together with the following CTL fairness assumption

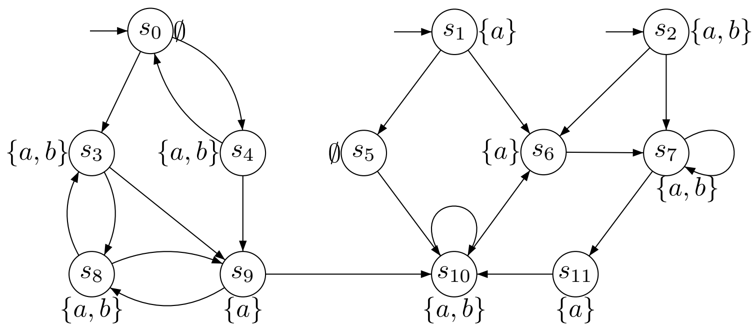
$$fair = \Box\Diamond\forall\bigcirc(a \wedge \neg b) \rightarrow \Box\Diamond\forall\bigcirc(b \wedge \neg a)$$
$$\wedge\ \Diamond\Box\exists\Diamond b \rightarrow \Box\Diamond b.$$

Check that $TS \models_{fair} \Phi$!



Exercise 3 (Bisimulation I): (2 points)

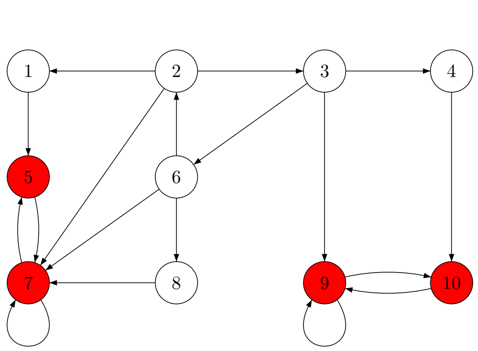
Consider the transition system TS over $AP = \{a, b\}$ outlined below:



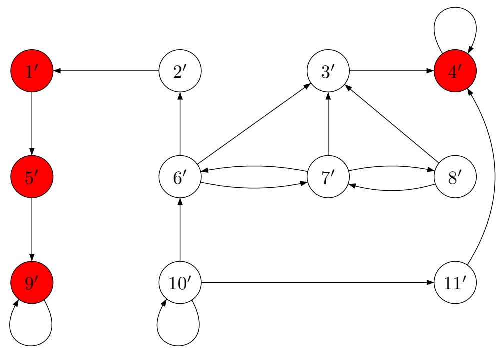
1. Determine the bisimulation equivalence $\sim_{TS}$ and depict the bisimulation quotient system $TS/\sim$.
2. For each bisimulation equivalence class C, provide a CTL formula Φ_C that holds only in the states in C.

Exercise 4 (Bisimulation II): (2 points)

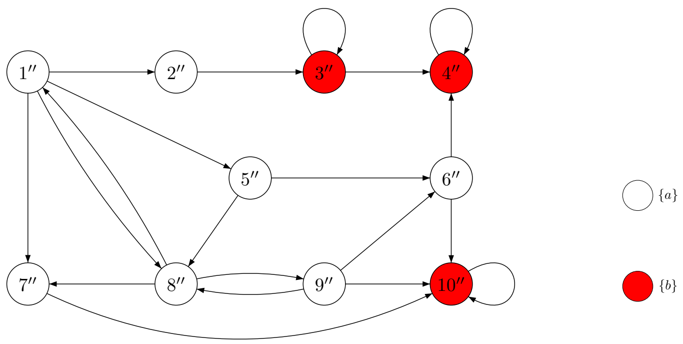
Consider the following three transition systems TS_1, TS_2, and TS_3, where all the states labelled with $\{a\}$ are initial states. Decide whether $TS_i \sim TS_j$ for $i, j \in \{1, 2, 3\}$ and $i \neq j$. If $TS_i \not\sim TS_j$, then provide a distinguishing CTL formula Φ such that $TS_i \models \Phi \iff TS_j \not\models \Phi$.



(a) TS_1



(b) TS_2



(c) TS_3