

ASSIGNMENT 3B

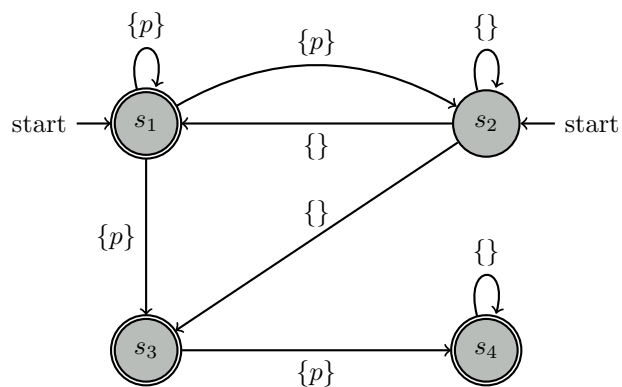
1. $\alpha = XFp$.

$$Voc(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4\}$$

$$I = \{s_1, s_2\}$$

$$G = \{s_1, s_3, s_4\}$$



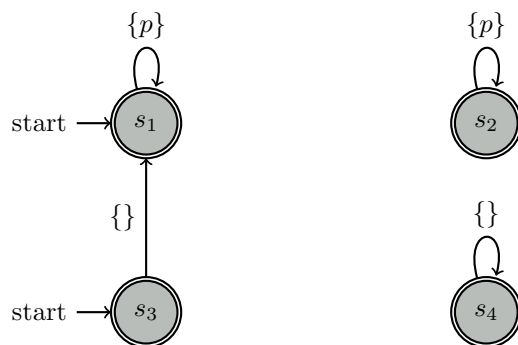
2. $\alpha = XGp$.

$$Voc(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4\}$$

$$I = \{s_1, s_3\}$$

$$G = \{s_1, s_2, s_3, s_4\}$$



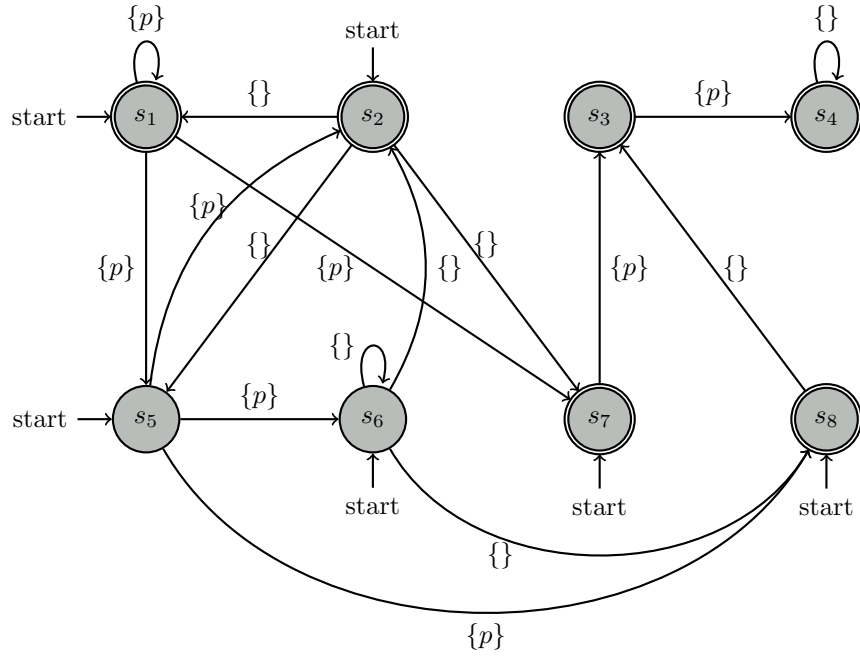
3. $\alpha = FXp$.

$$Voc(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$

$$I = \{s_1, s_2, s_5, s_6, s_7, s_8\}$$

$$G = \{s_1, s_2, s_3, s_4, s_7, s_8\}$$



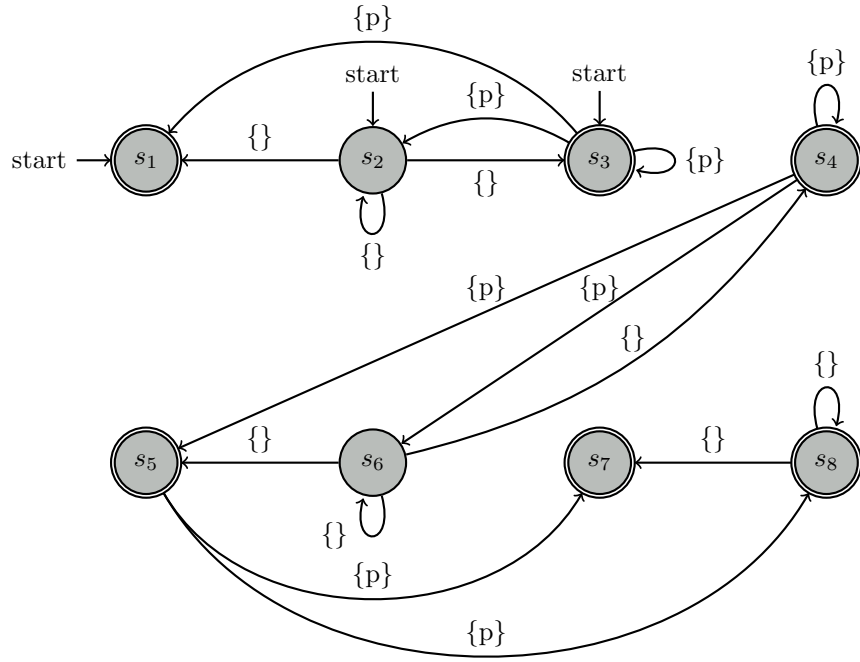
4. $\alpha = GFp$.

$$Voc(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$

$$I = \{s_1, s_2, s_3\}$$

$$G = \{s_1, s_3, s_4, s_5, s_7, s_8\}$$



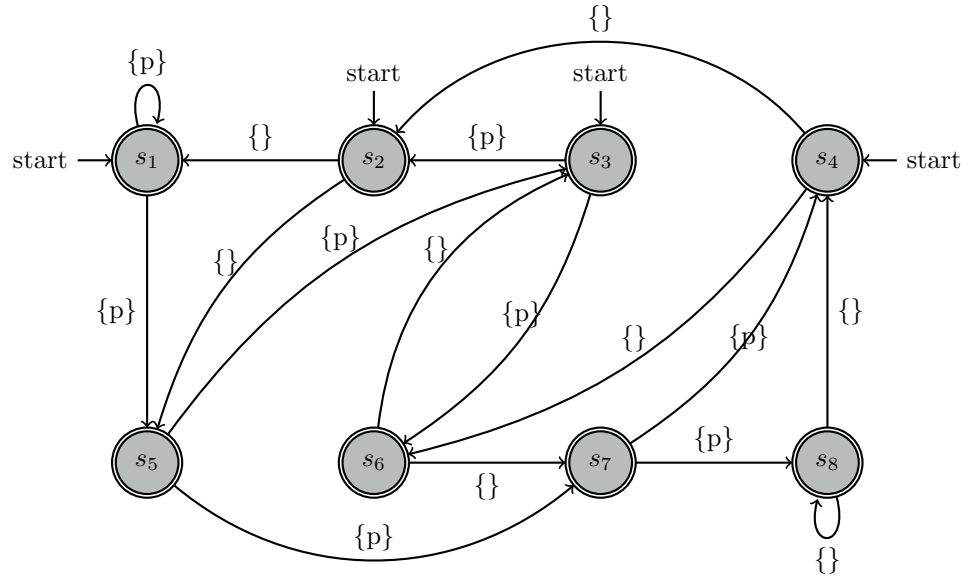
5. $\alpha = XXp$.

$$\text{Voc}(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$

$$I = \{s_1, s_2, s_3, s_4\}$$

$$G = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$



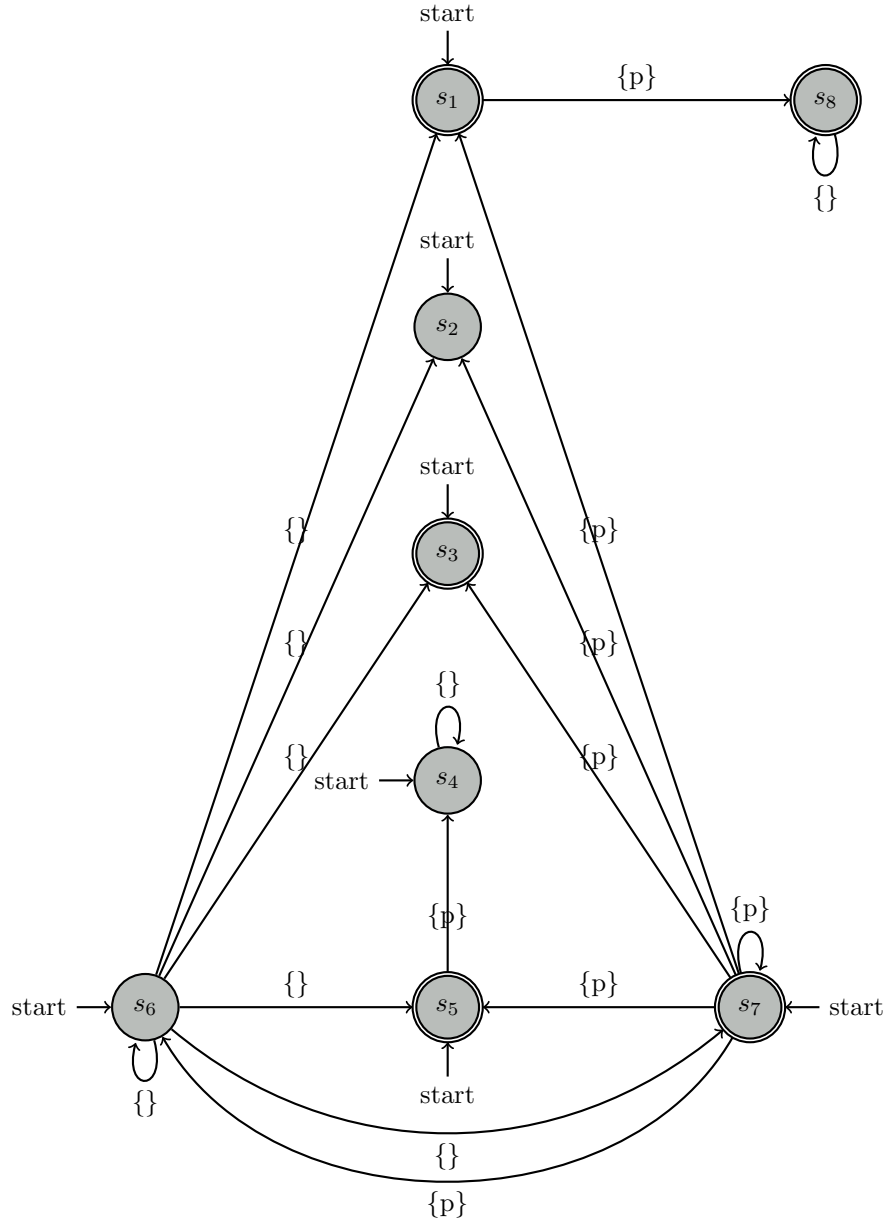
6. $\alpha = FFp$.

$$Voc(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$

$$I = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\}$$

$$G = \{s_1, s_3, s_5, s_7, s_8\}$$



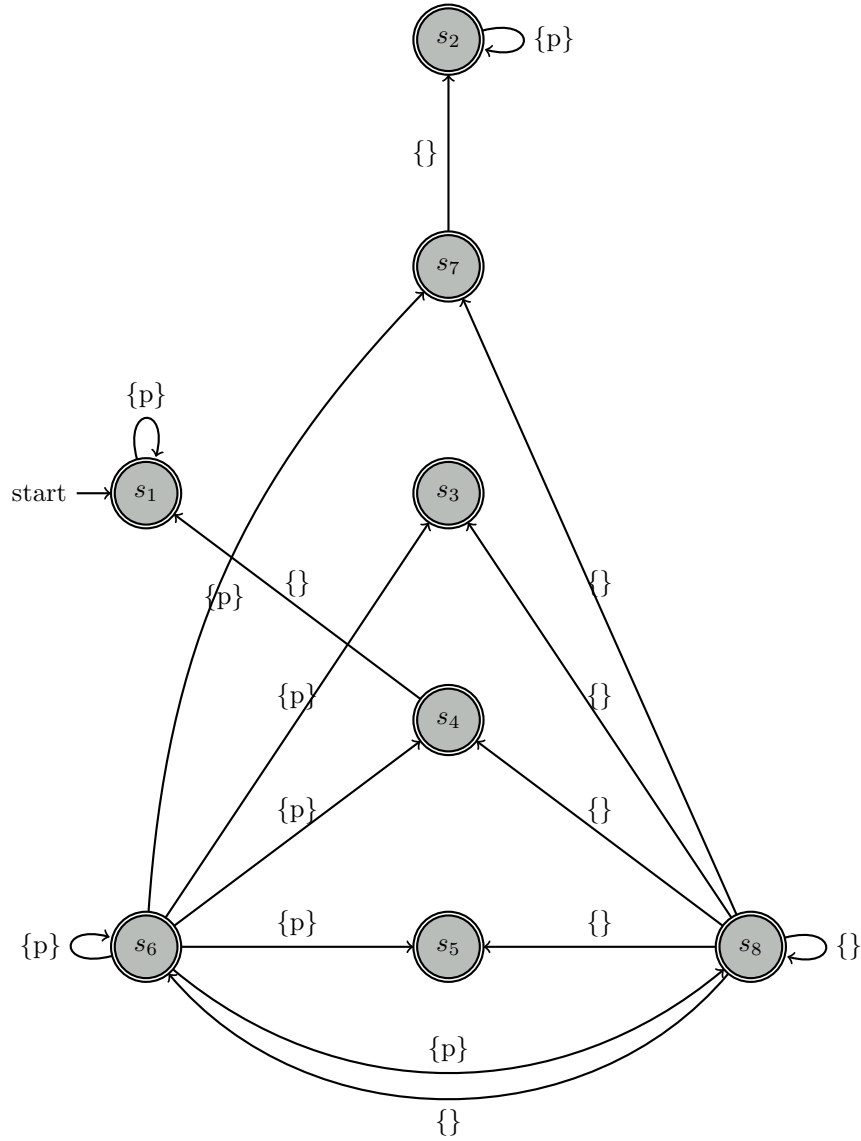
7. $\alpha = GGp$.

$$Voc(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$

$$I = \{s_1\}$$

$$G = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$



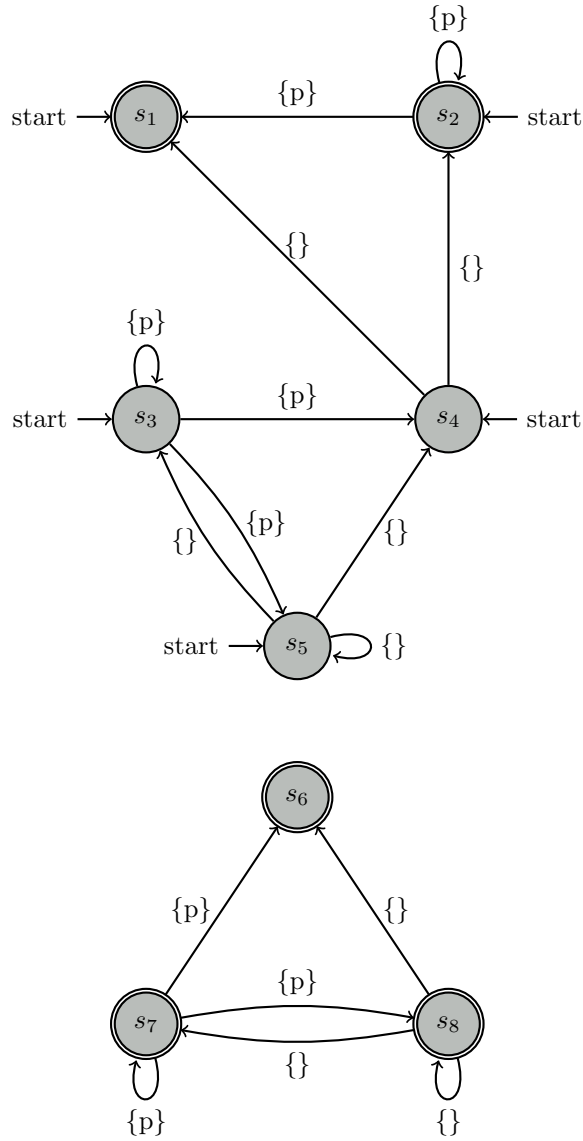
8. $\alpha = FGp$.

$$Voc(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$

$$I = \{s_1, s_2, s_3, s_4, s_5\}$$

$$G = \{s_1, s_2, s_6, s_7, s_8\}$$



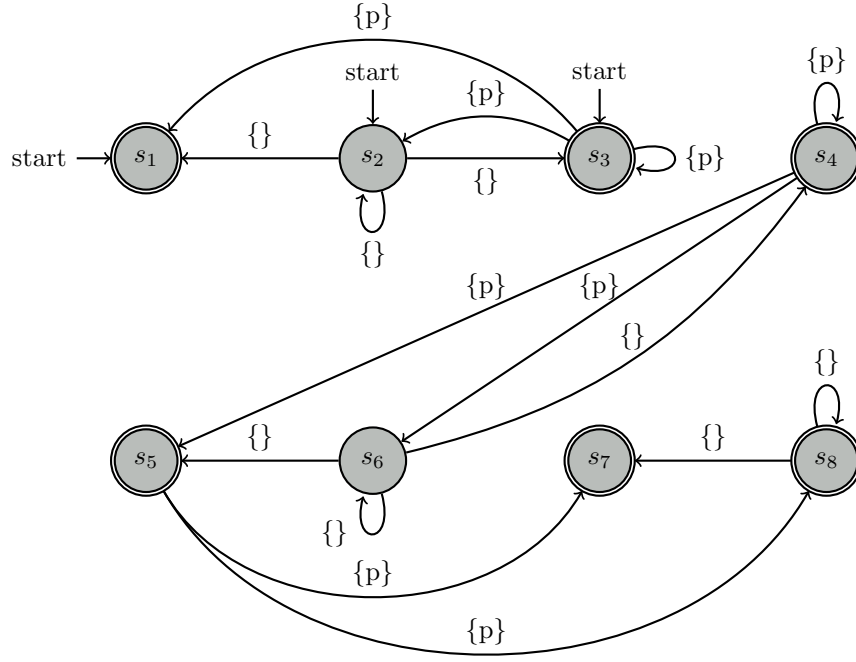
9. $\alpha = GFp$.

$$Voc(\alpha) = \{p\}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8\}$$

$$I = \{s_1, s_2, s_3\}$$

$$G = \{s_1, s_3, s_4, s_5, s_7, s_8\}$$



10. $\alpha = Fp \vee Fq$.

$$Voc(\alpha) = \{p, q\}$$

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\}$$

$$I = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}\}$$

$$G = \{s_1, s_3, s_4, s_6, s_7, s_9, s_{10}, s_{12}, s_{16}\}$$

Transitions

$$s_1 \xrightarrow{\{p\}} \{s_{16}\}$$

$$s_5 \xrightarrow{\{q\}} \{s_4, s_5, s_6\}$$

$$s_2 \xrightarrow{\{p\}} \{s_1, s_2, s_3\}$$

$$s_6 \xrightarrow{\{q\}} \{s_4, s_5, s_6\}$$

$$s_3 \xrightarrow{\{p\}} \{s_1, s_2, s_3\}$$

$$s_7 \xrightarrow{\{p, q\}} \{s_1, s_2, s_3\}$$

$$s_4 \xrightarrow{\{q\}} \{s_{16}\}$$

$$s_8 \xrightarrow{\{p\}} \{s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}\}$$

$$\begin{array}{ll}
s_9 \xrightarrow{\{p,q\}} \{s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}\} & \\
s_{10} \xrightarrow{\{p,q\}} \{s_{16}\} & \\
s_{11} \xrightarrow{\{p\}} \{s_4, s_5, s_6\} & s_{14} \xrightarrow{\{\}} \{s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}\} \\
s_{12} \xrightarrow{\{p,q\}} \{s_4, s_5, s_6\} & s_{15} \xrightarrow{\{q\}} \{s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}\} \\
s_{13} \xrightarrow{\{q\}} \{s_1, s_2, s_3\} & s_{16} \xrightarrow{\{\}} \{s_{16}\}
\end{array}$$

11. $\alpha = Gp \wedge Gq$.

$$\begin{aligned}
Voc(\alpha) &= \{p, q\} \\
S &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\} \\
I &= \{s_1\} \\
G &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\}
\end{aligned}$$

Transitions

$$\begin{array}{ll}
s_1 \xrightarrow{\{p,q\}} \{s_1\} & s_9 \xrightarrow{\{q\}} \{s_5, s_6, s_7\} \\
s_2 \xrightarrow{\{q\}} \{s_1\} & s_{10} \xrightarrow{\{\}} \{s_5, s_6, s_7\} \\
s_3 \xrightarrow{\{p,q\}} \{s_2, s_3, s_4\} & s_{11} \xrightarrow{\{p\}} \{s_2, s_3, s_4\} \\
s_4 \xrightarrow{\{q\}} \{s_2, s_3, s_4\} & s_{12} \xrightarrow{\{p,q\}} \{s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\} \\
s_5 \xrightarrow{\{p\}} \{s_1\} & s_{13} \xrightarrow{\{p\}} \{s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\} \\
s_6 \xrightarrow{\{p,q\}} \{s_5, s_6, s_7\} & s_{14} \xrightarrow{\{q\}} \{s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\} \\
s_7 \xrightarrow{\{p\}} \{s_5, s_6, s_7\} & s_{15} \xrightarrow{\{\}} \{s_2, s_3, s_4\} \\
s_8 \xrightarrow{\{\}} \{s_1\} & s_{16} \xrightarrow{\{\}} \{s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\}
\end{array}$$

12. $\alpha = F(p \rightarrow Gq)$.

$$\begin{aligned}
Voc(\alpha) &= \{p, q\} \\
S &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\} \\
I &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}\} \\
G &= \{s_1, s_2, s_3, s_4, s_5, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\}
\end{aligned}$$

Transitions

$$\begin{array}{ll}
s_1 \xrightarrow{\{q\}} \{\} & s_5 \xrightarrow{\{\}} \{s_{14}, s_{15}, s_{16}\} \\
s_2 \xrightarrow{\{p,q\}} \{\} & s_6 \xrightarrow{\{p\}} \{s_1, s_2, s_{12}, s_{13}\} \\
s_3 \xrightarrow{\{\}} \{\} & s_7 \xrightarrow{\{p,q\}} \{s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}\} \\
s_4 \xrightarrow{\{q\}} \{s_{14}, s_{15}, s_{16}\} & s_8 \xrightarrow{\{p\}} \{s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}\}
\end{array}$$

$$\begin{array}{ll}
s_9 \xrightarrow{\{\}} \{s_1, s_2, s_{12}, s_{13}\} & \\
s_{10} \xrightarrow{\{q\}} \{s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}\} & \\
s_{11} \xrightarrow{\{\}} \{s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}\} & s_{14} \xrightarrow{\{p,q\}} \{s_{14}, s_{15}, s_{16}\} \\
s_{12} \xrightarrow{\{p,q\}} \{s_1, s_2, s_{12}, s_{13}\} & s_{15} \xrightarrow{\{p\}} \{\} \\
s_{13} \xrightarrow{\{q\}} \{s_1, s_2, s_{12}, s_{13}\} & s_{16} \xrightarrow{\{p\}} \{s_{14}, s_{15}, s_{16}\}
\end{array}$$

13. $\alpha = G(p \rightarrow Fq)$.

$$\begin{aligned}
Voc(\alpha) &= \{p, q\} \\
S &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\} \\
I &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\} \\
G &= \{s_1, s_2, s_3, s_5, s_7, s_8, s_{10}, s_{11}, s_{13}, s_{14}, s_{15}, s_{16}\}
\end{aligned}$$

Transitions

$$\begin{array}{ll}
s_1 \xrightarrow{\{\}} \{\} & s_9 \xrightarrow{\{\}} \{s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}\} \\
s_2 \xrightarrow{\{p,q\}} \{s_2, s_2, s_3, s_4, s_5, s_6, s_7\} & s_{10} \xrightarrow{\{q\}} \{s_{14}, s_{15}, s_{16}\} \\
s_3 \xrightarrow{\{p,q\}} \{s_1\} & s_{11} \xrightarrow{\{p,q\}} \{s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}\} \\
s_4 \xrightarrow{\{p\}} \{s_2, s_3, s_4, s_5, s_6, s_7\} & s_{12} \xrightarrow{\{p\}} \{s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}\} \\
s_5 \xrightarrow{\{q\}} \{s_2, s_3, s_4, s_5, s_6, s_7\} & s_{13} \xrightarrow{\{p,q\}} \{s_{14}, s_{15}, s_{16}\} \\
s_6 \xrightarrow{\{\}} \{s_2, s_3, s_4, s_5, s_6, s_7\} & s_{14} \xrightarrow{\{\}} \{s_{14}, s_{15}, s_{16}\} \\
s_7 \xrightarrow{\{q\}} \{s_1\} & s_{15} \xrightarrow{\{p\}} \{s_1\} \\
s_8 \xrightarrow{\{q\}} \{s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}\} & s_{16} \xrightarrow{\{p\}} \{s_{14}, s_{15}, s_{16}\}
\end{array}$$

14. $\alpha = F(p \rightarrow Xq)$.

$$\begin{aligned}
Voc(\alpha) &= \{p, q\} \\
S &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\} \\
I &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}\} \\
G &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{15}, s_{16}\}
\end{aligned}$$

Transitions

$$\begin{array}{ll}
s_1 \xrightarrow{\{q\}} \{s_2, s_4, s_6, s_8, s_{10}, s_{12}, s_{14}\} & s_5 \xrightarrow{\{p,q\}} \{s_1, s_3, s_5, s_7, s_9, s_{11}, s_{13}\} \\
s_2 \xrightarrow{\{\}} \{s_2, s_4, s_6, s_8, s_{10}, s_{12}, s_{14}\} & s_6 \xrightarrow{\{p\}} \{s_1, s_3, s_5, s_7, s_9, s_{11}, s_{13}\} \\
s_3 \xrightarrow{\{q\}} \{s_1, s_3, s_5, s_7, s_9, s_{11}, s_{13}\} & s_7 \xrightarrow{\{q\}} \{s_{16}\} \\
s_4 \xrightarrow{\{\}} \{s_1, s_3, s_5, s_7, s_9, s_{11}, s_{13}\} & s_8 \xrightarrow{\{\}} \{s_{16}\}
\end{array}$$

$$\begin{array}{ll}
s_9 \xrightarrow{\{p,q\}} \{s_{15}\} & s_{13} \xrightarrow{\{p,q\}} \{s_2, s_4, s_6, s_8, s_{10}, s_{12}, s_{14}\} \\
s_{10} \xrightarrow{\{p\}} \{s_{15}\} & s_{14} \xrightarrow{\{p\}} \{s_2, s_4, s_6, s_8, s_{10}, s_{12}, s_{14}\} \\
s_{11} \xrightarrow{\{q\}} \{s_{15}\} & s_{15} \xrightarrow{\{p,q\}} \{s_{16}\} \\
s_{12} \xrightarrow{\{\}} \{s_{15}\} & s_{16} \xrightarrow{\{p\}} \{s_{16}\}
\end{array}$$

15. $\alpha = G(p \rightarrow Xq)$.

$$\begin{aligned}
Voc(\alpha) &= \{p, q\} \\
S &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\} \\
I &= \{s_1, s_2, s_3, s_4, s_5, s_6\} \\
G &= \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13}, s_{14}, s_{15}, s_{16}\}
\end{aligned}$$

Transitions

$$\begin{array}{ll}
s_1 \xrightarrow{\{q\}} \{s_1, s_3, s_5\} & s_9 \xrightarrow{\{q\}} \{s_8, s_{10}, s_{12}, s_{14}, s_{16}\} \\
s_2 \xrightarrow{\{\}} \{s_1, s_3, s_5\} & s_{10} \xrightarrow{\{\}} \{s_8, s_{10}, s_{12}, s_{14}, s_{16}\} \\
s_3 \xrightarrow{\{q\}} \{s_2, s_4, s_6\} & s_{11} \xrightarrow{\{p,q\}} \{s_7, s_9, s_{11}, s_{13}, s_{15}\} \\
s_4 \xrightarrow{\{\}} \{s_2, s_4, s_6\} & s_{12} \xrightarrow{\{p\}} \{s_7, s_9, s_{11}, s_{13}, s_{15}\} \\
s_5 \xrightarrow{\{p,q\}} \{s_1, s_3, s_5\} & s_{13} \xrightarrow{\{p,q\}} \{s_2, s_4, s_6\} \\
s_6 \xrightarrow{\{p\}} \{s_1, s_3, s_5\} & s_{14} \xrightarrow{\{p\}} \{s_2, s_4, s_6\} \\
s_7 \xrightarrow{\{q\}} \{s_7, s_9, s_{11}, s_{13}, s_{15}\} & s_{15} \xrightarrow{\{p,q\}} \{s_8, s_{10}, s_{12}, s_{14}, s_{16}\} \\
s_8 \xrightarrow{\{\}} \{s_7, s_9, s_{11}, s_{13}, s_{15}\} & s_{16} \xrightarrow{\{p\}} \{s_8, s_{10}, s_{12}, s_{14}, s_{16}\}
\end{array}$$