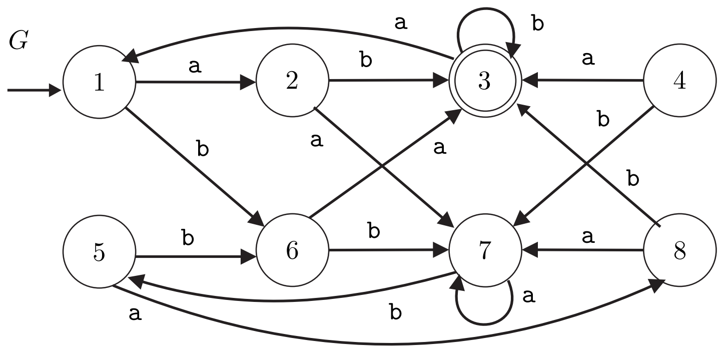
Exercise Sheet 4: Complexity

Problem 9:

Use Hopcroft's algorithm to minimize the automaton in the following figure. How many steps do you need?



Problem 10:

We want to study the computational complexity of several well-known algorithms. We consider automata $G = (X, \Sigma, \delta, x_0, X_\mathrm{m})$ and $C = (Y, \Sigma, \gamma, y_0, Y_\mathrm{m})$.

a. Determine the computational complexity of $p^{-1}(L(G))$ for the inverse projection $p^{-1} : \Sigma^\star \to 2^{\Gamma^\star}$ with $\Sigma \subseteq \Gamma$.

b. Assume that G is nondeterministic. What is the complexity of making G deterministic?

c. Assume G is a plant, $K = L_\mathrm{m}(C)$ is a specification and Σ_u is a set of uncontrollable events. What is the complexity of $SupCon(K, G, \Sigma_\mathrm{u})$?

d. Assume that $p : \Sigma^\star \to \hat{\Sigma}^\star$ is a natural projection. Find the complexity of verifying if p is a natural observer for $L_\mathrm{m}(G)$ from the literature.

e. Assume that $p : \Sigma^\star \to \hat{\Sigma}^\star$ is a natural projection. Find the complexity of extending the alphabet $\hat{\Sigma}$ such that p becomes a natural observer for $L_\mathrm{m}(G)$ from the literature.

Hint: You can check the following paper:

L. Feng and W.Wonham, "On the computation of natural observers in discrete-event systems," Discrete Event Dyn. Syst.: Theor. Appl., vol. 20, no. 1, pp. 63–102, Mar. 2010.