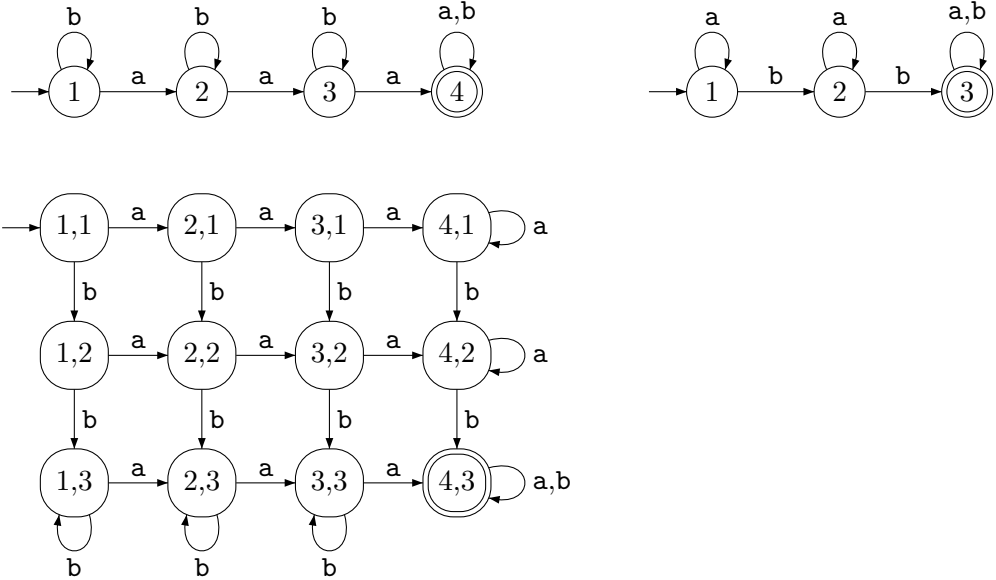
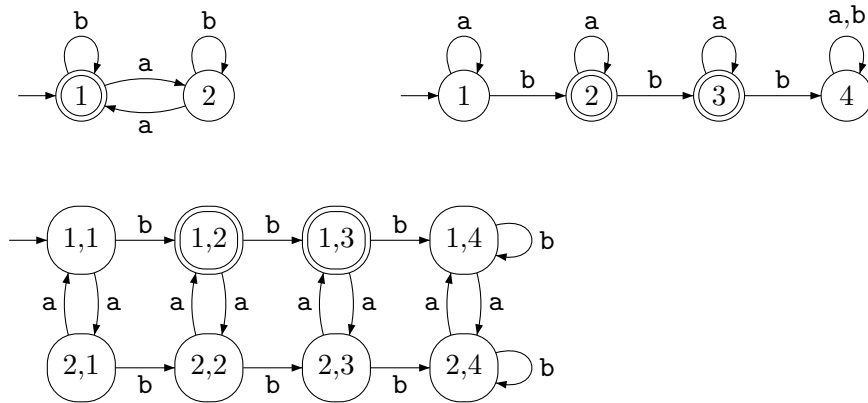


## Selected Tutorial Solutions, Week 9

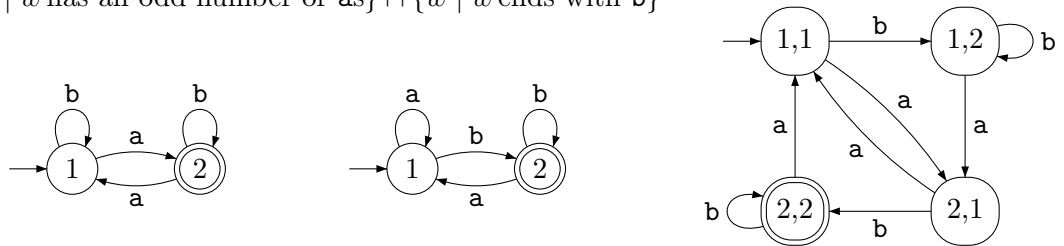
62. (a)  $\{w \mid w \text{ has at least three as}\} \cap \{w \mid w \text{ has at least two bs}\}$



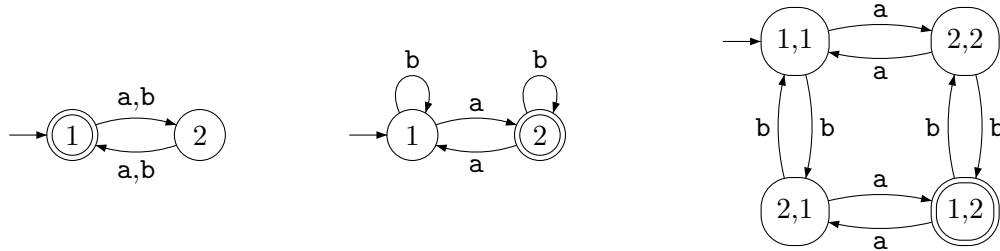
- (b)  $\{w \mid w \text{ has an even number of as}\} \cap \{w \mid w \text{ has one or two bs}\}$



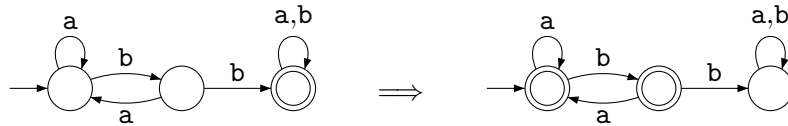
- (c)  $\{w \mid w \text{ has an odd number of as}\} \cap \{w \mid w \text{ ends with b}\}$



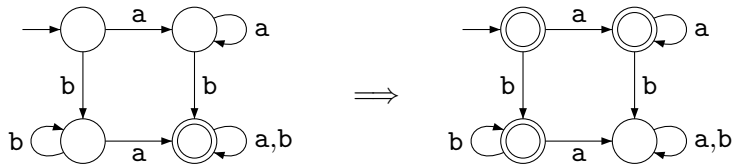
(d)  $\{w \mid w \text{ has an even length}\} \cap \{w \mid w \text{ has an odd number of as}\}$



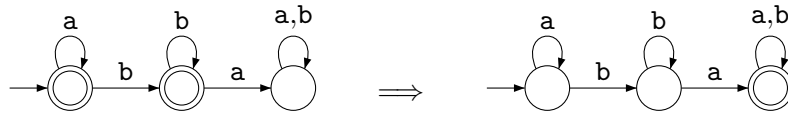
63. (a)  $\{w \mid w \text{ does not contain the substring } bb\}$



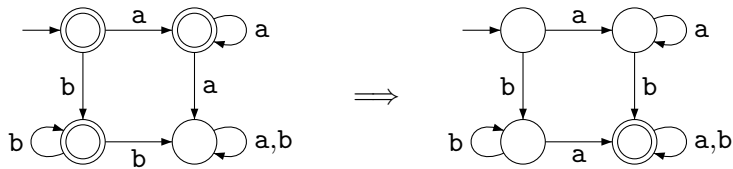
(b)  $\{w \mid w \text{ contains neither the substring } ab \text{ nor } ba\}$



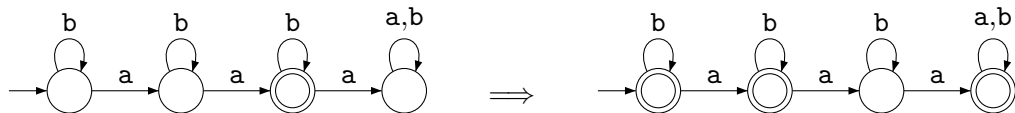
(c)  $\{w \mid w \text{ is any string not in } a^*b^*\}$



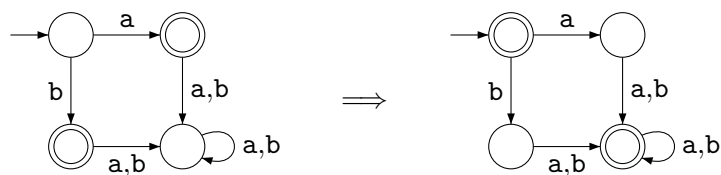
(d)  $\{w \mid w \text{ is any string not in } a^* \cup b^*\}$  (compare to (b)!) )



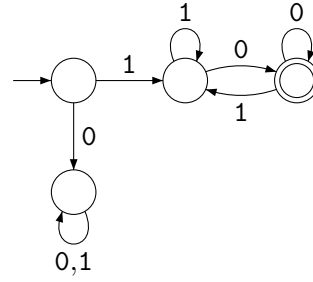
(e)  $\{w \mid w \text{ is any string that doesn't contain exactly two as}\}$



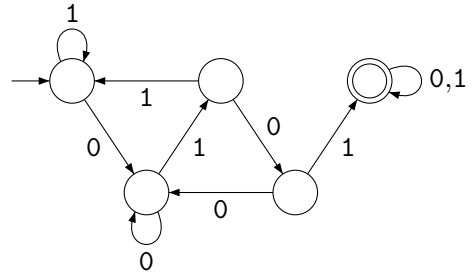
(f)  $\{w \mid w \text{ is any string except } a \text{ and } b\}$



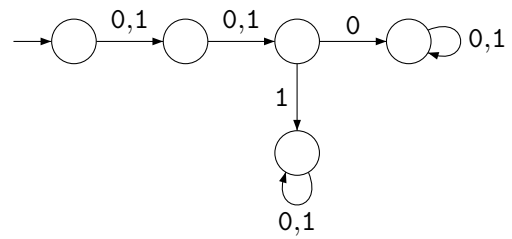
64. (a)  $\{w \mid w \text{ begins with a 1 and ends with a 0}\}$



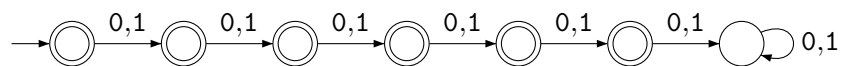
(b)  $\{w \mid w \text{ contains the substring 0101}\}$



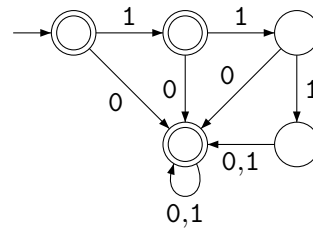
(c)  $\{w \mid w \text{ has length at least 3 and its third symbol is 0}\}$



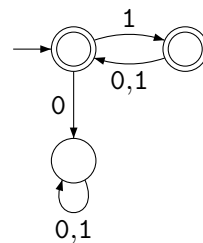
(d)  $\{w \mid \text{the length of } w \text{ is at most 5}\}$



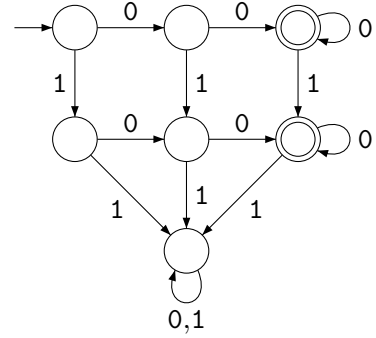
(e)  $\{w \mid w \text{ is any string except 11 and 111}\}$



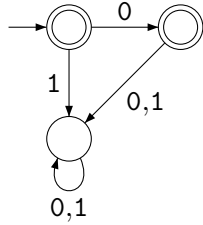
(f)  $\{w \mid \text{every odd position of } w \text{ is a 1}\}$



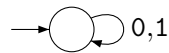
(g)  $\{w \mid w \text{ contains at least two 0s and at most one 1}\}$



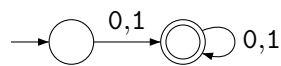
(h)  $\{\epsilon, 0\}$



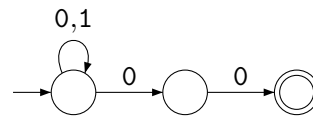
(i) The empty set



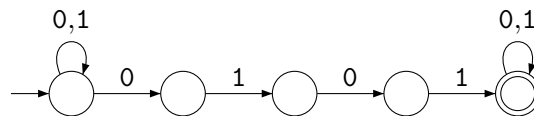
(j) All strings except the empty string



65. (a)  $\{w \mid w \text{ ends with } 00\}$  using three states



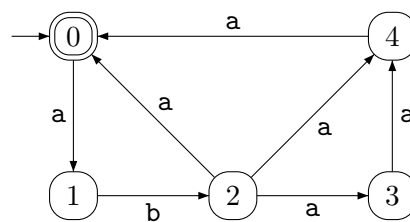
(b)  $\{w \mid w \text{ contains the substring } 0101\}$  using five states



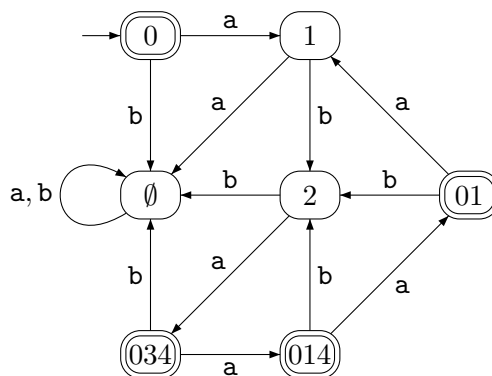
(c) The language  $\{\epsilon\}$  using one state



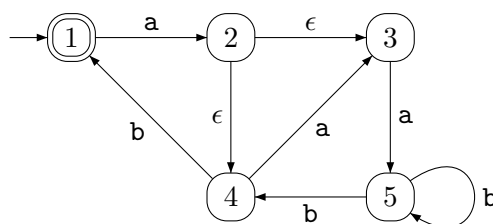
66. From this NFA:



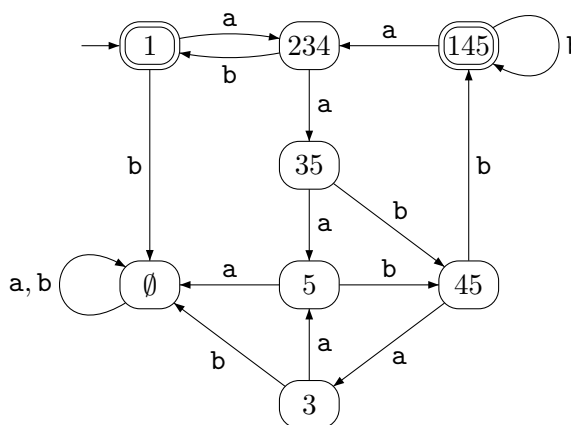
we end up with the following DFA:



67. From this NFA:



we end up with this DFA:



68. (a)  $\{w \mid w \text{ begins with a 1 and ends with a 0}\}: 1(0 \cup 1)^*0$   
 (b)  $\{w \mid w \text{ contains the substring 0101}\}: (0 \cup 1)^*0101(0 \cup 1)^*$   
 (c)  $\{w \mid w \text{ has length at least 3 and its third symbol is 0}\}: (0 \cup 1)(0 \cup 1)0(0 \cup 1)^*$   
 (d)  $\{w \mid \text{the length of } w \text{ is at most 5}\}: (\epsilon \cup 0 \cup 1)(\epsilon \cup 0 \cup 1)(\epsilon \cup 0 \cup 1)(\epsilon \cup 0 \cup 1)(\epsilon \cup 0 \cup 1)$   
 (e)  $\{w \mid w \text{ is any string except 11 and 111}\}: \epsilon \cup 1 \cup 1111^* \cup (0 \cup 1)^*0(0 \cup 1)^*$   
 (f)  $\{w \mid \text{every odd position of } w \text{ is a 1}\}: (1(0 \cup 1))^*(\epsilon \cup 1)$   
 (g)  $\{w \mid w \text{ contains at least two 0s and at most one 1}\}: 0^*(00 \cup 001 \cup 010 \cup 100)0^*$   
 (h)  $\{\epsilon, 0\}: \epsilon \cup 0$   
 (i) The empty set:  $\emptyset$   
 (j) All strings except the empty string:  $(0 \cup 1)(0 \cup 1)^*$