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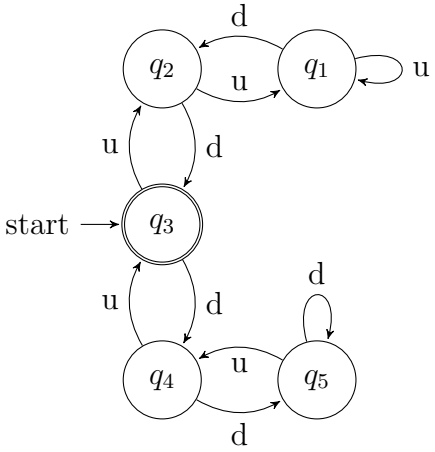
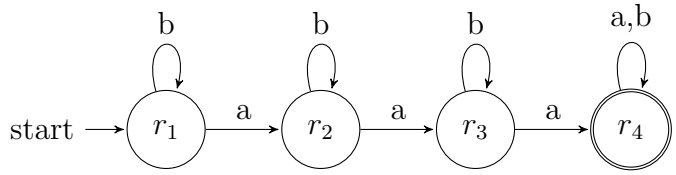
COMP.3040 Foundation of Computer Science

HW2

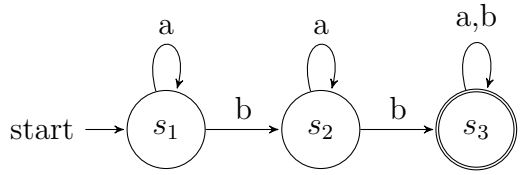
1.3) $M = (\{q1, q2, q3, q4, q5\}, \{u, d\}, \delta, q3, \{q3\})$



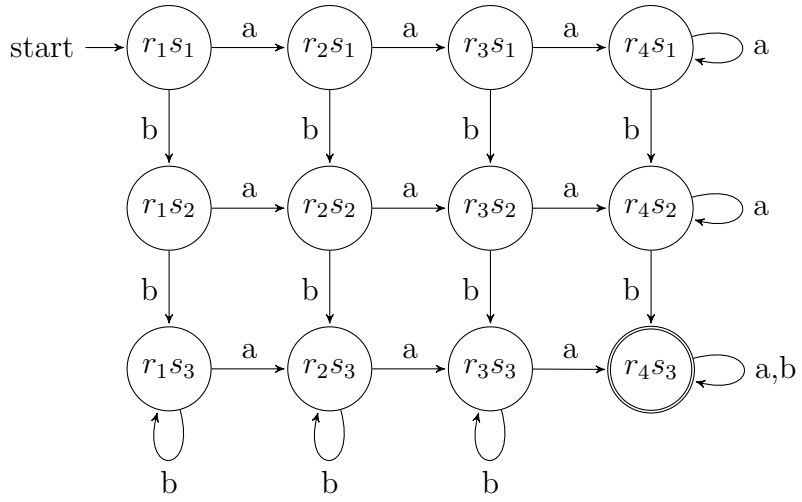
1.4) a. $\{\omega|\omega$ has at least three a's$\}$



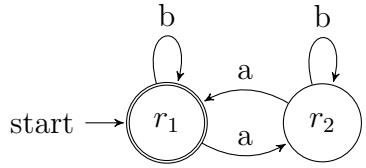
$\{\omega|\omega$ has at least two b's$\}$



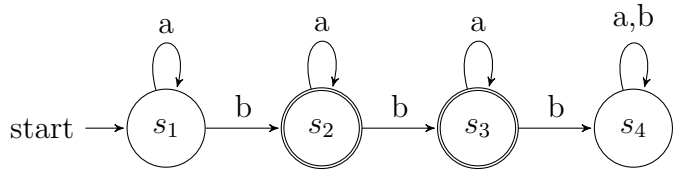
$\{\omega|\omega$ has at least three a's and at least two b's$\}$



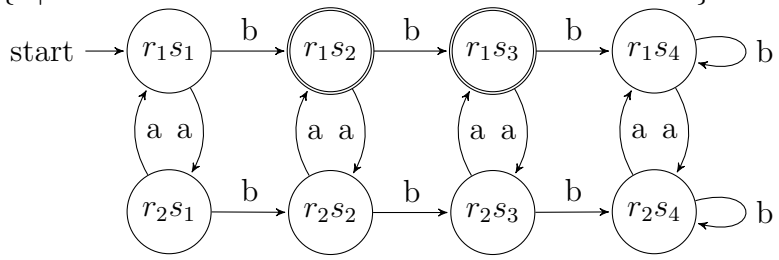
c. $\{\omega|\omega$ has an even number of a's$\}$



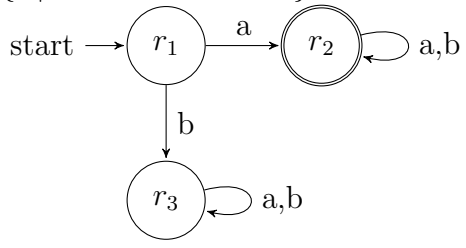
$\{\omega|\omega$ has one or two b's$\}$



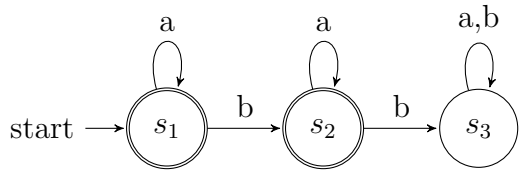
$\{\omega|\omega$ has an even number of a's and one or two b's$\}$



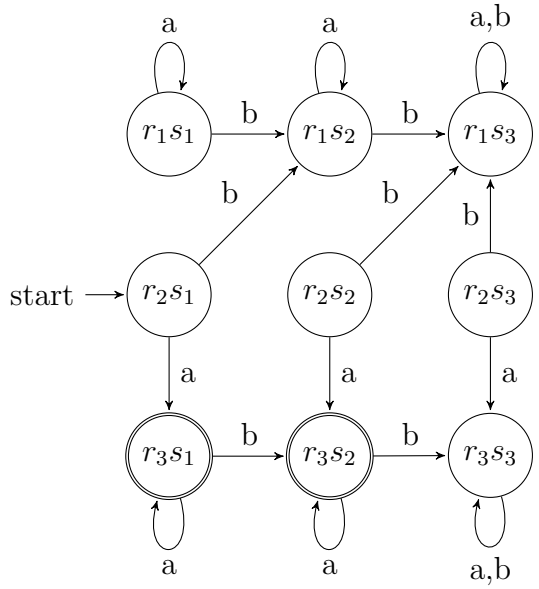
e. $\{\omega|\omega$ starts with an a$\}$



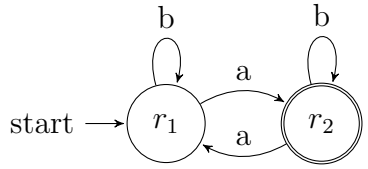
$\{\omega|\omega$ has at most one b$\}$



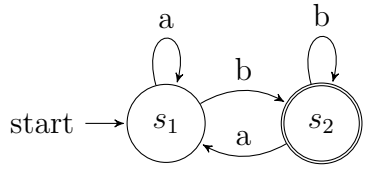
$\{\omega|\omega$ starts with an a and has at most one b$\}$



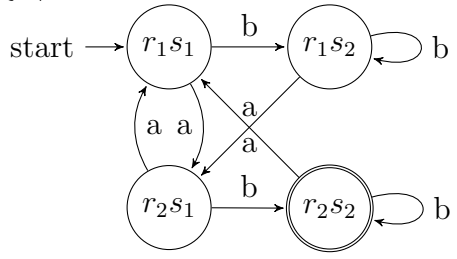
f. $\{\omega|\omega$ has an odd number of a's$\}$



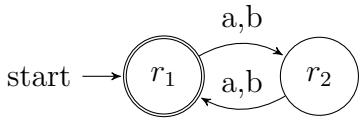
$\{\omega|\omega$ ends with a b$\}$



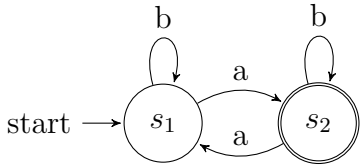
$\{\omega|\omega$ has an odd number of a's and ends with a b$\}$



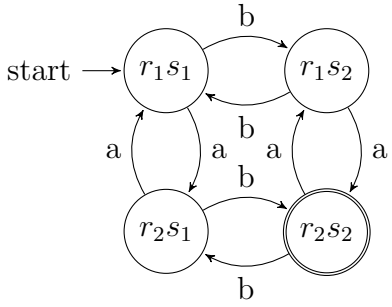
g. $\{\omega|\omega$ has an even length$\}$



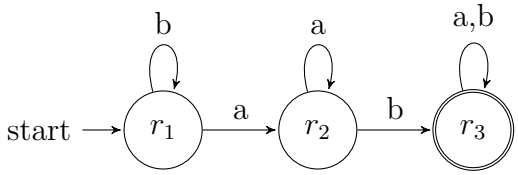
$\{\omega|\omega$ has an odd number of a's$\}$



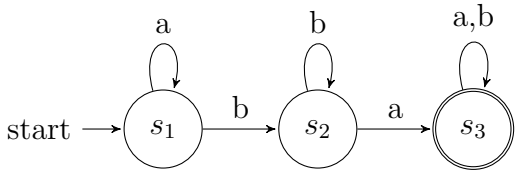
$\{\omega|\omega$ has an even length and an odd number of a's$\}$



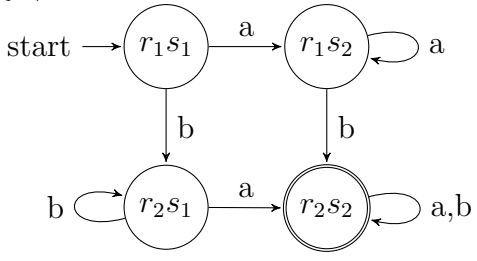
1.5) c. $\{\omega|\omega$ contains the string "ab"$\}$



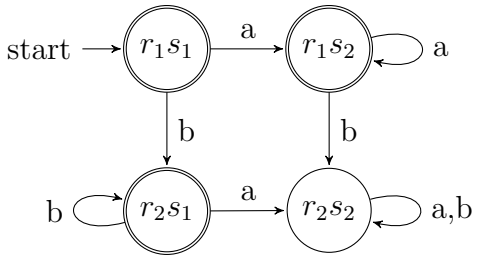
$\{\omega|\omega$ contains the string "ba"$\}$



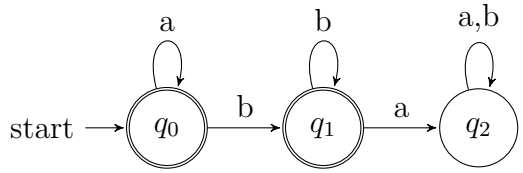
$\{\omega|\omega$ contains the string "ab" or "ba"$\}$



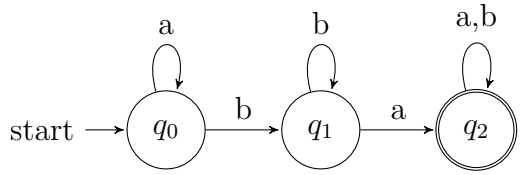
$\{\omega|\omega$ contains neither the string "ab" nor "ba"$\}$


start
r_1s_1
a
r_1s_2
a
b
b
b
r_2s_1
a
r_2s_2
a,b

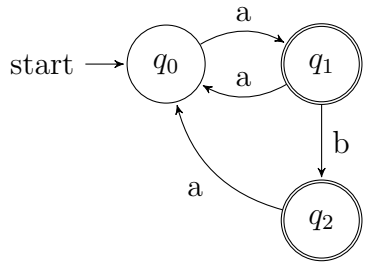
d. $\{\omega|\omega$ is any string in $a^*b^*\}$



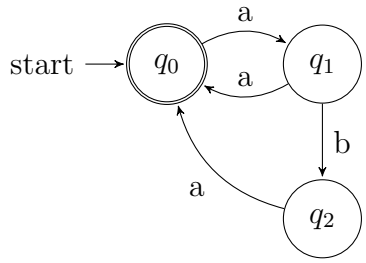
$\{\omega|\omega$ is any string not in $a^*b^*\}$



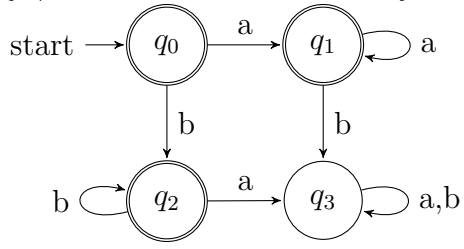
e. $\{\omega|\omega$ is any string in $(ab^*)^*\}$



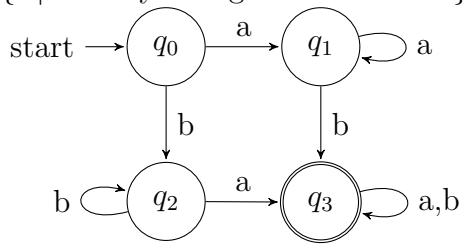
$\{\omega|\omega$ is any string not in $(ab^*)^*\}$



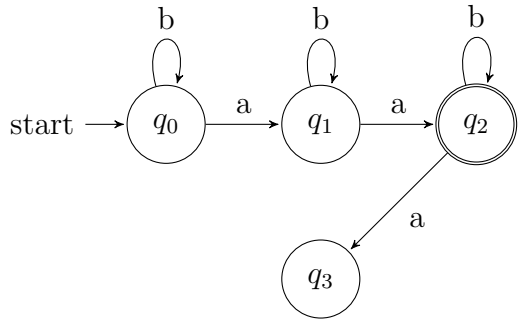
f. $\{\omega|\omega$ is any string in a* $\cup$ b*$\}$



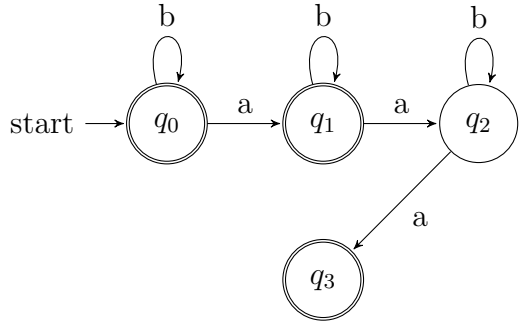
$\{\omega|\omega$ is any string not in a* $\cup$ b*$\}$



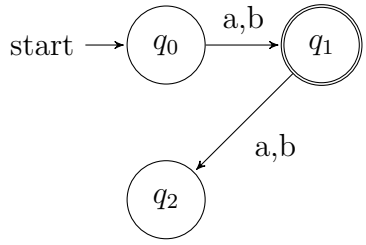
g. {$\omega|\omega$ is any string that contains exactly two a's}



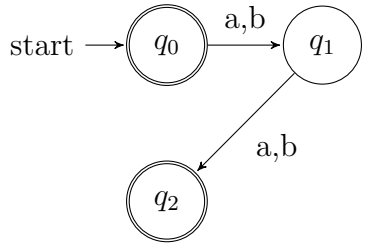
{$\omega|\omega$ is any string that doesn't contain exactly two a's}



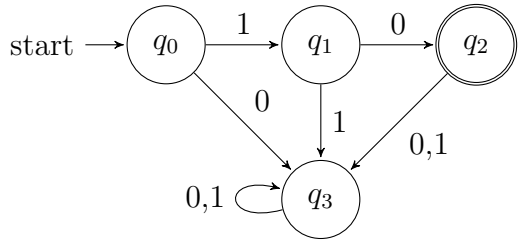
h. {$\omega|\omega$ is the string "a" or the string "b"}



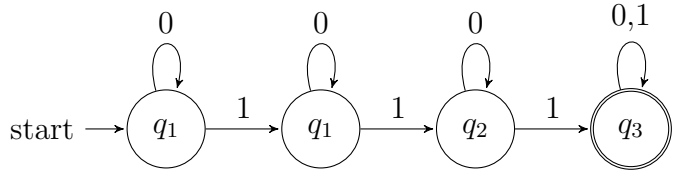
{$\omega|\omega$ is any string except "a" and "b"}



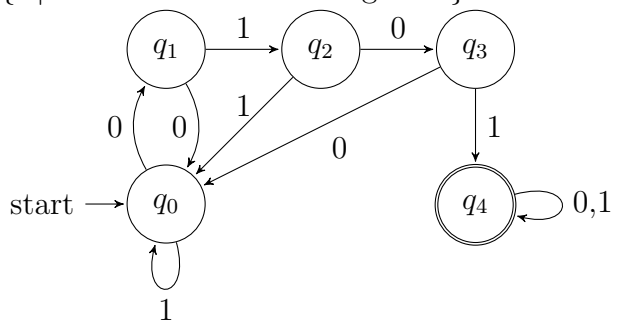
1.6) a. {$\omega|\omega$ begins with a 1 and ends with a 0}



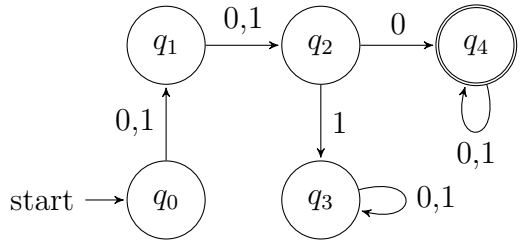
b. $\{\omega|\omega$ contains at least three 1's$\}$



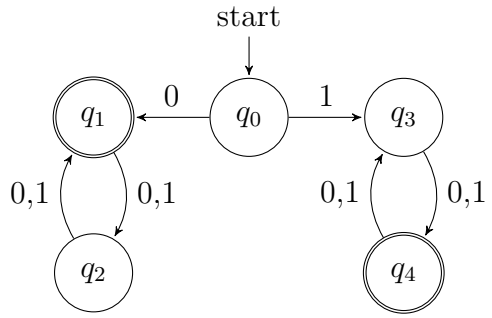
c. $\{\omega|\omega$ contains the substring 0101$\}$



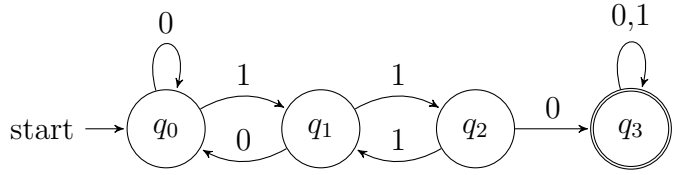
d. $\{\omega|\omega$ has a length at least 3 and the third symbol is a 0$\}$



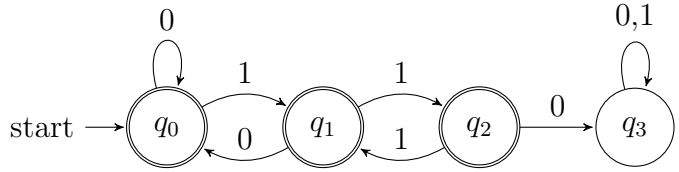
e. $\{\omega|\omega$ starts with a 0 and has an odd length or starts with a 1 and has an even length$\}$



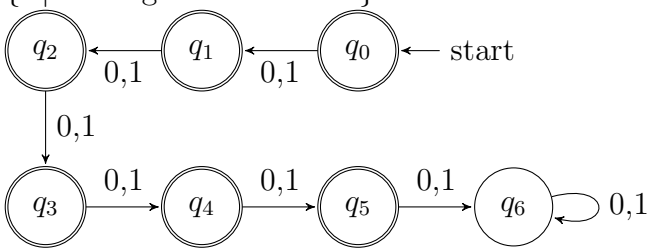
f. $\{\omega|\omega$ contains the substring 110$\}$



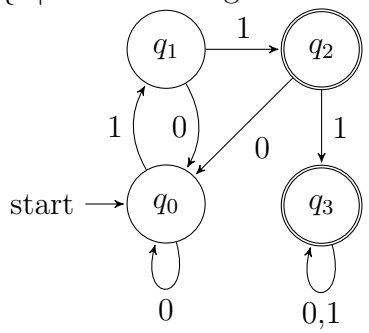
{ω|ω does not contain the substring 110}



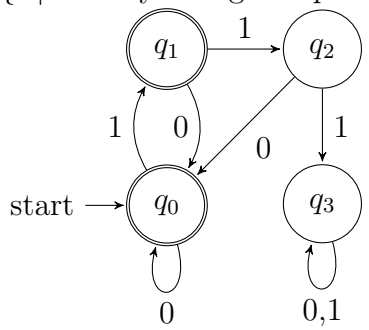
g. {ω|ω's length is at most 5}



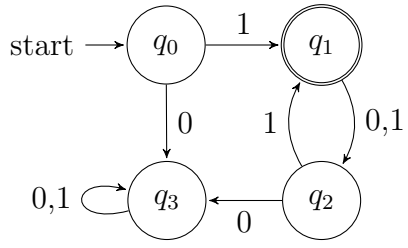
h. {ω|ω is the string 11 or 111}



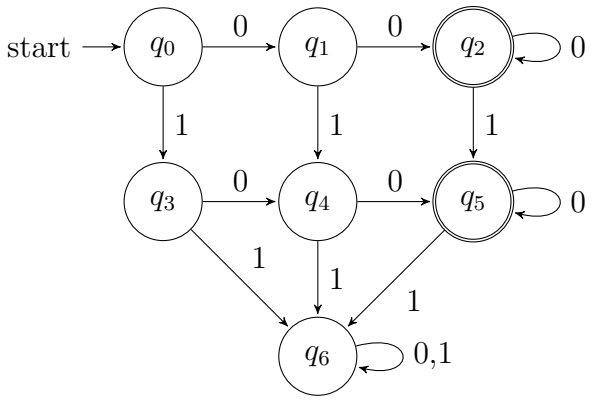
{ω|ω is any string except 11 and 111}



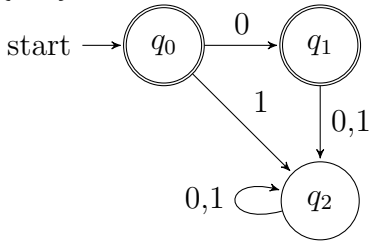
i. {ω|every odd position in ω is a 1}



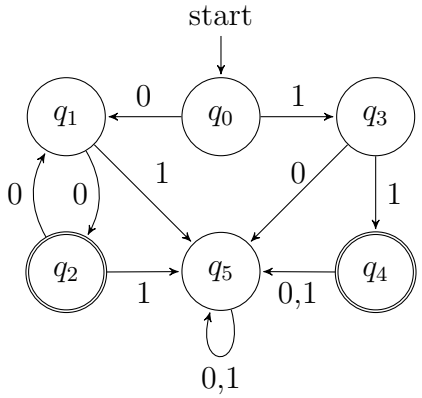
j. {ω|ω contains at least two 2's and at most one 1}



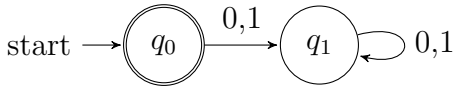
k. $\{\varepsilon, 0\}$



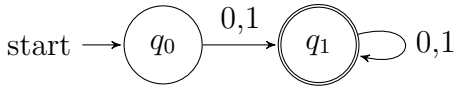
l. $\{\omega | \omega$ contains an even number of 0's, or contains exactly two 1's$\}$



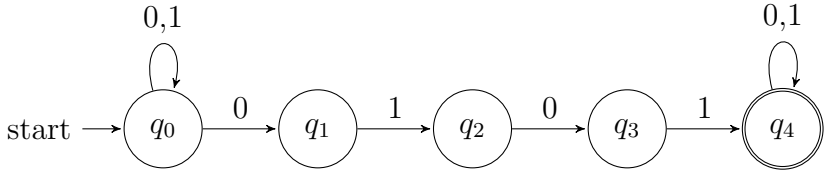
m. The empty set



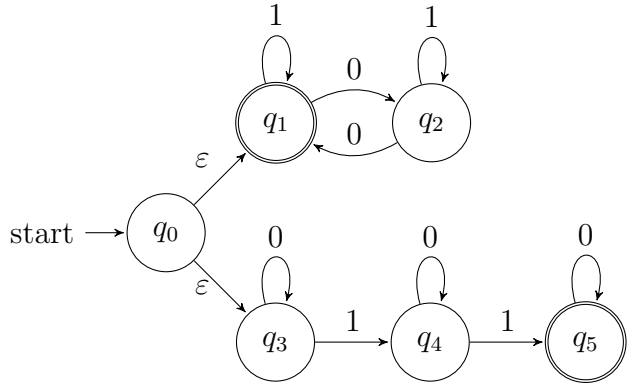
n. All strings except the empty string



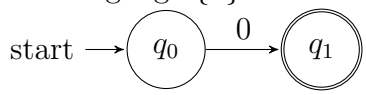
1.7) b. Exercise 1.6c with five states



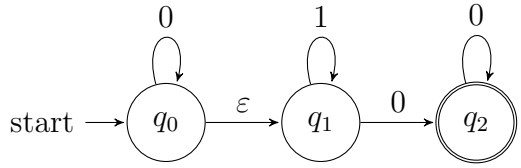
c. Exercise 1.6l with 6 states



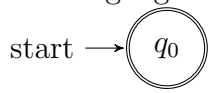
d. The language $\{0\}$ with two states



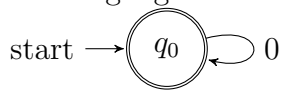
e. The language $0^*1^*0^+$ with three states



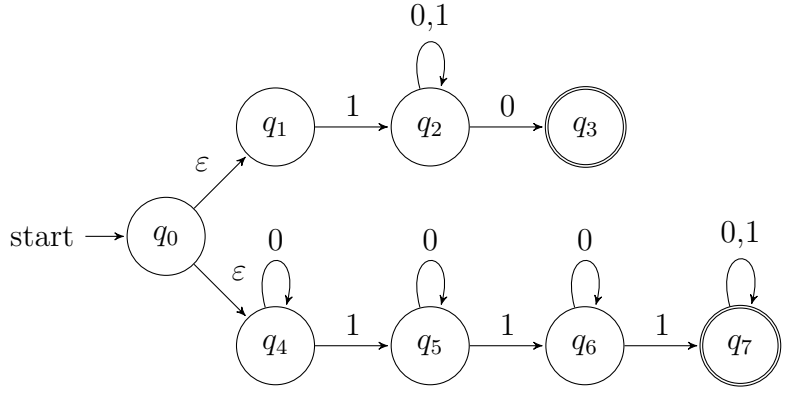
g. The language ε with one state



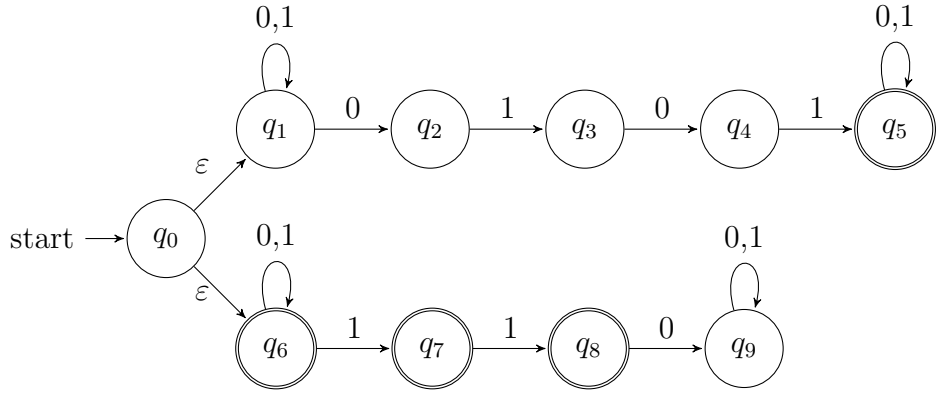
h. The language 0^* with one state



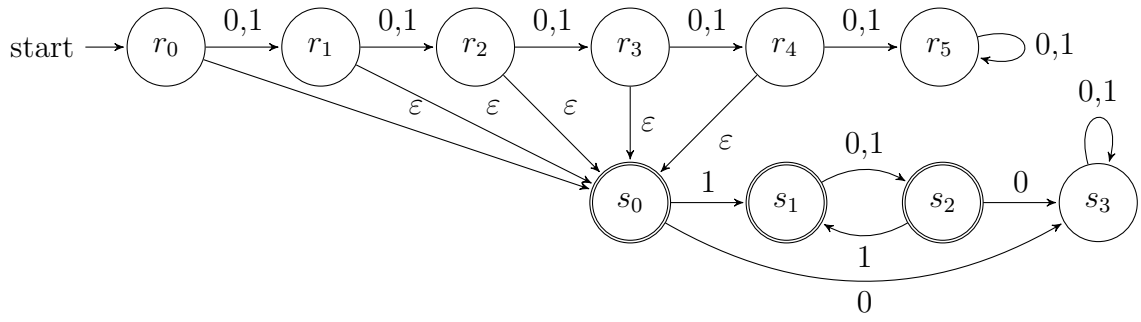
1.8) a. The NFA of the union of the languages in exercises 1.6a and 1.6b



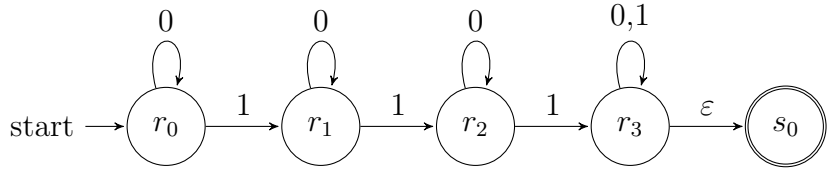
b. The NFA of the union of the languages in exercises 1.6c and 1.6f



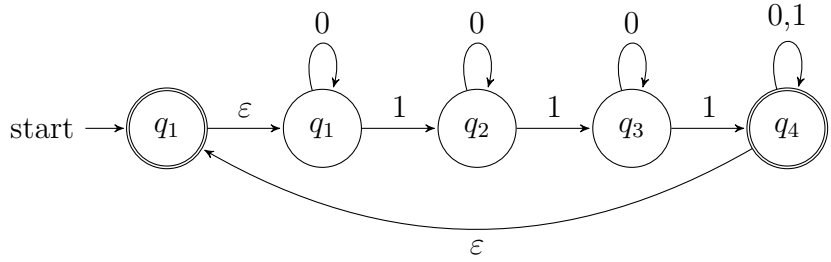
1.9) a. The NFA of the concatenation of the languages in exercises 1.6g and 1.6i



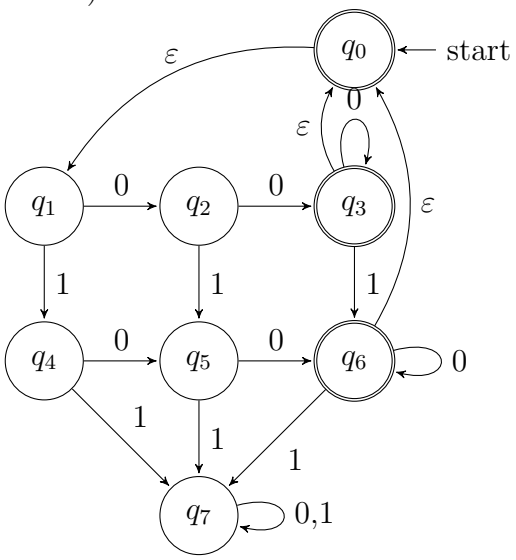
b. The NFA of the concatenation of the languages in exercises 1.6b and 1.6m



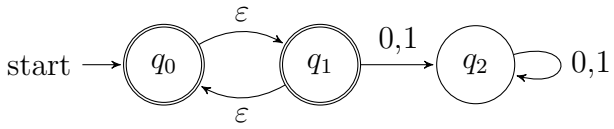
1.10) a. The star of the language in exercise 1.6b



b. The star of exercise 1.6j (I couldn't figure out a way to make this graph look better)

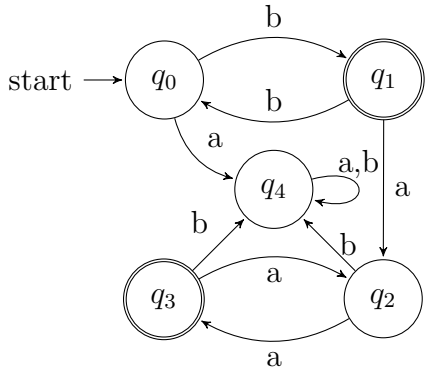


c. The star of exercise 1.6m

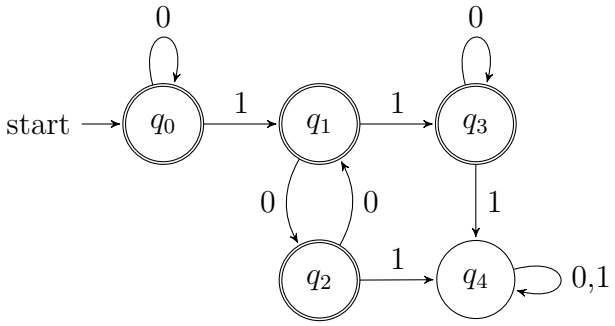


1.12) D = $\{\omega|\omega$ contains an even number of as and an odd number of bs and does not contain the substring ab$\}$

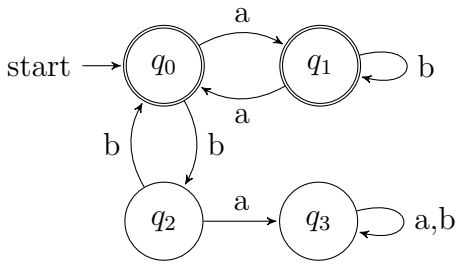
Regular Expression: $b(bb)^*(aa)^*$



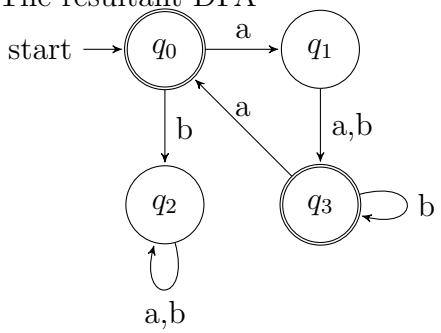
1.13) F = $\{\omega|\omega$ does not contain a pair of 1's separated by an odd number of symbols$\}$
By creating a 4-state NFA for the complement of this language, and then converting it to a DFA, I was able to produce the following.



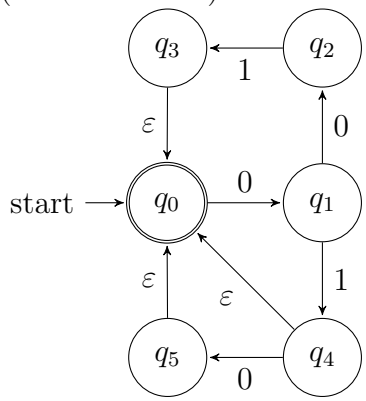
1.16) a. The resultant DFA



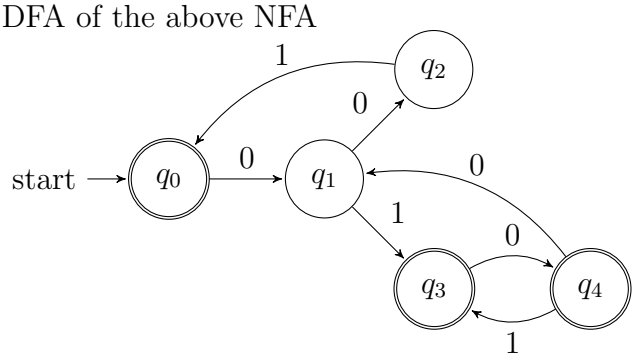
b. The resultant DFA



1.17) a. $(01 \cup 001 \cup 010)^*$



b. DFA of the above NFA



1.18) a. $1\Sigma^*0$

b. $\Sigma^*1\Sigma^*1\Sigma^*1\Sigma^*$

c. $\Sigma^*0101\Sigma^*$

d. $\Sigma\Sigma0\Sigma^*$

e. $(0 \cup 1\Sigma)(\Sigma\Sigma)^*$

f. $0^*(10^+)^*1^*$

g. $(\varepsilon \cup \Sigma)^5$

h. $\varepsilon \cup \Sigma \cup 0\Sigma \cup 10 \cup 0\Sigma\Sigma \cup 10\Sigma \cup 110 \cup \Sigma^3\Sigma^+$

i. $(1\Sigma)^*(\varepsilon \cup 1)$

j. $00^+ \cup 100^+ \cup 010^+ \cup 00^+1$

k. $\varepsilon \cup 0$

l. $1^*(01^*01^*)^* \cup 0^*10^*10^*$

m. $\emptyset$

n. Σ^+

1.20) a. **Members:** aab, bb
Not Members: baa, bbba

b. **Members:** ab, abab
Not Members: babab, bab

c. **Members:** aa, bbbb
Not Members: aabb, bbba

d. **Members:** aaa, aaaaaa
Not Members: aa, aaaa

e. **Members:** aaabaaa, baabbab
Not Members: babbbbb, aaaaaaa

f. **Members:** aba, bab
Not Members: ababab, bababa

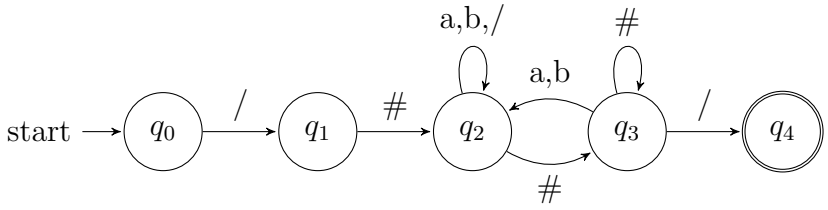
g. **Members:** b, ab
Not Members: a, ba

h. **Members:** abbaba, bbabaaab
Not Members: b, ε

1.21) a. **Regular Expression:** $(a^*b)(a \cup ba^*b)^*$

b. **Regular Expression:** $(\varepsilon \cup ((a \cup b)a^*b)((b \cup (a(a \cup b)))a^*b)^*(\varepsilon \cup a))$

1.22) a. The resultant DFA



b. $/\#(a \cup b \cup / \cup \#^*(a \cup b)^*)^*\#/$