

# CS – 204: Assignment 1

14 . 02 . 2021

1.  $L^*$  –

ab aa baa ab aa

aa aa baa aa

baa aa ab aa

$L^4$  –

aa aa baa aa

baa aa ab aa

2. Given,

$$\Sigma = \{a, b\}$$

$$L = \{aa, bb\}$$

So,

$$\overline{L} = \Sigma^* - L = \{a, b\}^* - \{aa, bb\}$$

3. a)  $P : S \rightarrow bS \mid Sb \mid a$

$$G = (\{S\}, \{a, b\}, S, P)$$

b)  $P : S \rightarrow aS \mid bS \mid Sb \mid a$

$$G = (\{S\}, \{a, b\}, S, P)$$

4. a)  $P : S \rightarrow aSb \mid Sb \mid b$

$$G = (\{S\}, \{a, b\}, S, P)$$

b)  $P : S \rightarrow aSbb \mid \lambda$

$$G = (\{S\}, \{a, b\}, S, P)$$

c)  $P : S \rightarrow aSb \mid aa$

$$G = (\{S\}, \{a, b\}, S, P)$$

d)  $P : S \rightarrow aSb \mid aaa$

$$G = ( \{S\}, \{a, b\}, S, P )$$

e)  $P :$

$$S \rightarrow S_1 S_2 B$$

$$S_1 \rightarrow a S_1 b \mid S_1 b \mid b$$

$$S_2 \rightarrow a S_2 b b \mid \lambda$$

$$G = ( \{S, S_1, S_2\}, \{a, b, \lambda\}, S, P )$$

f) It can be observed that all elements of  $a^n b^{2n}$  are part of  $a^n b^m$  except  $\lambda$ . Hence

$$L_1 \cup L_2 = L_1 \cup \{\lambda\}.$$

$$P : S \rightarrow a S b \mid S b \mid b \mid \lambda$$

$$G = ( \{S\}, \{a, b, \lambda\}, S, P )$$

5. We will prove that the 2 grammars,  $G_1$  and  $G_2$  are not equivalent by providing a counterexample.

Deriving from the  $G_1$ ,

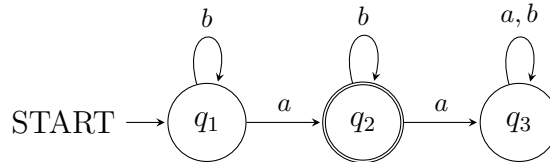
$$S \Rightarrow a S b \Rightarrow a S S b \Rightarrow a a S b \Rightarrow a a a b$$

Similarly, for  $G_2$

$$S \Rightarrow a S b \Rightarrow a a b$$

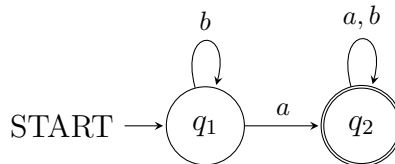
$$\Rightarrow a a S b b \Rightarrow a a a b b$$

Thus,  $aaab \in G_1$  and  $aaab \notin G_2$ . As a result, they are not equivalent.



**Figure 1:** All strings with exactly one  $a$

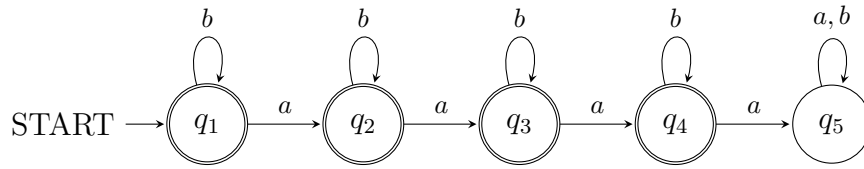
6. a)



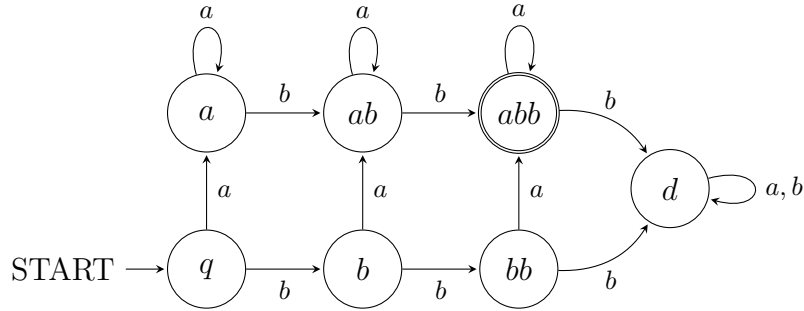
**Figure 2:** All strings with at least one  $a$

b)

c)

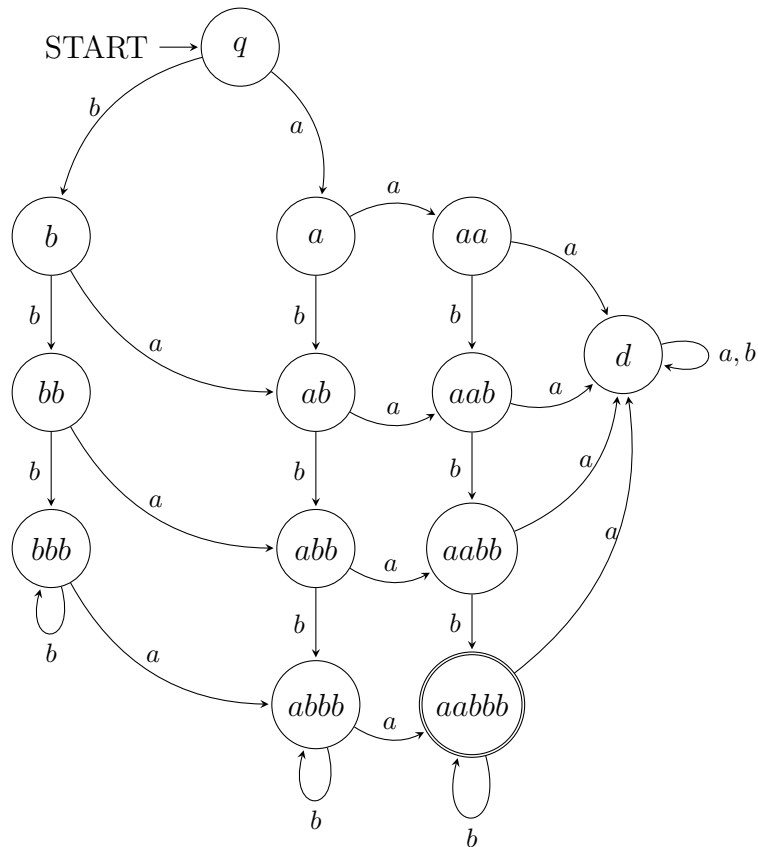


**Figure 3:** All strings with no more than 3 a's



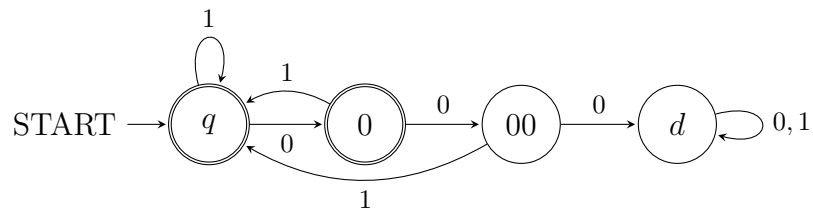
**Figure 4:** All strings with at least one a and exactly two b's

d)



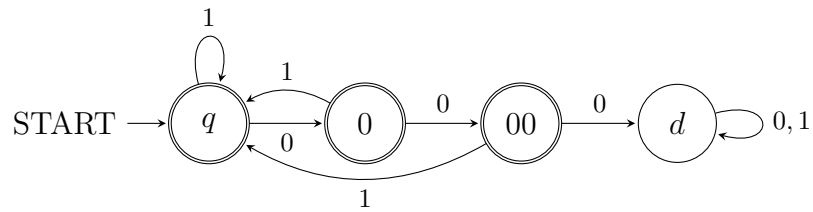
**Figure 5:** All strings with exactly two a's and more than two b's

e)



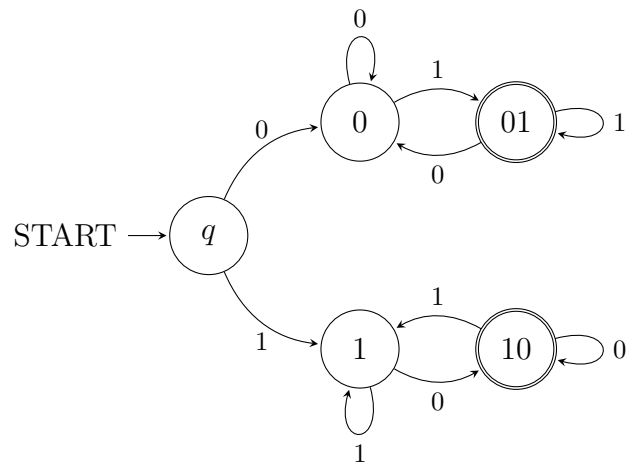
**Figure 6:** *All strings where every 00 is followed by 1*

7. a)



**Figure 7:** *All strings containing 00 but not 000*

b)

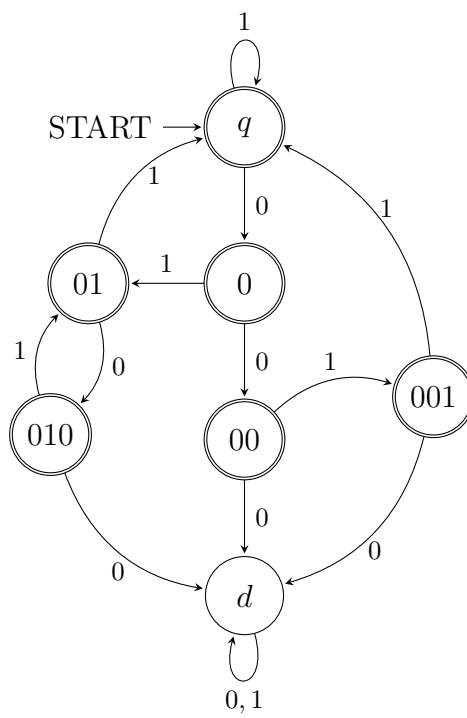


**Figure 8:** *All strings where leftmost symbol differs from rightmost*

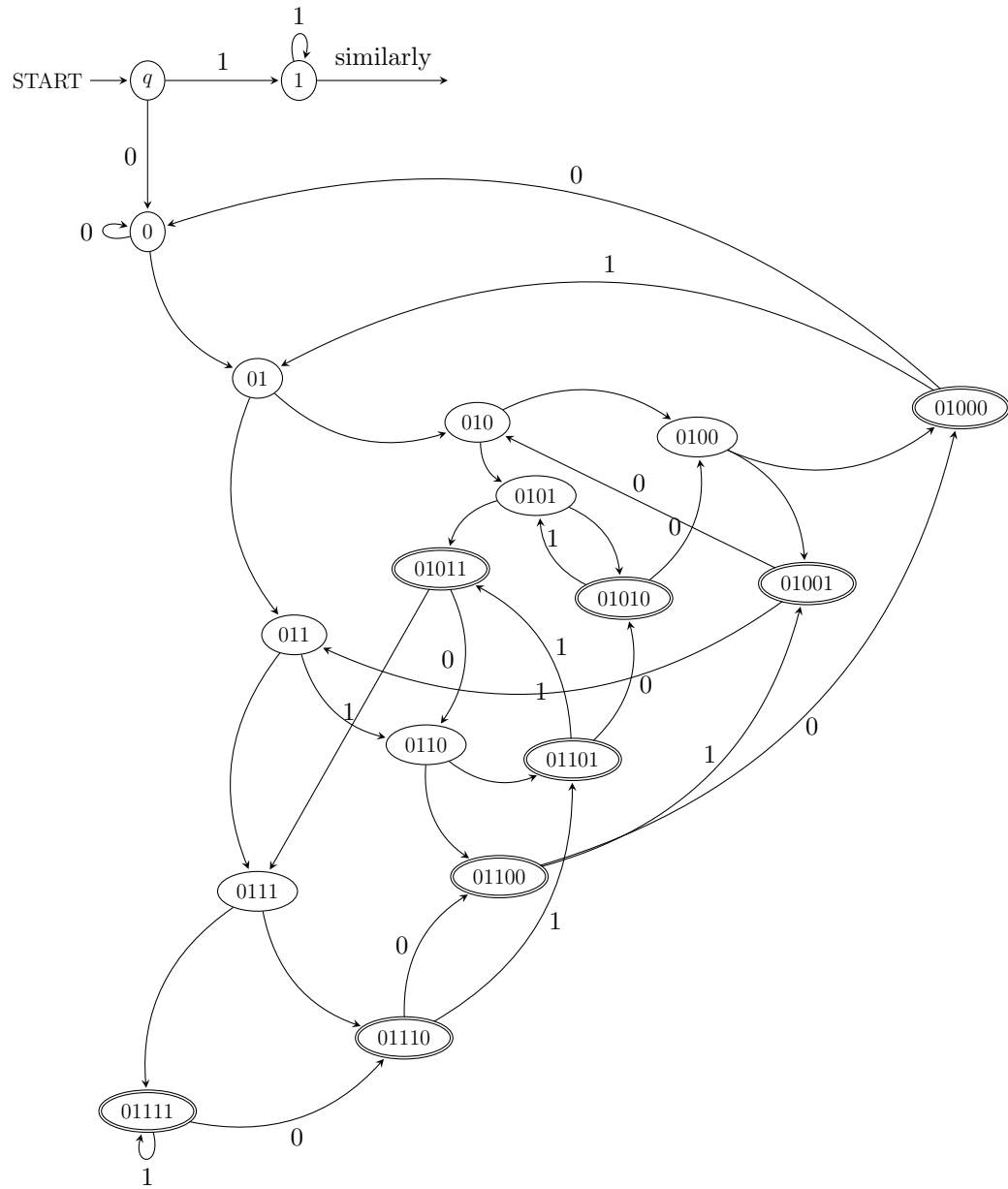
c)

d)

e)



**Figure 9:** *All strings where every substring of 4 symbols has at most 2 0's*



**Figure 10:** All strings of length 5 or more where 4th symbol from the right is different from leftmost