CS – 204: Assignment 1

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Group 13

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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,

$$\begin{aligned}\overline{L} &= \Sigma^* - L \\ &= \{w \mid w \in \Sigma^n, n > 2\} + \{\lambda, a, b, ab, ba\}\end{aligned}$$

3. Note: Regex is Regular Expression

   a) Regex - $b*ab*$
   $P : S \to bS \mid Sb \mid a$
   $G = (\{S\}, \{a, b\}, S, P)$

   b) Regex - $(a*b*)*a(a*b*)*$
   $P : S \to aS \mid Sa \mid bS \mid Sb \mid a$
   $G = (\{S\}, \{a, b\}, S, P)$

   c) Regex - $b*ab*ab*ab*$

P :

$S \to aS_1 \mid bS \mid \lambda$

$S_1 \to aS_2 \mid bS_1 \mid \lambda$

$S_2 \to aS_3 \mid bS_2 \mid \lambda$

$S_3 \to bS_3 \mid \lambda$

$G = (\{S, S_1, S_2, S_3\}, \{a, b, \lambda\}, S, P)$

d) Regex - $(a * b*) * a(a * b*) * a(a * b*) * a(a * b*)*$

P :

$S \to aS_1 \mid aS \mid Sa \mid bS \mid Sb$

$S_1 \to aS_2 \mid aS_1 \mid S_1a \mid bS_1 \mid S_1b$

$S_2 \to aS_3 \mid aS_2 \mid S_2a \mid bS_2 \mid S_2b$

$S_3 \to \lambda \mid aS_3 \mid S_3a \mid bS_3 \mid S_3b$

$G = (\{S, S_1, S_2, S_3\}, \{a, b, \lambda\}, S, P)$

4. a) Regex - $a^n b^m$, $m > n \geq 0$

$P : S \to aSb \mid Sb \mid b$

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

b) Regex - $a^n (bb)^n$, $n \geq 0$

$P : S \to aSbb \mid \lambda$

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

c) Regex - $aaa(a^n b^n)b$, $n \geq 0$

$P : S \to aSb \mid aaab$

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

d) Regex - $(aaa)a^n b^n, n \geq 0$

$P : S \to aSb \mid aaa$

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

e) Regex - $a^n b^m \cdot a^n (bb)^n$, $m > n \geq 0$

P :

$S \to S_1 S_2$

$S_1 \to aS_1b \mid S_1b \mid b$

$S_2 \to aS_2bb \mid \lambda$

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

f) Regex - $a^n b^m$, $m \geq n \geq 0$

It can be observed that $L_1 \cup L_2 = L_1 \cup \{\lambda\}$.

$P : S \to aSb \mid Sb \mid b \mid \lambda$

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

g) Regex - $a^n b^m \cdot a^n b^m \cdot a^n b^m$, $m > n \geq 0$

P :

$S \rightarrow S_1 S_2 S_3$

$S_1 \rightarrow aS_1b \mid S_1b \mid b$

$S_2 \rightarrow aS_2b \mid S_2b \mid b$

$S_3 \rightarrow aS_3b \mid S_3b \mid b$

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

h) Regex - $(a^n b^m)*$, $m > n \geq 0$

P :

$S \rightarrow SS$

$S \rightarrow aSb \mid Sb \mid b$

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

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,

$$S \Rightarrow aSb \Rightarrow aSSb \Rightarrow aaSb \Rightarrow aaab$$

Similarly, for G_2

$$S \Rightarrow aSb \Rightarrow aab$$
$$\Rightarrow aaSbb \Rightarrow aaabb$$

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

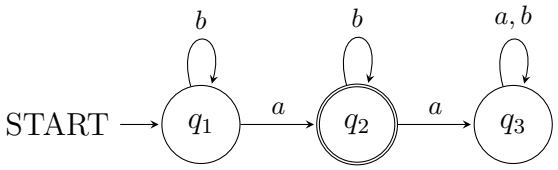

Figure 1: *All strings with exactly one a*

6. a)

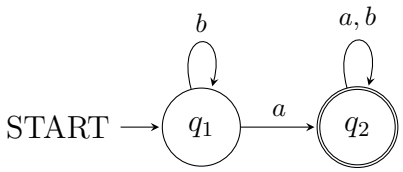

Figure 2: *All strings with at least one a*

b)

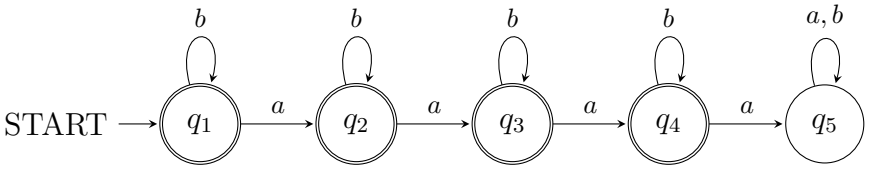

Figure 3: *All strings with no more than 3 a's*

c)

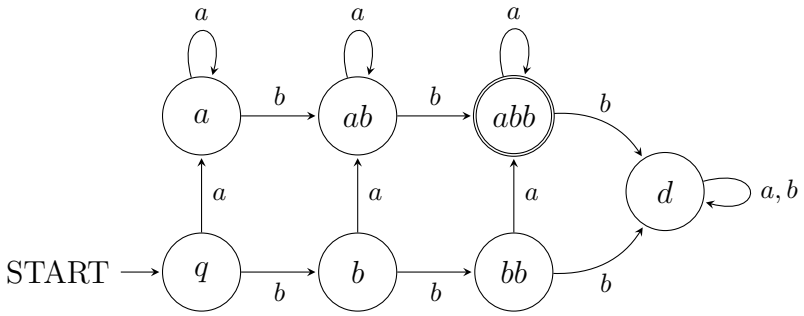

Figure 4: *All strings with at least one a and exactly two b's*

d)

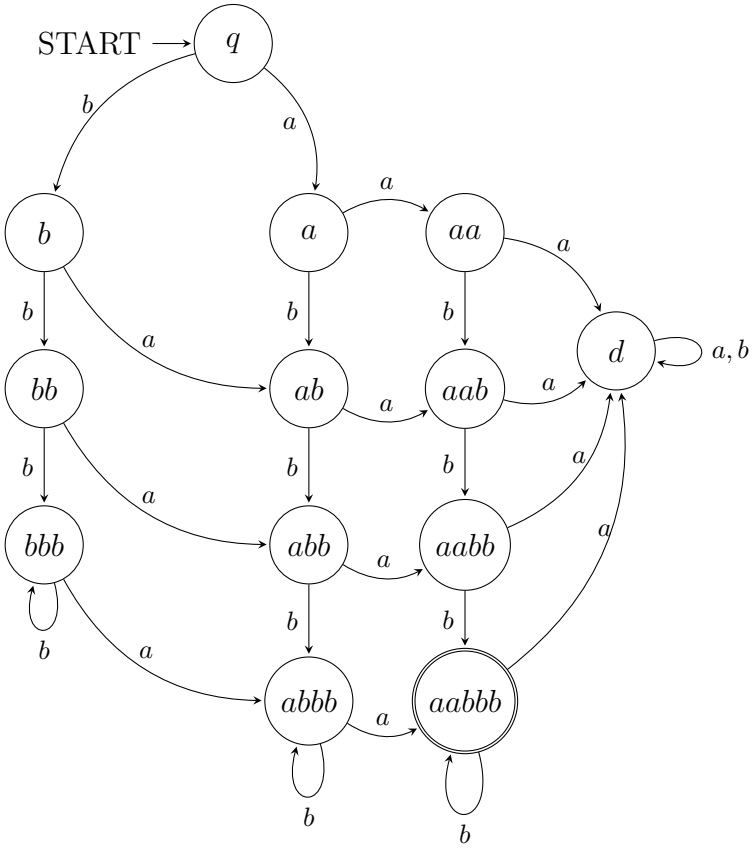

Figure 5: *All strings with exactly two a's and more than two b's*

e)

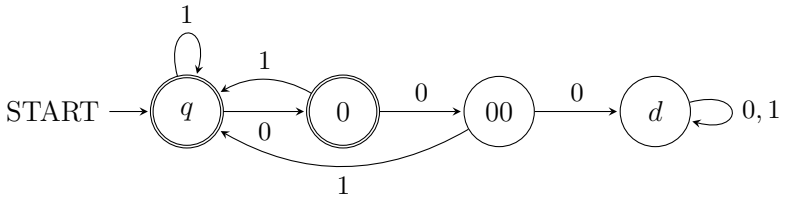

Figure 6: *All strings where every 00 is followed by 1*

7. a)

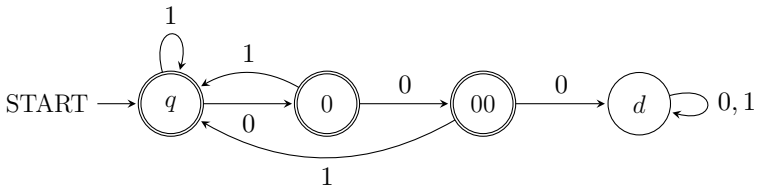

Figure 7: *All strings containing 00 but not 000*

b)

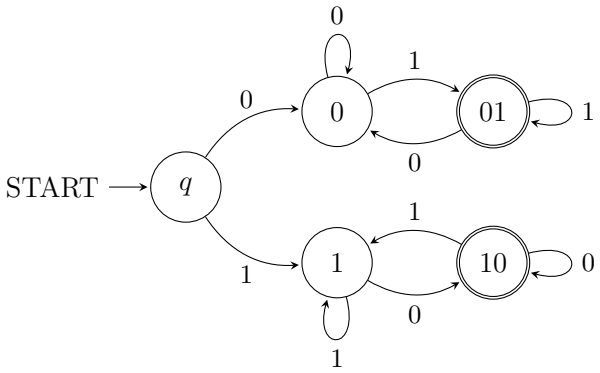

Figure 8: *All strings where leftmost symbol differs from rightmost*

c)

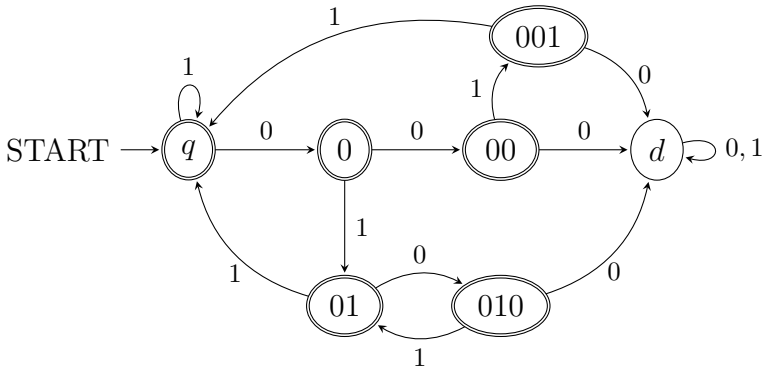

Figure 9: *All strings where every substring of 4 symbols has at most 2 0's*

d)

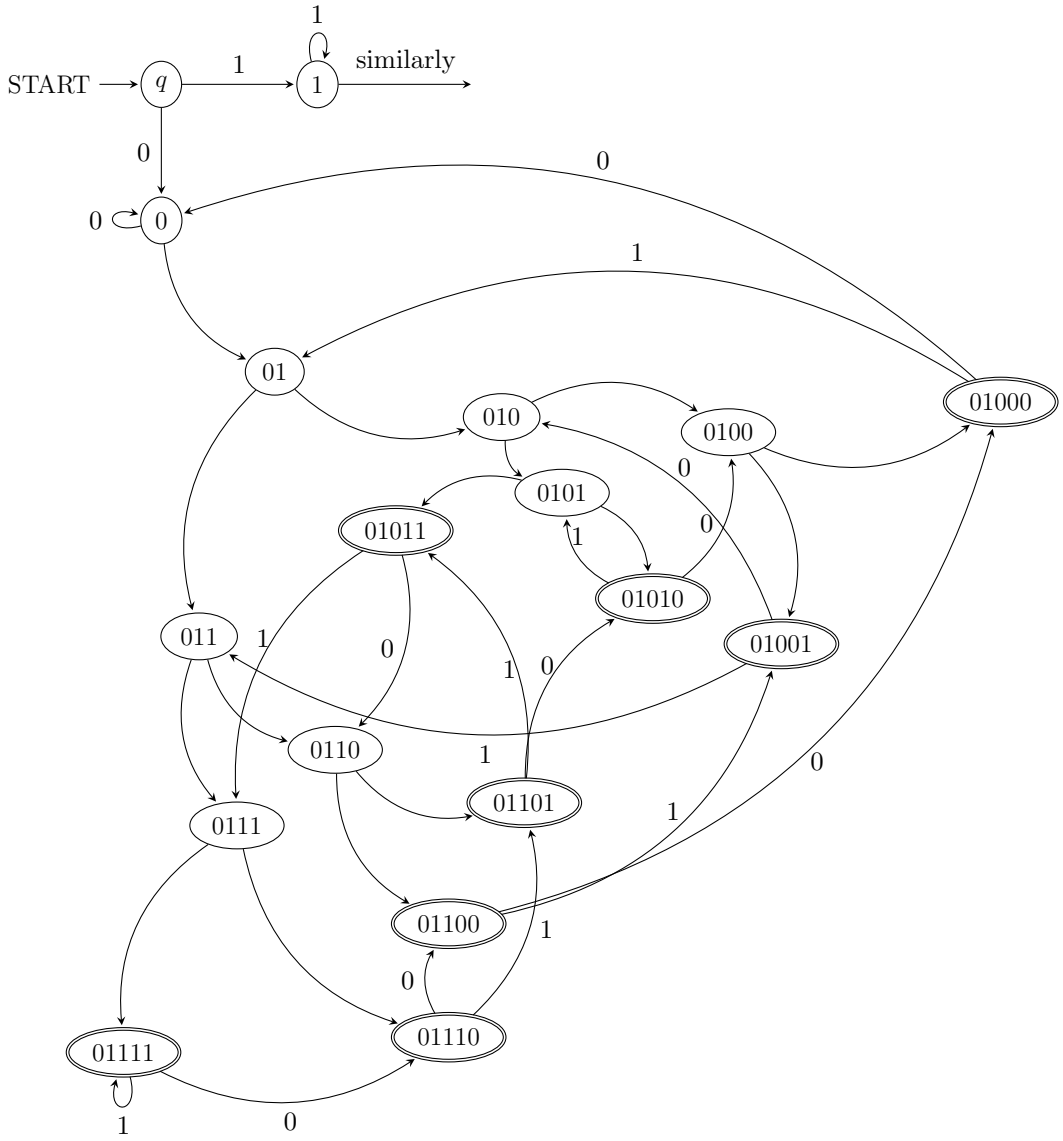

Figure 10: *All strings of length 5 or more where 4th symbol from the right is different from leftmost*

e)

Note that only 0's branch of the dfa is drawn. The 1's branch can generated in a similar way. Also, the transitions that are clearly marked by the states itself are ommitted to avoid cluttering.

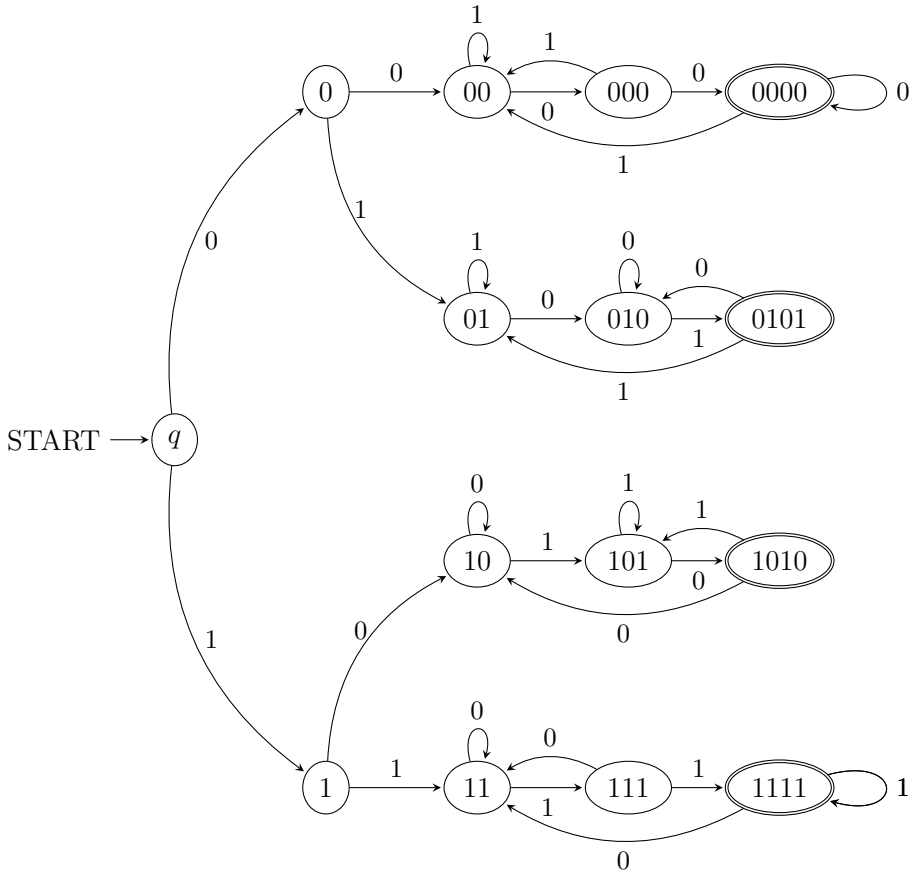

Figure 11: *All strings where leftmost two and rightmost two symbols are identical*

f)

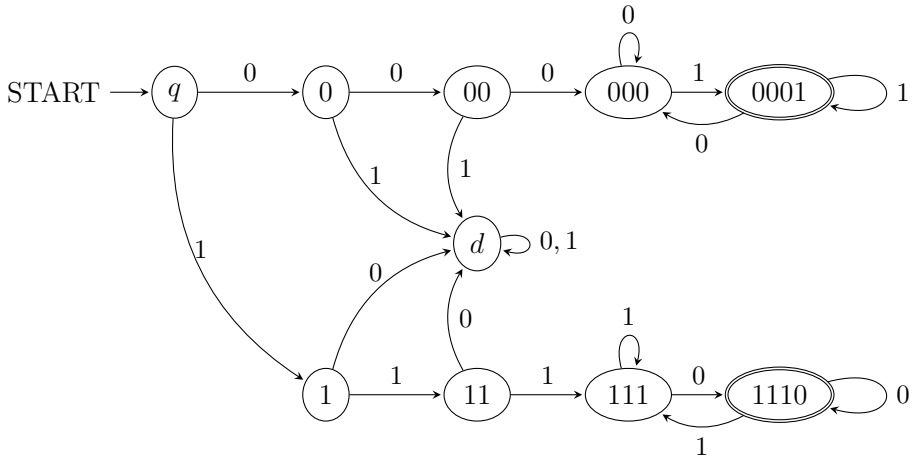

Figure 12: *All strings where leftmost 3 symbols are identical, but different from rightmost symbol*

g)