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. 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 - $b * ab * a * b*$

   $P : S \to aS \mid bS \mid Sb \mid a$

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

   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 - $b * ab * ab * ab * a * b*$

   $P :$

$$S \to aS_1 \mid bS$$
$$S_1 \to aS_2 \mid bS_1$$
$$S_2 \to aS_3 \mid bS_2$$
$$S_3 \to aS_3 \mid bS_3 \mid \lambda$$

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

4. a) Regex - $(ab) * b$

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

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

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

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

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

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

   $P : S \to aSb \mid aa$

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

   d) Regex - $(aaa)(ab)*$

   $P : S \to aSb \mid aaa$

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

   e) Regex - $(ab) * ba * (bb)*$

   $P :$

   $$S \to S_1 S_2 B$$
   $$S_1 \to aS_1 b \mid S_1 b \mid b$$
   $$S_2 \to aS_2 bb \mid \lambda$$

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

   f) Regex - $(ab) * b + a * (bb)*$

   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 - $(ab) * b(ab) * b(ab) * b$

   $P :$

   $$S \to SSS$$
   $$S \to aSb \mid Sb \mid b$$

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

h) Regex - $((ab)*b)*$

P :

$$S \to AB$$
$$A \to aAb \mid Ab \mid b$$
$$B \to AB \mid \lambda$$

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

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.

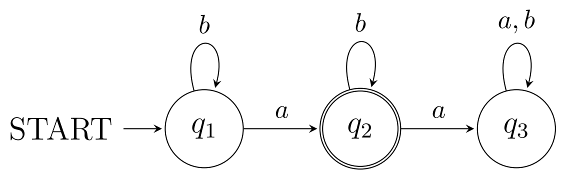

Figure 1: *All strings with exactly one a*

6. a)

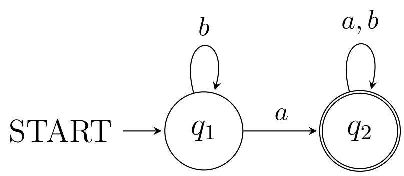

Figure 2: *All strings with at least one a*

b)

c)

d)

e)

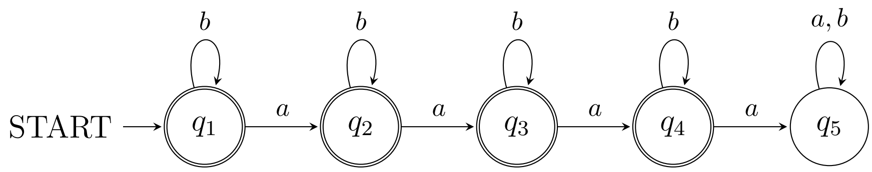

Figure 3: *All strings with no more than 3 a's*

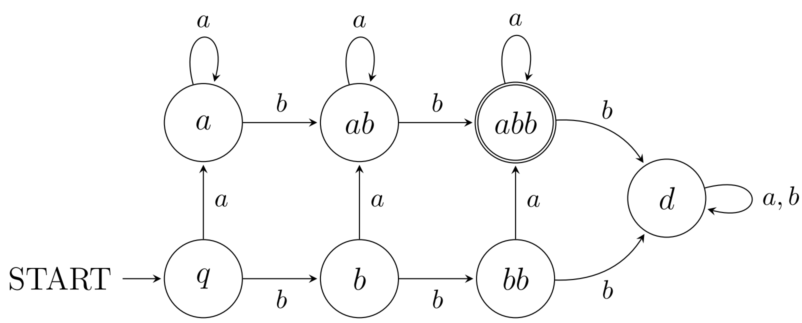

Figure 4: *All strings with at least one a and exactly two b's*

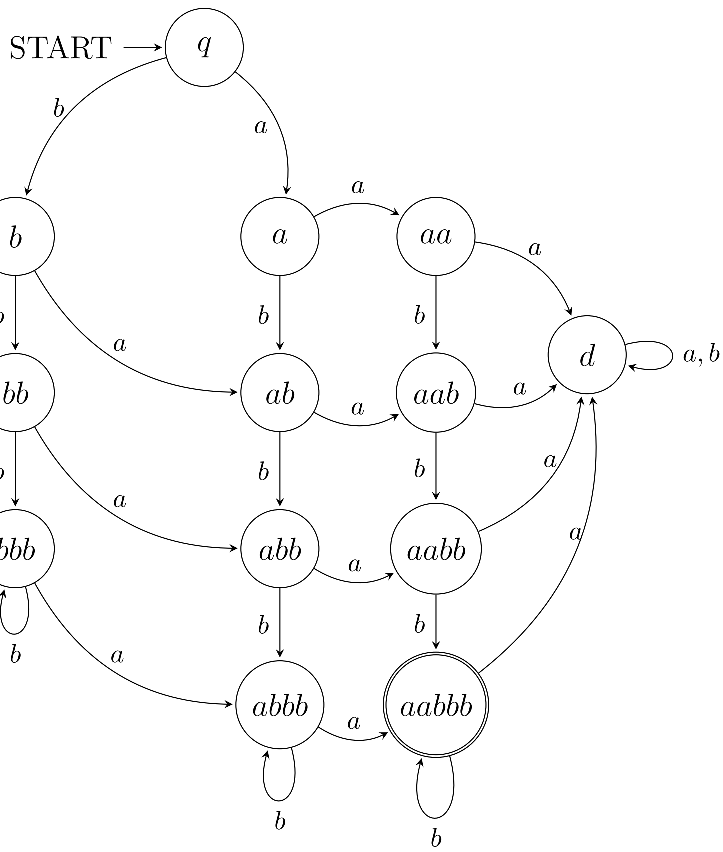

Figure 5: *All strings with exactly two a's and more than two b's*

7. a)

   b)

   c)

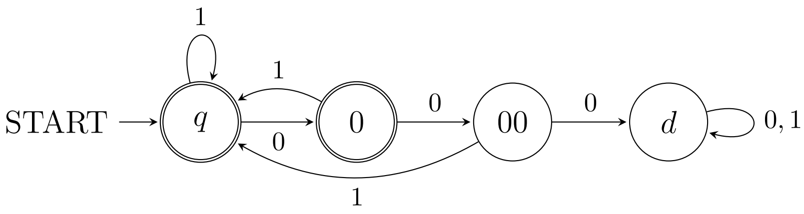

Figure 6: *All strings where every 00 is followed by 1*

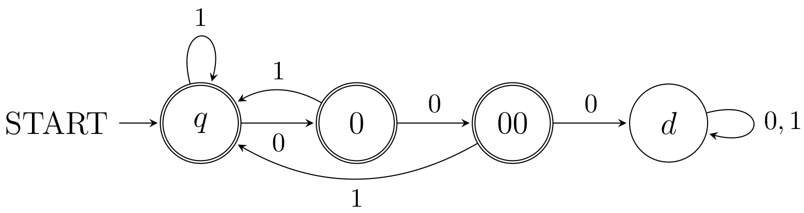

Figure 7: *All strings containing 00 but not 000*

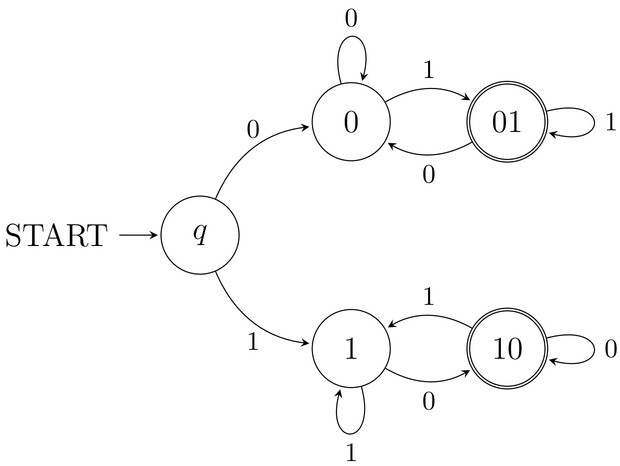

Figure 8: *All strings where leftmost symbol differs from rightmost*

d)

e)

f)

g)

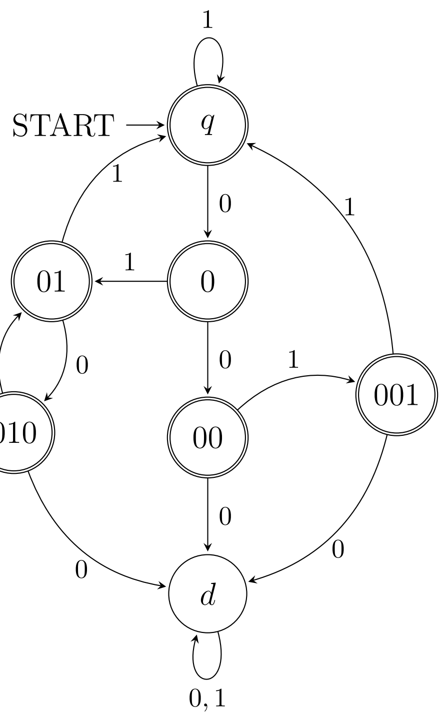

Figure 9: *All strings where every substring of 4 symbols has at most 2 0's*

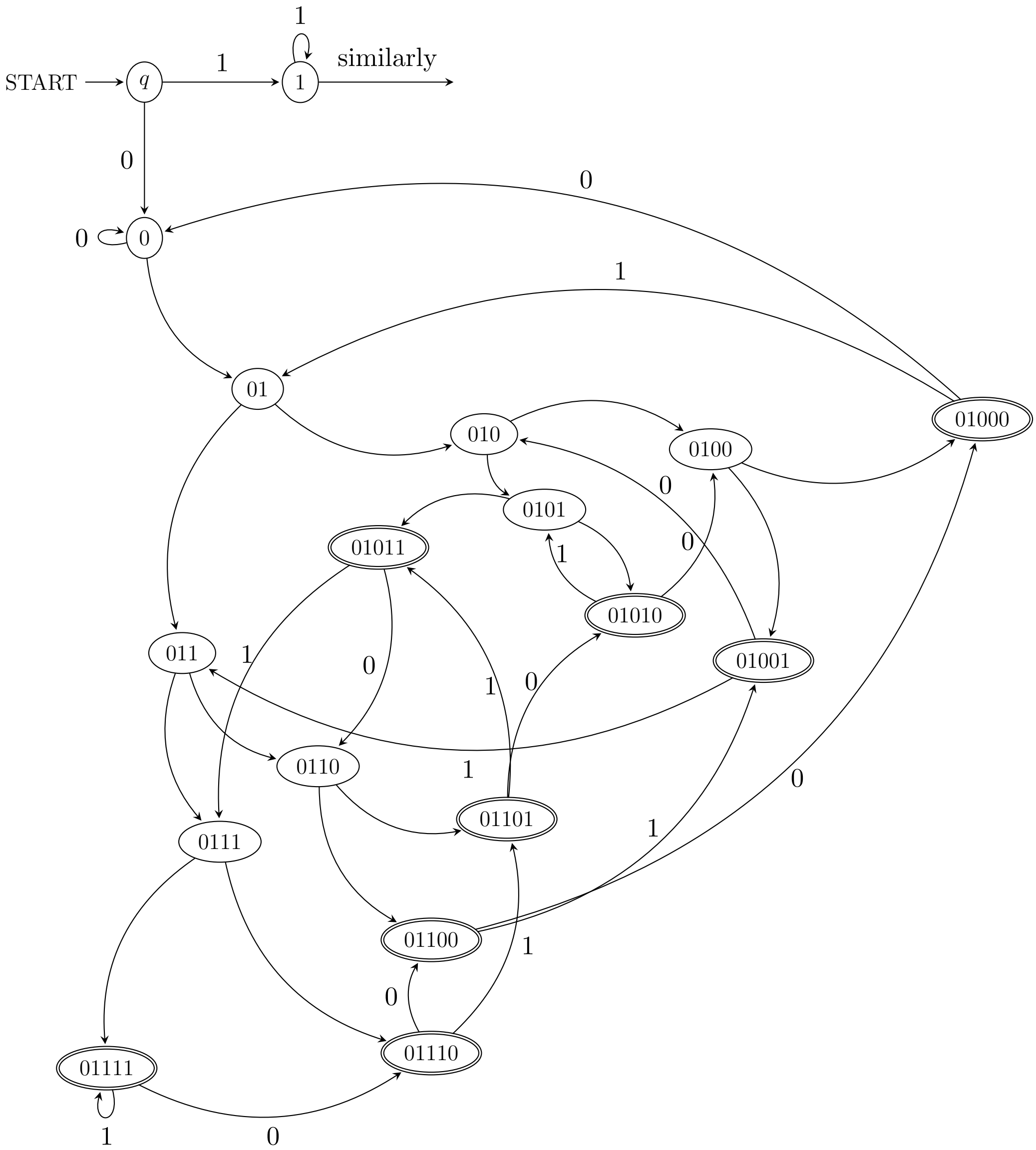

Figure 10: *All strings of length 5 or more where 4th symbol from the right is different from leftmost*

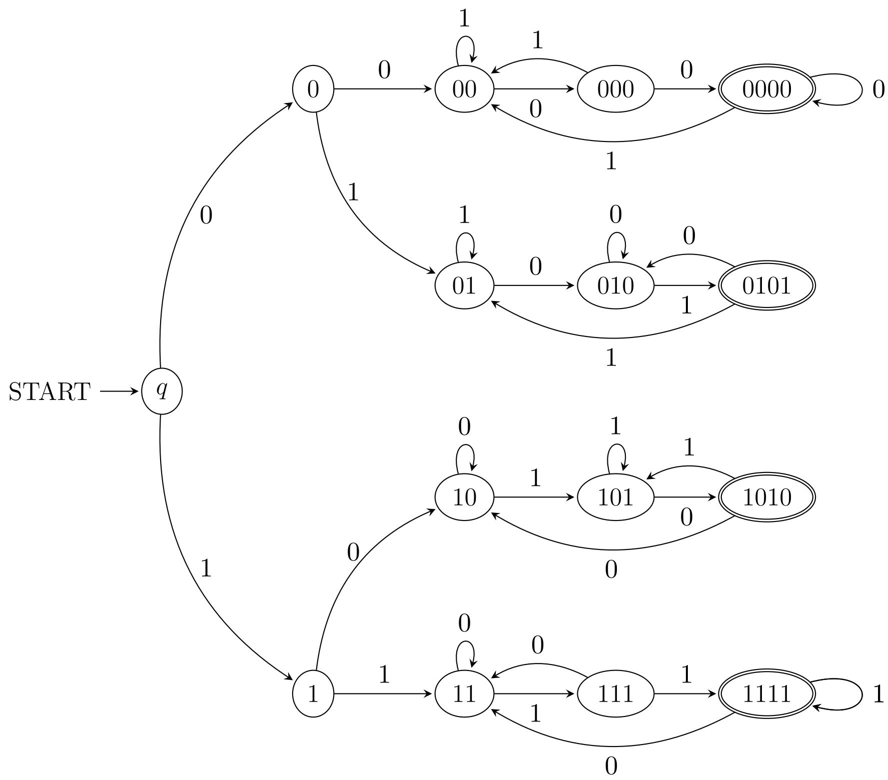

Figure 11: *All strings where leftmost two and rightmost two symbols are identical*

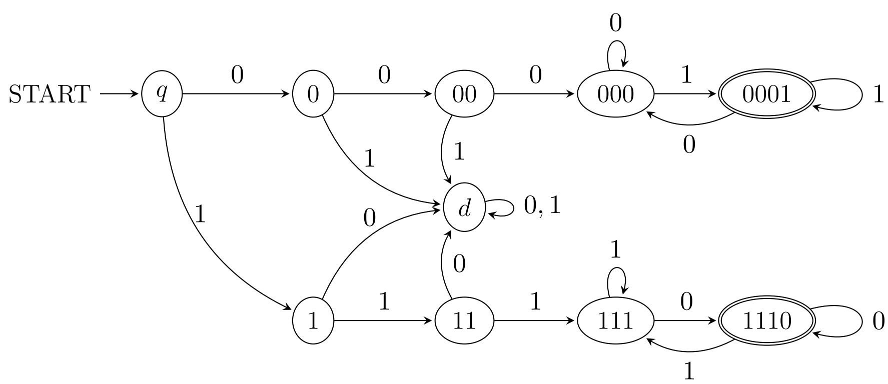

Figure 12: *All strings where leftmost 3 symbols are identical, but different from rightmost symbol*