

*Luiz Henrique Batista Beraldi*

### 1COP020 - Lista de Exercícios 01

1.  **Exercício Teórico:** Determine os seguintes fechos de Kleene:

$$(a) \{ab, c\}^* = \{\lambda, ab, c, abab, abc, cc, cab, \dots\}$$

$$(b) \{a, b, c\}^+ = \{a, b, c, aa, ab, ac, ba, bc, ca, cb, \dots\}$$

$$(c) \{abc\}^* = \{\lambda, abc, abcabc, abcababcabc, \dots\}$$

2.  **Exercício Teórico:** Determine o resultado das seguintes operações nas linguagens indicadas:

$$(a) \{a, b\} \cup \{c, d\} = \{a, b, c, d\}$$

$$(b) \{100, 010, 110\} \cup \{00, 01, 11\} = \{100, 010, 110, 00, 01, 11\}$$

$$(c) \{101, 110\} \cdot \{00, 11\} = \{10100, 10111, 11000, 11011\}$$

$$(d) \{Anab, Emanu, Gabri, Isab, Rafa\} \cdot \{ela\} = \{Amabela, Emanuela, Gabriela, Isabela, Rafaela\}$$

3.  **Exercício Teórico:** Considere o seguinte alfabeto:

$$\Sigma = \{\text{A}, \text{B}, \text{C}\}$$

determine:

$$(a) \Sigma^2 = \{\text{AA}, \text{AB}, \text{AC}, \text{BA}, \text{BB}, \text{BC}, \text{CA}, \text{CB}, \text{CC}\}$$

$$(b) \Sigma^3 = \text{No verso}$$

$$(c) \Sigma^2 \cup \Sigma^2 = \{\text{AA}, \text{AB}, \text{AC}, \text{BA}, \text{BB}, \text{BC}, \text{CA}, \text{CB}, \text{CC}\}$$

$$(d) \Sigma^2 \cdot \Sigma^2 = \text{No verso}$$

4.  **Exercício Teórico:** Considere os seguintes alfabetos:

$$\begin{aligned} \Sigma_1 &= \{H_2, Fe\} \\ \Sigma_2 &= \{SO_4, O_2, Cl_2\} \end{aligned}$$

determine:

$$(a) \Sigma_1^2 = \{H_2H_2, H_2Fe, FeFe, FeH_2\}$$

$$(b) \Sigma_1^2 \cup \Sigma_2^2 = \{H_2, Fe, H_2H_2, H_2Fe, FeFe, FeH_2, SO_4, O_2, Cl_2, SO_4O_2, SO_4S_2, SO_4Cl_2, O_2O_2, O_2SO_4, O_2Cl_2, Cl_2Cl_2, Cl_2SO_4, Cl_2O_2\}$$

$$(c) \Sigma_1^1 \cdot \Sigma_2^1 = \{H_2SO_4, H_2O_2, H_2Cl_2, FeSO_4, FeO_2, FeCl_2\}$$

## LISTA\_1\_EXERCICIO\_3\_LETRA\_B

$\sum^3 = \{ \text{fdd}, \text{dd}, \text{d}, \text{r}, \text{rr}, \text{r}, \text{d}, \text{rr} \}$

## LISTA\_1\_EXERCÍCIO\_3\_LETRA=d

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LISTA\_2\_EXERCICIO\_1.LETRA\_a

$c^*a(c/a)^*b(a/b/c)^*$

(c/a)(c/a)

LISTA\_2\_EXERCICIO\_1.LETRA\_b

$(b/c)^*(a(b/c)^*(a(b/c)^*)^*)^*$

LISTA\_2\_EXERCICIO\_1.LETRA\_c

$(0/1)^*00$

LISTA\_2\_EXERCICIO\_1.LETRA\_d

$(0/1)^*1(0/1)1(0/1)11.$

LISTA\_2\_EXERCICIO\_2.LETRA\_a

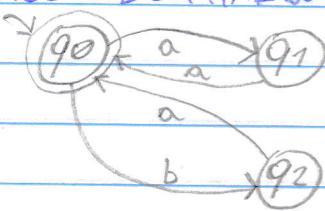
Pode-se gerar qualquer número binário de 0 à 15, menos o 6.

LISTA\_2\_EXERCICIO\_2.LETRA\_b

$1+5k$ , caracteres, onde  $k \geq 1$ .

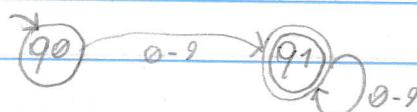
LISTA\_2\_EXERCICIO\_3.LETRA\_a

$((a/b)a)^* =$



LISTA\_2\_EXERCICIO\_3.LETRA\_b

$[0-9]^+ =$



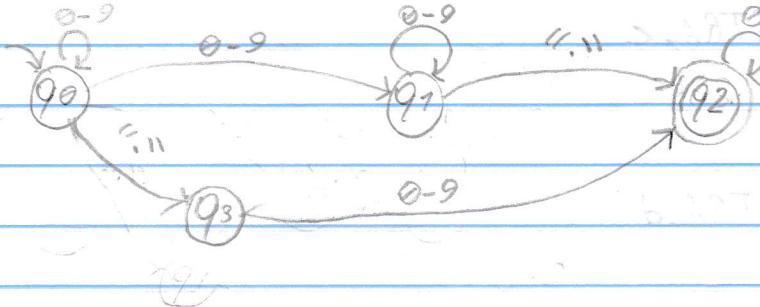
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LISTA\_2\_EXERCICIO\_3\_LETRA\_c

$$[a-z][a-z0-9]^* = \begin{array}{c} 0-9 \\ \textcircled{90} \end{array} \xrightarrow{a-z} \begin{array}{c} 0-9 \\ \textcircled{91} \end{array} \xrightarrow{a-z0-9} \dots$$

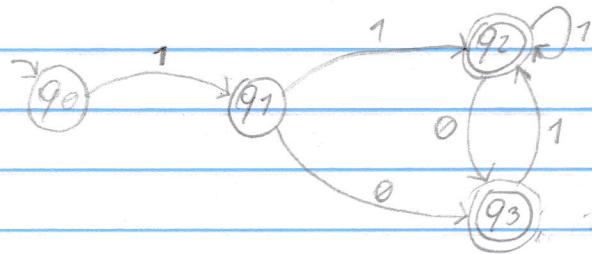
LISTA\_2\_EXERCICIO\_3\_LETRA\_d

$$([0-9]^+ ". "[0-9]^*) | ([0-9]^* ". "[0-9]^+) =$$



LISTA\_2\_EXERCICIO\_3\_LETRA\_e

$$(1(01)^* (11|10|01)) | (11|10|1) =$$



LISTA\_2\_EXERCICIO\_4\_LETRA\_a

if

LISTA\_2\_EXERCICIO\_4\_LETRA\_b

$$[a-z][a-z0-9]^*$$

LISTA\_2\_EXERCICIO\_4\_LETRA\_c

$$[0-9]^+$$

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LISTA\_2\_EXERCICIO\_4\_LETRA\_d

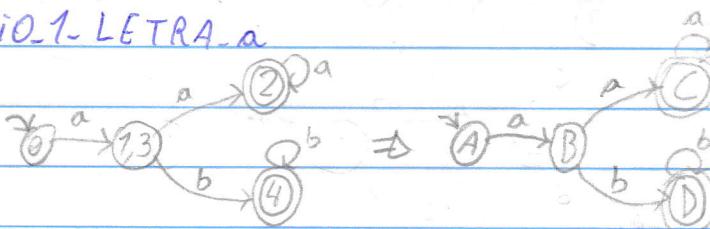
$$([0-9]^+ \cup \cdot \cup [0-9]^*) \mid (\cdot \cup [0-9]^+)$$

LISTA\_2\_EXERCICIO\_4\_LETRA\_e

$$(\cdot \cup \cdot \cup \cdot \cup [a-z]^* \cup \cdot \cup w) \mid (\cdot \cup \cdot^+)$$

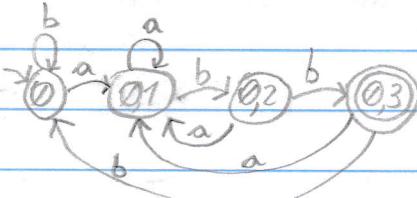
LISTA\_3\_EXERCICIO\_1\_LETRA\_a

	a	b
{0}	{1,3}	$\emptyset$
{1,3}	{2}	{4}
*{2}	{2}	$\emptyset$
*{4}	$\emptyset$	{4}



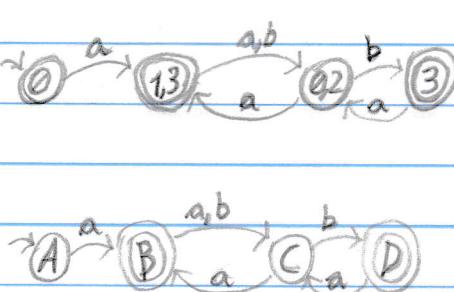
LISTA\_3\_EXERCICIO\_1\_LETRA\_b

	a	b
{0}	{0,1}	{0,3}
{0,1}	{0,1}	{0,2}
{0,2}	{0,1}	{0,3}
*{0,3}	{0,1}	{0,3}



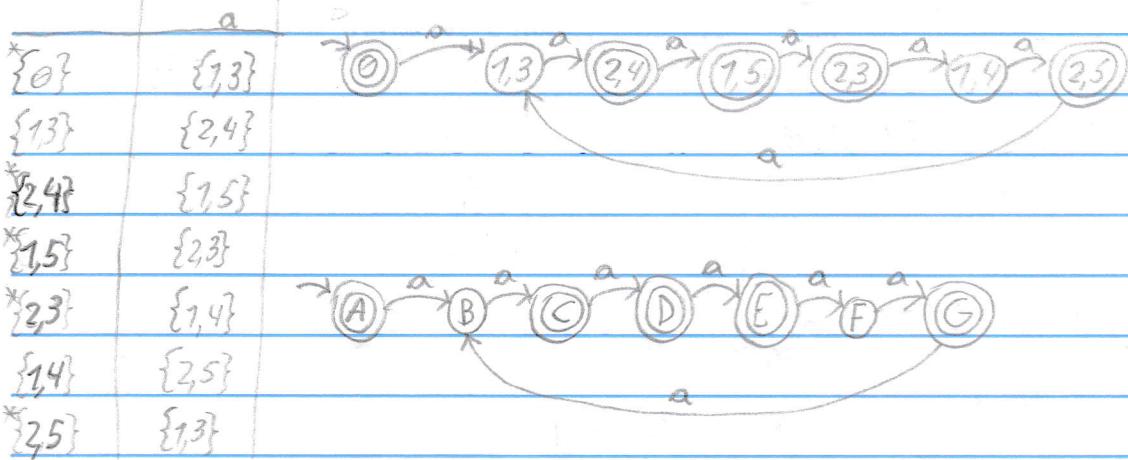
LISTA\_3\_EXERCICIO\_1\_LETRA\_c

	a	b
{0}	{1,3}	$\emptyset$
{1,3}	{0,2}	{0,2}
{0,2}	{1,3}	{3}
{3}	{0,2}	$\emptyset$

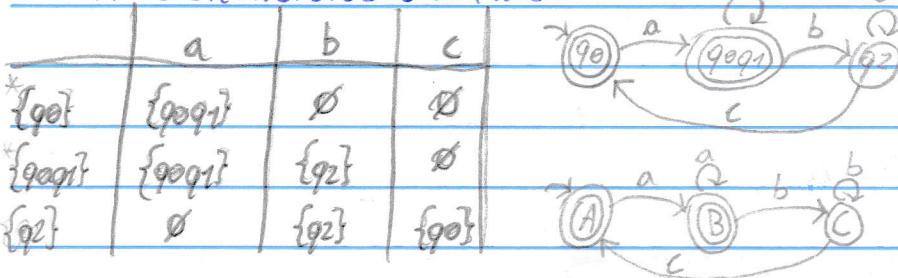


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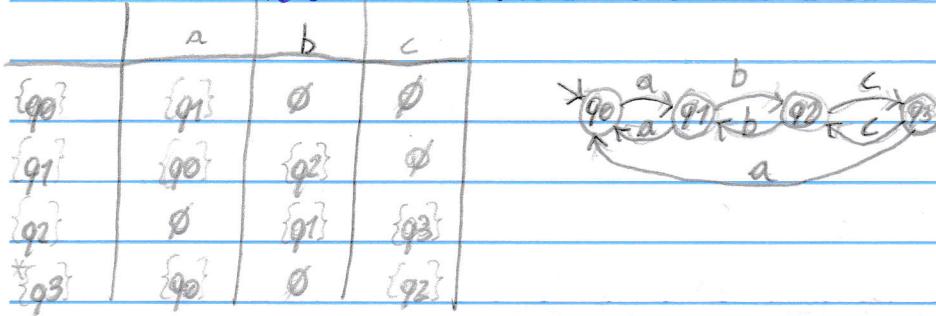
LISTA\_3\_EXERCICIO\_1.LETRA\_d



LISTA\_3\_EXERCICIO\_1.LETRA\_e



LISTA\_3\_EXERCICIO\_1.LETRA\_f

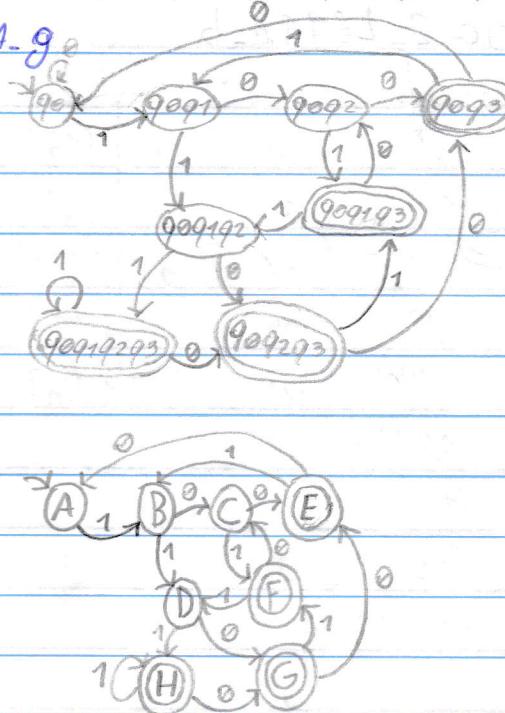


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Algoritmo de ordenação topológica

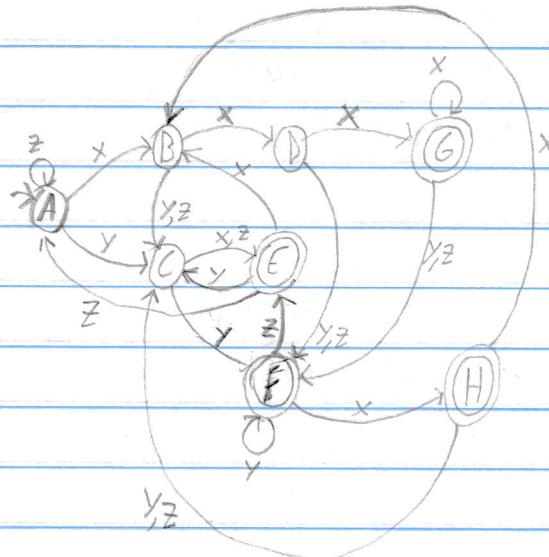
LISTA\_3\_EXERCICIO\_1 LETRA\_g

- |            |          |            |
|------------|----------|------------|
| 0          | 1        |            |
| {90}       | {90}     | {9091}     |
| {9091}     | {9092}   | {909192}   |
| {9092}     | {9093}   | {909193}   |
| {9093}     | {90}     | {9091}     |
| {909192}   | {909293} | {90919293} |
| {909193}   | {9092}   | {909192}   |
| {909293}   | {9093}   | {909193}   |
| {90919293} | {909293} | {90919293} |



LISTA\_3\_EXERCICIO\_2 LETRA\_a

	X	Y	Z	
A	{1,2,3,4}	{1,2,3,4,5}	{1,2,3,4,6}	{1,2,3,4}
B	{1,2,3,4,5}	{1,2,3,4,5,6}	{1,2,3,4,6}	{1,2,3,4,6}
C	{1,2,3,4,6}	{1,2,3,4,7}	{1,2,3,4,6,7}	{1,2,3,4,7}
D	{1,2,3,4,5,6}	{1,2,3,4,5,6,7}	{1,2,3,4,6,7}	{1,2,3,4,6,7}
E	{1,2,3,4,7}*	{1,2,3,4,5,7}	{1,2,3,4,6}	{1,2,3,4}
F	{1,2,3,4,6,7}*	{1,2,3,4,5,7}	{1,2,3,4,6,7}	{1,2,3,4,7}
G	{1,2,3,4,5,6,7}*	{1,2,3,4,5,6,7}	{1,2,3,4,6,7}	{1,2,3,4,6,7}
H	{1,2,3,4,5,7}*	{1,2,3,4,5,6}	{1,2,3,4,6,7}	{1,2,3,4,6,7}



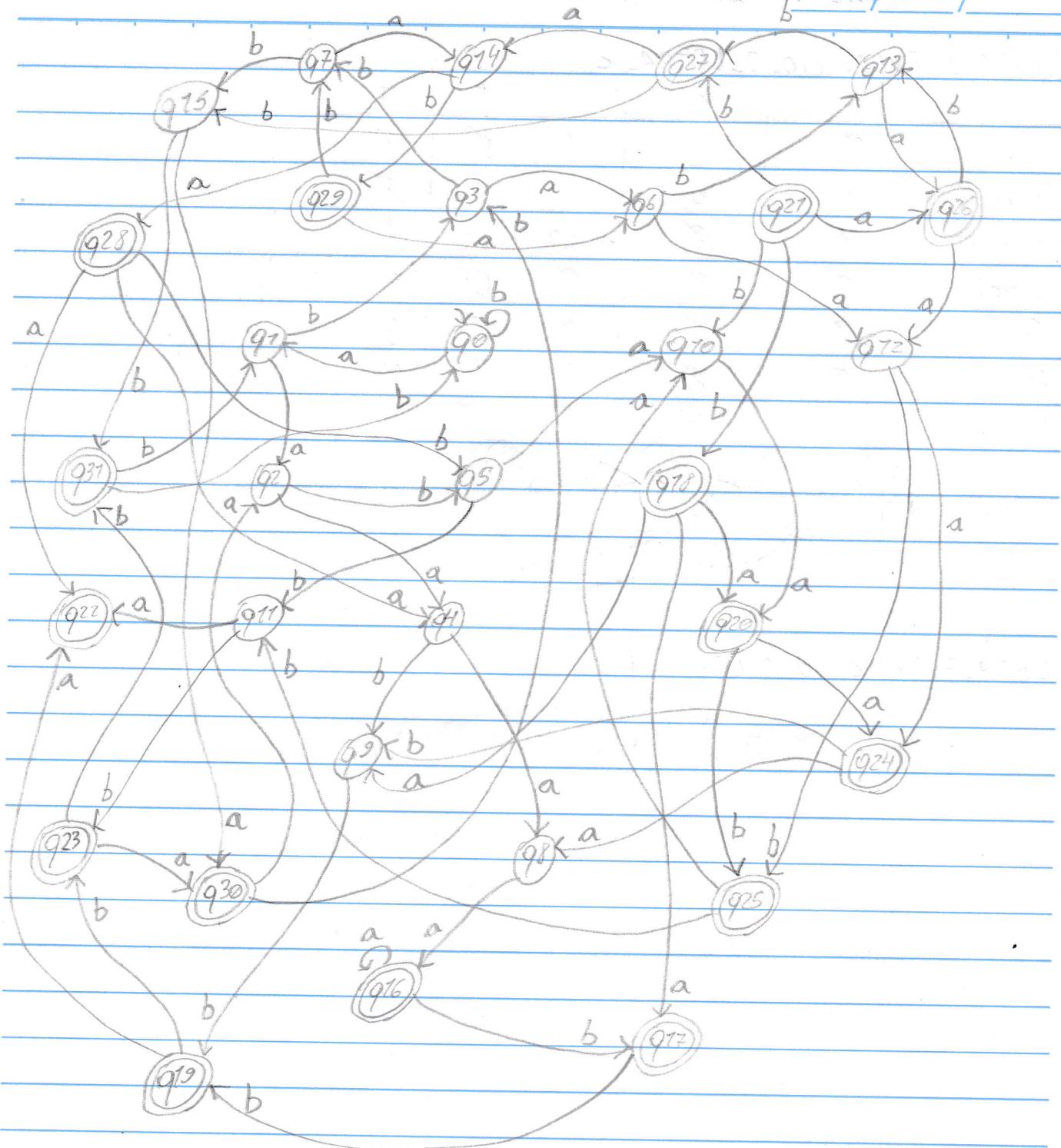
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LISTA\_3 EXERCÍCIO\_2 LETRA\_b

a	b	a	b
{1}	{1,2}	{1}	q1
{1,2}	{1,2,3}	{1,3}	q2
{1,2,3}	{1,2,3,4}	{1,3,4}	q3
{1,3}	{1,2,4}	{1,4}	q4
{1,2,3,4}	{1,2,3,4,5}	{1,3,4,5}	q5
{1,3,4}	{1,2,4,5}	{1,4,5}	q6
{1,2,4}	{1,2,3,5}	{1,3,5}	q7
{1,4}	{1,2,5}	{1,5}	q8
{1,2,3,4,5}	{1,2,3,4,5,6}	{1,3,4,5,6}	q9
{1,3,4,5}	{1,2,4,5,6}	{1,4,5,6}	q10
{1,2,4,5}	{1,2,3,5,6}	{1,3,5,6}	q11
{1,4,5}	{1,2,5,6}	{1,5,6}	q12
{1,2,3,5}	{1,2,3,4,6}	{1,3,4,6}	q13
{1,3,5}	{1,2,4,6}	{1,4,6}	q14
{1,2,5}	{1,2,3,6}	{1,3,6}	q15
{1,5}	{1,2,6}	{1,6}	q16
{1,2,3,4,5,6}	{1,2,3,4,5,6}	{1,3,4,5,6}	q17
{1,3,4,5,6}	{1,2,4,5,6}	{1,4,5,6}	q18
{1,2,4,5,6}	{1,2,3,5,6}	{1,3,5,6}	q19
{1,4,5,6}	{1,2,5,6}	{1,5,6}	q20
{1,2,3,5,6}	{1,2,3,4,6}	{1,3,4,6}	q21
{1,3,5,6}	{1,2,4,6}	{1,4,6}	q22
{1,2,5,6}	{1,2,3,6}	{1,3,6}	q23
{1,5,6}	{1,2,6}	{1,6}	q24
{1,2,3,4,6}	{1,2,3,4,5}	{1,3,4,5}	q25
{1,3,4,6}	{1,2,3,5}	{1,4,5}	q26
{1,2,4,6}	{1,2,3,5}	{1,3,5}	q27

### LISTA 3 - EXERCÍCIO 2 - LETRA b

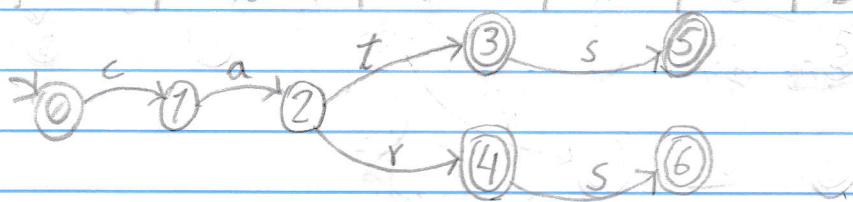
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LISTA\_3\_ EXERCICIO\_2 LETRA\_c

	a	c	r	t	s
0 $\{1, 5, 10, 14\}$	$\emptyset$	$\{2, 6, 11, 15\}$	$\emptyset$	$\emptyset$	$\emptyset$
1 $\{2, 6, 11, 15\}$	$\{3, 7, 12, 16\}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
2 $\{3, 7, 12, 16\}$	$\emptyset$	$\emptyset$	$\{13, 17\}$	$\{9, 8\}$	$\emptyset$
3 $\{13, 17\}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\{18\}$
4 $\{9, 8\}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\{9\}$
5 $\{18\}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
6 $\{9\}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$



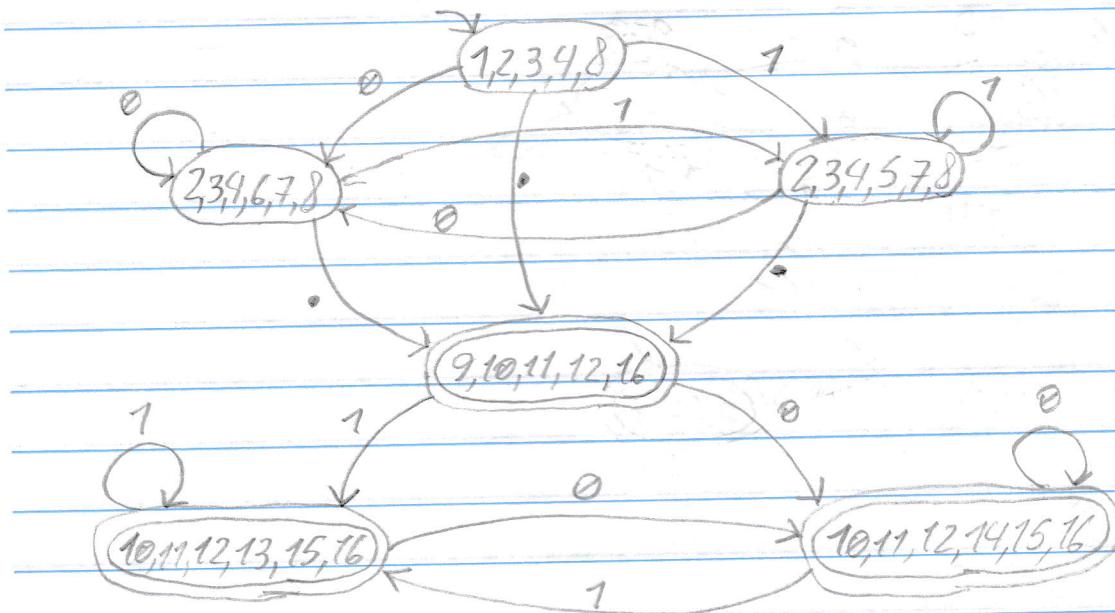
LISTA\_3\_ EXERCICIO\_2 LETRA\_d

	a
$\{0, 1, 3\}$	$\{2, 4\}$
$\{2, 4\}$	$\{1, 5\}$
$\{1, 5\}$	$\{2, 3\}$
$\{2, 3\}$	$\{1, 4\}$
$\{1, 4\}$	$\{2, 5\}$
$\{2, 5\}$	$\{1, 3\}$
$\{1, 3\}$	$\{2, 4\}$

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LISTA-3 EXERCICIO-2 LETRA-e

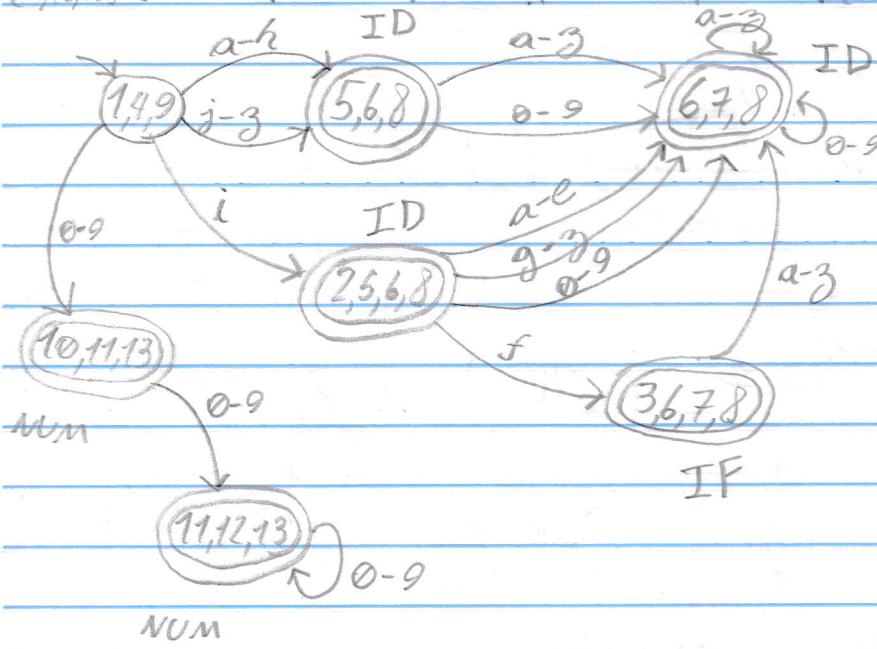
0	1	0	1
{1,2,3,4,8}	{2,3,4,6,7,8}	{2,3,4,5,7,8}	{9,10,11,12,16}
{2,3,4,6,7,8}	{2,3,4,6,7,8}	{2,3,4,5,7,8}	{9,10,11,12,16}
{2,3,4,5,7,8}	{2,3,4,6,7,8}	{2,3,4,5,7,8}	{9,10,11,12,16}
{9,10,11,12,16}	{10,11,12,13,15,16}	{10,11,12,13,15,16}	Ø
{10,11,12,14,15,16}	{10,11,12,13,15,16}	{10,11,12,13,15,16}	Ø
{10,11,12,13,15,16}	{10,11,12,14,15,16}	{10,11,12,13,15,16}	Ø



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### LISTA\_3 EXERCICIO\_3

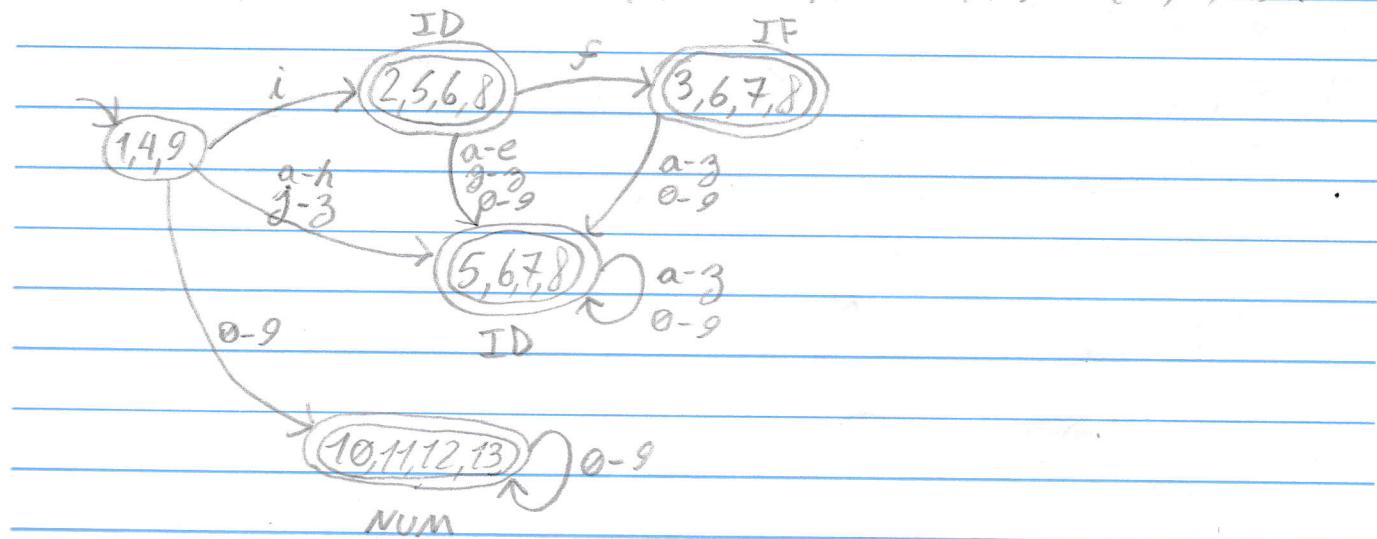
a-e	f	g-h	i	j-3	o-9
{1,4,9}	{5,6,8}	{5,6,8}	{5,6,8}	{5,6,8}	{10,11,13}
{5,6,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}
{2,5,6,8}	{6,7,8}	{3,6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}
{10,11,13}					{11,12,13}
{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}
{3,6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}
{11,12,13}					{11,12,13}



LISTA\_4\_EXERCICIO\_1-LETRA\_a

a-e	f	g-h	i	j-3	0-9	
{1,9,9}	{3,6,8}	{5,6,8}	{5,6,8}	{2,5,6,8}	{5,6,8}	{10,11,13}
{2,5,6,8}	{6,7,8}	{3,6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	
{3,6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	
{5,6,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	
{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	{6,7,8}	
{10,11,13}					{11,12,13}	
{11,12,13}					{11,12,13}	

{2,5,6,8}	X					
{3,6,7,8}	X	X				
{5,6,8}	X	X	X			
{6,7,8}	X	X	X			
{10,11,13}	X	X	X	X	X	
{11,12,13}	X	X	X	X	X	
{1,9,9}	{2,5,6,8}	{3,6,7,8}	{5,6,8}	{6,7,8}	{10,11,13}	



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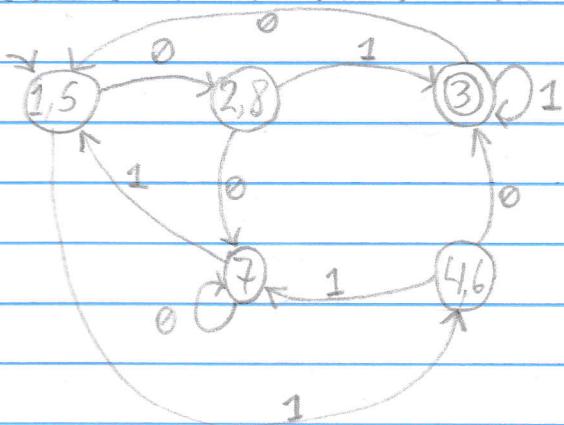
LISTA\_4\_EXERCICIO\_1 LETRA\_b

a	b					
{1}	{2}	{4}	{2}	X		
{2}*	{3}	Ø	{3}	X	X	
{3}	{2}	Ø	{4}	X	X	
{4}*	{5}	Ø	{5}	X	X	X
{5}	{4}	Ø	{1}	{2}	{3}	{4}



LISTA\_4\_EXERCICIO\_1 LETRA\_c

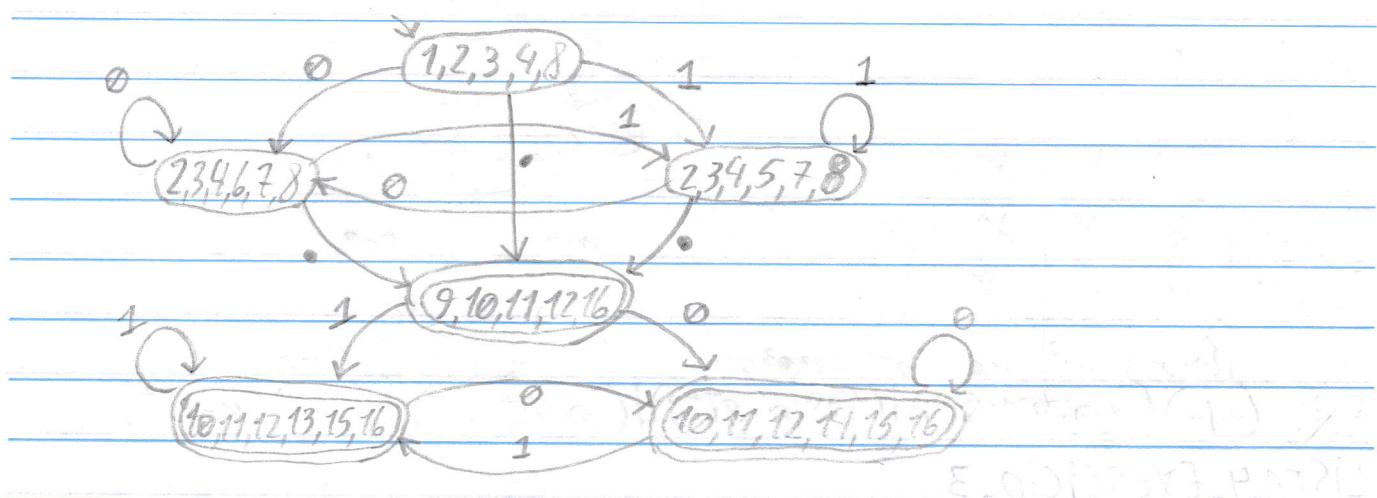
Ø	1						
{1}	{2}	{6}	{2}	X			
{2}	{7}	{3}	{3}*	X	X		
{3}	{1}	{3}	{4}	X	X	X	
{4}	{3}	{7}	{5}		X	X	X
{5}	{8}	{6}	{6}	X	X	X	X
{6}	{3}	{7}	{7}	X	X	X	X
{7}	{7}	{5}	{8}	X	X	X	X
{8}	{7}	{3}	{1}	{2}	{3}*	{4}	{5}



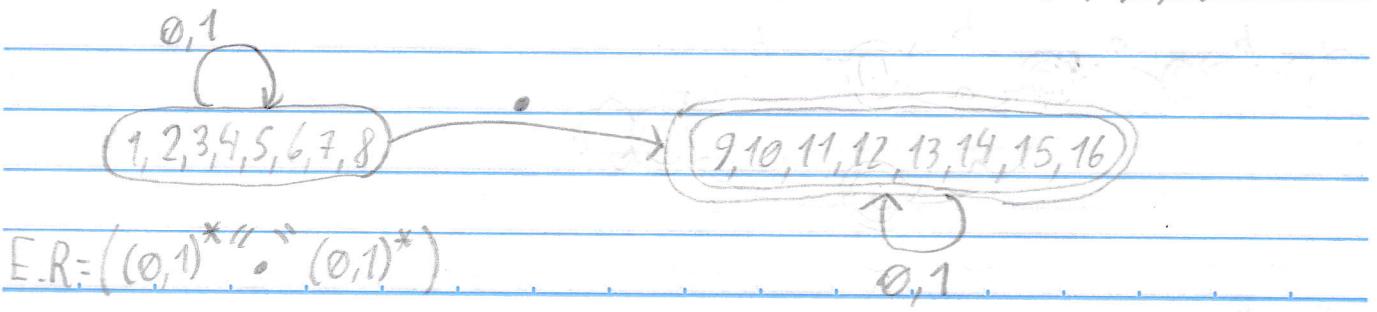
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### LISTA\_4\_EXERCICIO\_2 - LETRA-a

$\emptyset$	1	•	•
{1,2,3,4,8}	{2,3,4,6,7,8}	{2,3,4,5,7,8}	{9,10,11,12,16}
{2,3,8,6,7,8}	{2,3,4,6,7,8}	{2,3,4,5,7,8}	{9,10,11,12,16}
{2,3,4,5,7,8}	{2,3,4,6,7,8}	{2,3,4,5,7,8}	{9,10,11,12,16}
{9,10,11,12,16}	{10,11,12,14,15,16}	{10,11,12,13,15,16}	
{10,11,12,14,15,16}	{10,11,12,14,15,16}	{10,11,12,13,15,16}	
{10,11,12,13,15,16}	{10,11,12,14,15,16}	{10,11,12,13,15,16}	



{2,3,4,6,7,8}					
{2,3,4,5,7,8}					
{9,10,11,12,16}*	X	X	X		
{10,11,12,14,15,16}*	X	X	X		
{10,11,12,13,15,16}*	X	X	X		
	{1,2,3,4,8}	{2,3,4,6,7,8}	{2,3,4,5,7,8}	{9,10,11,12,16}*	{10,11,12,13,15,16}

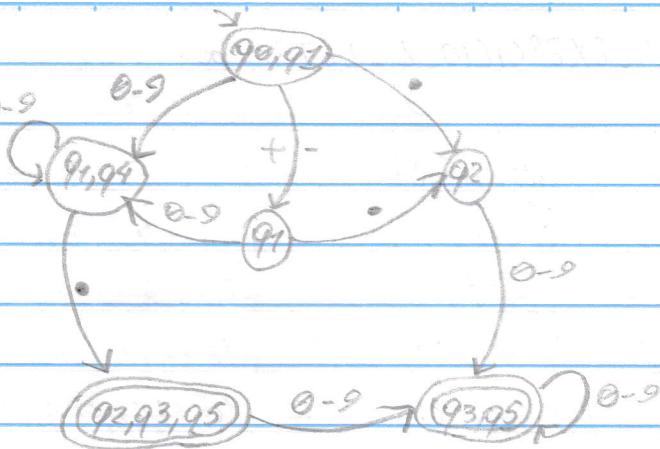


$((+|-)(([0-9]^+."))|(".". "[0-9]^+))|(([0-9]^+."))|(".". "[0-9]^+)$

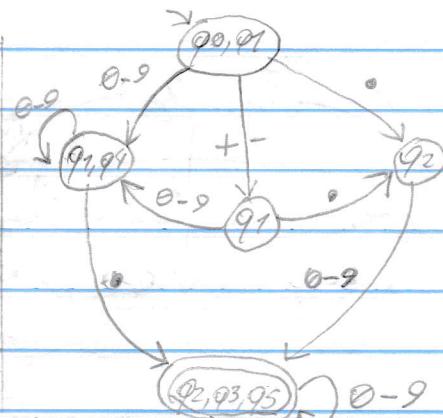
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### LISTA\_4\_EXERCICIO\_2-LETRA-b

+,-	0-9	.	0-9	.	0-9	.	0-9	.	0-9	.	0-9	.
{90,91}	{91}	{91,94}	{92}									
{91}	.	{91,94}	{92}									
{91,94}	.	{91,94}	{92,93,95}									
{92}	.	{93,95}										
{92,93,95}*	{95}	{93,95}	{95}									
{93,95}*	{95}	{93,95}	{95}									



{91}	X											
{91,94}	X	X										
{92}	X	X	X									
{92,93,95}*	X	X	X	X								
{93,95}*	X	X	X	X								



E.R.:  $(+|-)(([0-9]^+."))|(".". "[0-9]^+))|(([0-9]^+."))|(".". "[0-9]^+)$

### LISTA\_4\_EXERCICIO\_3

Automato A

1 {0,16,17,18}

a

b

{1,19,20}

2 {1,2,19,20}

{0,3,4,6,8,10,11,12,13,14,15,17,18,21,22,23}

3 {0,3,4,6,8,10,11,12,13,14,15,17,18,21,22,23}

{4,5,6,8,9,11,12,13,15,23}

{1,2,6,7,13,19,20,23}

4 {4,5,6,8,9,11,12,13,15,23}

{4,5,6,8,9,11,12,13,15,23}

{6,7,13,23}

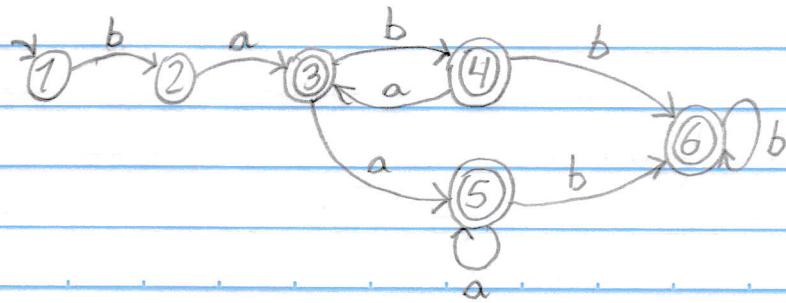
5 {1,2,6,7,13,19,20,23}

{0,3,4,6,8,10,11,12,13,14,15,17,18,21,22,23}

{6,7,13,23}

6 {6,7,13,23}

{6,7,13,23}



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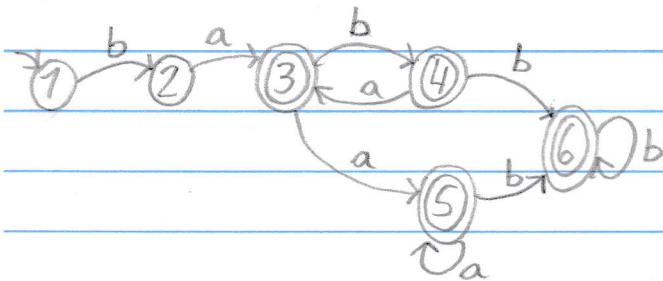
LISTA 4 - EXERCÍCIO 3

2	X				
3	X	X			
4	X	X	X		
5	X	X	X	X	
6	X	X	X	X	X
1	2	3	4	5	

O automato já está minimizado

Automato B

$\{0, 9, 10, 11\}^*$	1	$\{1, 2, 5, 6, 12, 13, 14\}$
$\{1, 2, 5, 6, 12, 13, 14\}$	2	$\{0, 3, 4, 6, 7, 8, 11, 13, 19, 15, 16, 17\}$
$\{0, 3, 4, 6, 7, 8, 11, 13, 14, 15, 16, 17\}^*$	3	$\{6, 7, 8, 13, 14, 15, 16, 17\}$
$\{6, 7, 8, 13, 14, 15, 16, 17\}^*$	4	$\{6, 7, 8, 13, 14, 15, 16, 17\}$
$\{1, 2, 5, 6, 8, 9, 12, 13, 14, 17\}^*$	5	$\{8, 9, 17\}$
$\{8, 9, 17\}^*$	6	$\{8, 9, 17\}$



2	X				
3	X	X			
4	X	X	X		
5	X	X	X	X	
6	X	X	X	X	X
1	2	3	4	5	

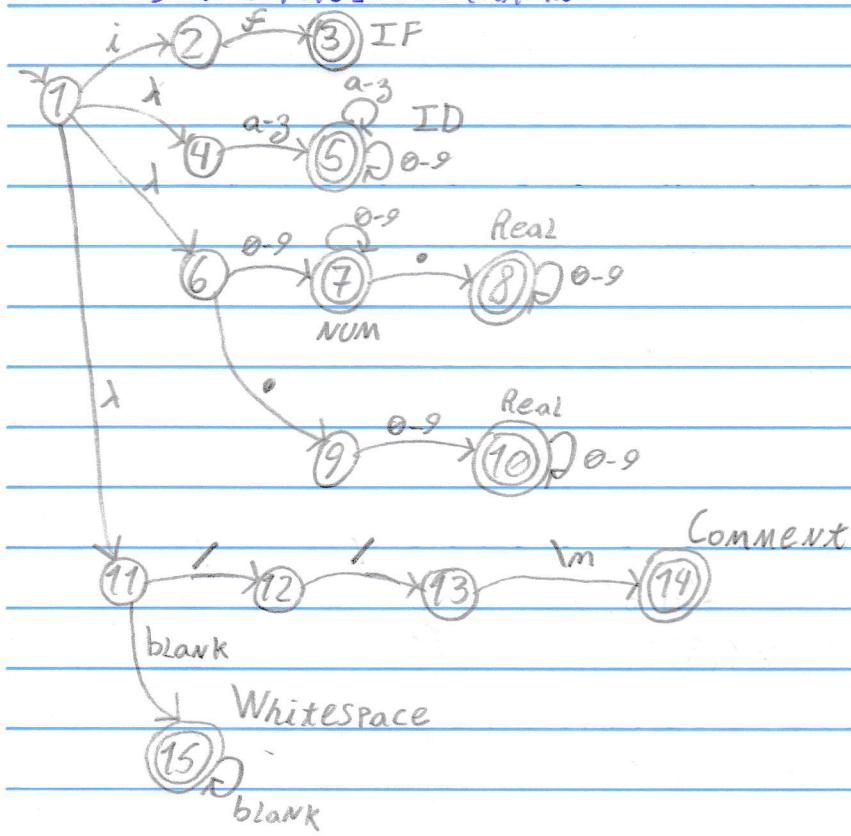
O automato já está minimizado

O automato A e o B são equivalentes!

E.R.:  $ba((a^*b^*)|((ba)^*)|(b^*))$

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LISTA\_9\_EXERCICIO\_4-LETRA\_a

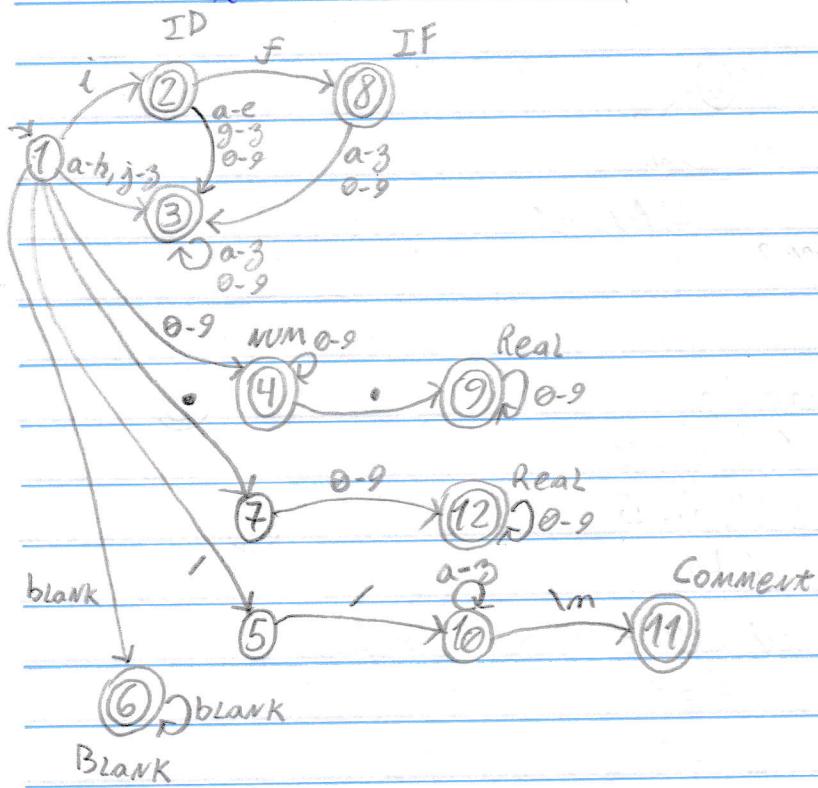


LISTA\_9\_EXERCICIO\_4-LETRA\_b

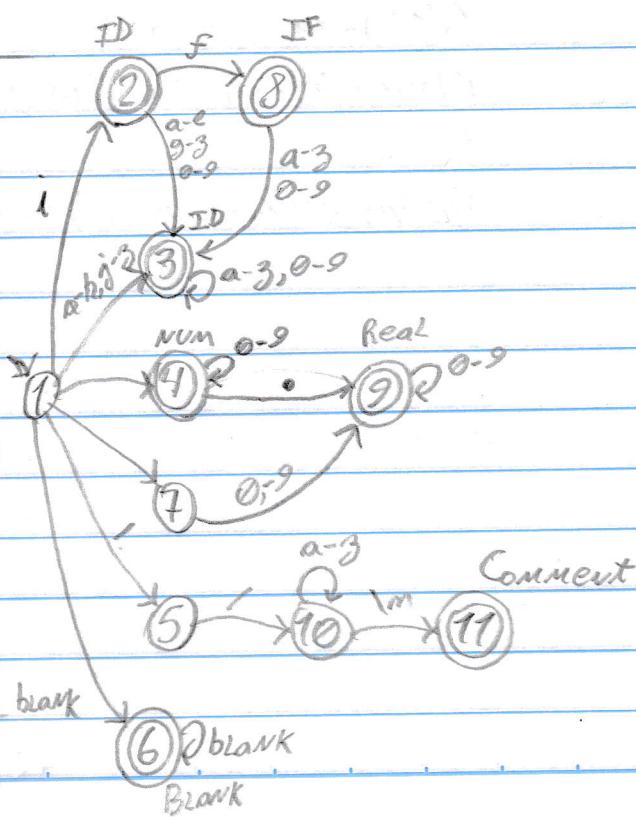
	$i$	$a-3$	$0-9$	$/$	blank	$\cdot$	$f$	$\backslash m$
1	{11}	{2,5}	{5}	{7}	{12}	{15}	{9}	
2	{2,5}	{5}	{5}	{5}		{3,5}		ID
3	{5}	{5}	{5}	{5}		{5}		ID
4	{7}		{7}		{8}			NUM
5	{12}			{13}				
6	{15}			{15}				BLANK
7	{9}			{10}				
8	{3,5}	{5}	{5}	{5}		{5}		IF
9	{8}			{8}				Real
10	{13}	{13}	{13}		{13}	{14}		
11	{14}							Comment
12	{10}			{10}				Real

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## LISTA-4-EXERCICIO-4-LETRA-b

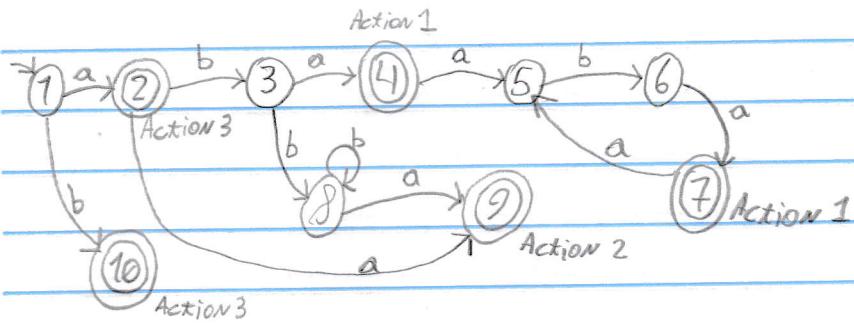


2	X										
3	X	X									
4	X	X	X								
5	X	X	X	X							
6	X	X	X	X	X						
7	X	X	X	X	X	X					
8	X	X	X	X	X	X	X				
9	X	X	X	X	X	X	X				
10	X	X	X	X	X	X	X	X			
11	X	X	X	X	X	X	X	X	X		
12	X	X	X	X	X	X	X	X	X	blank	
	1	2	3	4	5	6	7	8	9	10	11



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## LISTA 5. EXERCICIO-3



S a b      entrada = abababba'b'a

1 2 10       $S(1, a) = 2^*$ ,  $S(2, b) = 3$

2 9 3       $S(3, a) = 4^*$ ,  $S(4, a) = 5$

3 4 8       $S(5, b) = 6$ ,  $S(6, b) = X$

4 5      Último estado final (4)  $\Rightarrow aba$  (action 1)

5 - 6       $S(7, a) = 2^*$ ,  $S(2, b) = 3$

6 7       $S(3, b) = 8$ ,  $S(8, a) = 9^*$

7 5       $S(9, b) = X$

8 9 8      Último estado final (9)  $\Rightarrow abba$  (action 2)

9       $S(1, b) = 10^*$ ,  $S(10, a) = X$

10      Último estado final (10)  $\Rightarrow b$  (action 3)

$S(1, a) = 2^*$

Último estado final (2)  $\Rightarrow a$  (action 3)