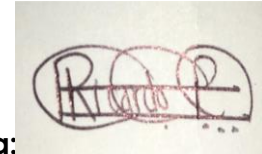


Facultad: Ingeniería de Sistemas
Carrera: Computación
Asignatura: ICCR163 - Fundamentos de ciencias de la computación
Profesor: PhD. Josafá Pontes
Fecha: 07 de septiembre de 2020



Estudiante: Ricardo Xavier Paredes

Firma:

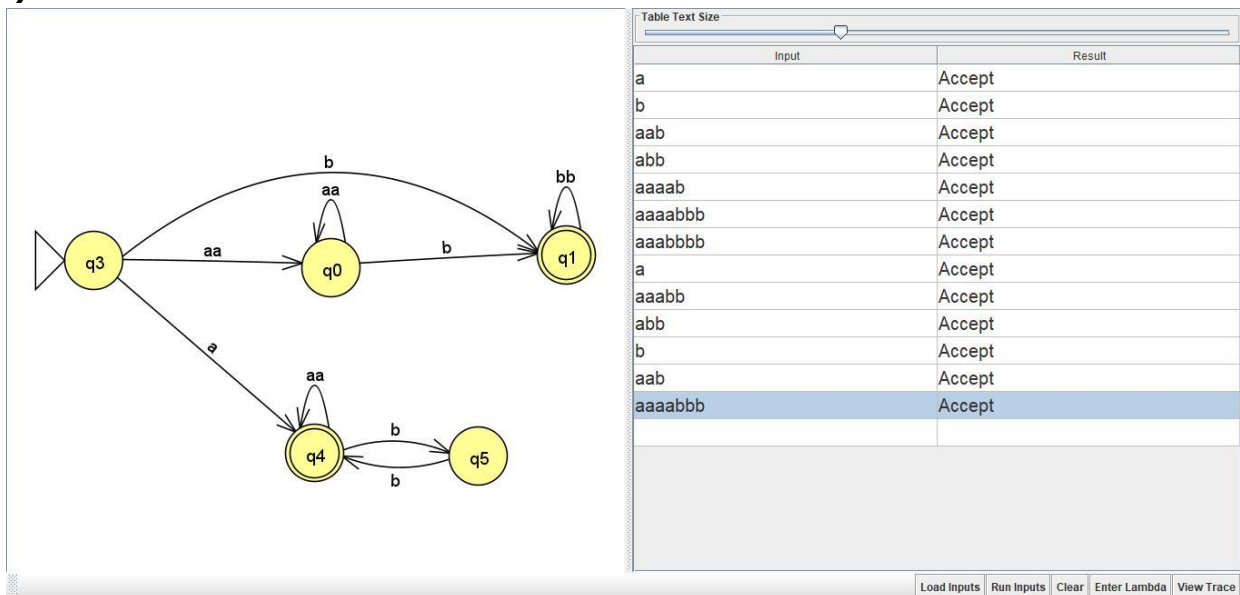
(Vale 30% de la nota del segundo bimestre)

Durante el examen, queda prohibido todo tipo de copia. Cualquier detección de copia será severamente sancionada con **nota igual a cero** en el examen. Contestarlas preguntas en el propio Word. Al final, enviar el archivo .doc y el idéntico .pdf firmado junto con todos archivos del JFLAP.

1) Encuentre i) el dfa, ii) la gramática lineal-derecha (CFG Stanford), y iii) la expresión regular formal y práctica (regex101.com) a partir del autómata simplificado para los siguientes lenguajes sobre el alfabeto $\Sigma = \{a,b\}$.

a) (7.5%) $L = \{w \in \{a,b\}^* \mid w = a^n b^m : n + m \text{ es impar}\}$.

i) DFA:



ii) Gramática Lineal a la Derecha.

Start symbol: **S**

S → **bB** | **aaA** | **aC**

B → **bbB** | ϵ

A → **aaA** | **bB**

C → **bD** | ϵ

D → **bC**

To test the CFG above, input test strings here, one per line. An empty line corresponds to the empty string. Results will be shown automatically.

```

a
aab
aaaabbb
aa
aabb
aaaabbb
aaaaaabbbaabb
abbaa

```

Test Results for CFG

#	String	Matches
1	"a"	Yes See Derivation
2	"b"	Yes See Derivation
3	"abb"	Yes See Derivation
4	"baa"	No
5	"aa"	No
6	"aab"	Yes See Derivation
7	"aaaab"	Yes See Derivation
8	"aaaabbb"	Yes See Derivation
9	"aaabbbb"	No
10	"a"	Yes See Derivation
11	"aaabb"	No
12	"abb"	Yes See Derivation
13	"b"	Yes See Derivation
14	"aab"	Yes See Derivation
15	"aaaabbb"	Yes See Derivation
16	"aa"	No

iii) Expresión Regular y Práctico

Expresión Regular: $r = (b + (aa(aa)^*b(bb)^*) + (a(aa)^*(bb)^*))$

Expresión Práctica (Regex101): $^b | (aa(aa)^*b(bb)^*) | (a(aa)^*(bb)^*)$

SAVE & SHARE
Save Regex ctrl+s

FLAVOR
 <> PCRE (PHP) ✓
 <> ECMAScript (JavaScript)
 <> Python
 <> Golang

FUNCTION
 ★ Match ✓
 Substitution
 Unit Tests

TOOLS
 Code Generator
 ★ Regex Debugger

REGULAR EXPRESSION
 15 matches, 328 steps (~0ms)
 ^b|(aa(aa)*b(bb)*)|(a(aa)*(bb)*)\$ /gm

TEST STRING

```

a
b
abb
baa
aa
aab
aaaaa
aaaabbb
aaaabbbb
a
aaaab
abb
b
aab
aaaaaabb
aa
aabb
aaaabbb

```

EXPLANATION
 ^ asserts position at start of a line
 ▼ 1st Capturing Group
 b matches the character b literally (case sensitive)
 ▼ 1st Alternative
 ▼ 2nd Alternative
 ▼ 2nd Capturing Group

MATCH INFORMATION
 Match 1
 Full match 0-1 a
 Group 1 0-1 a
 Group 5 0-1 a

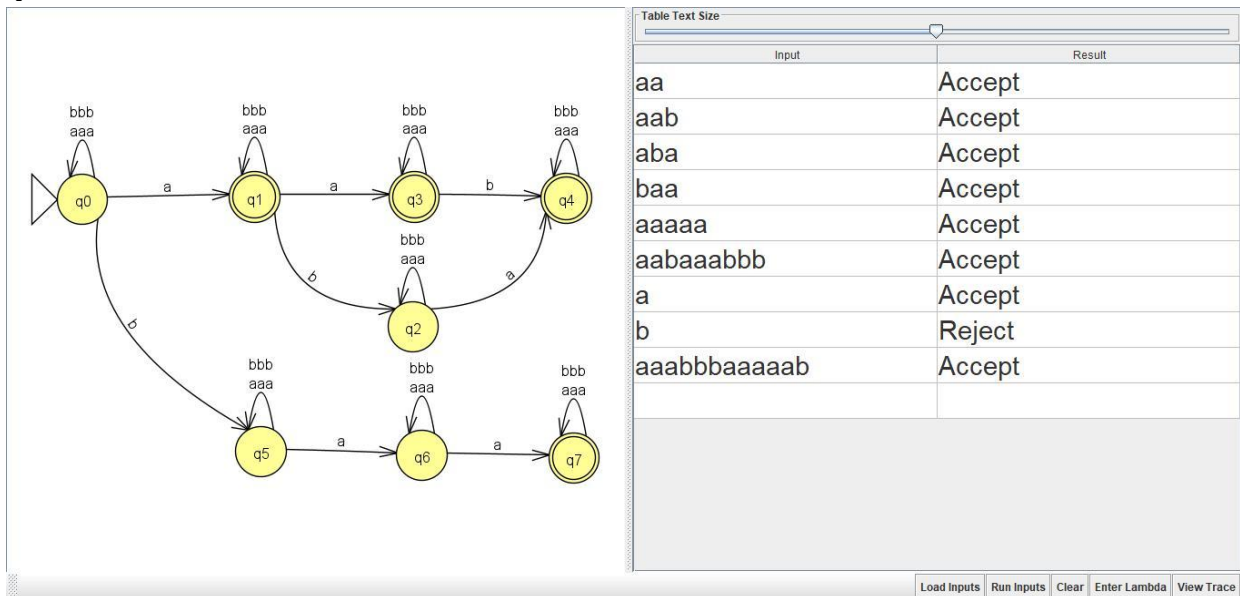
QUICK REFERENCE
 Search reference
 All Tokens
 ★ Common Tokens ✓
 General Tokens
 Anchors

A single character... [abc]
 A character exce... [^abc]
 A character in the... [a-z]
 A character not i... [^a-z]
 A character in ... [a-zA-Z]

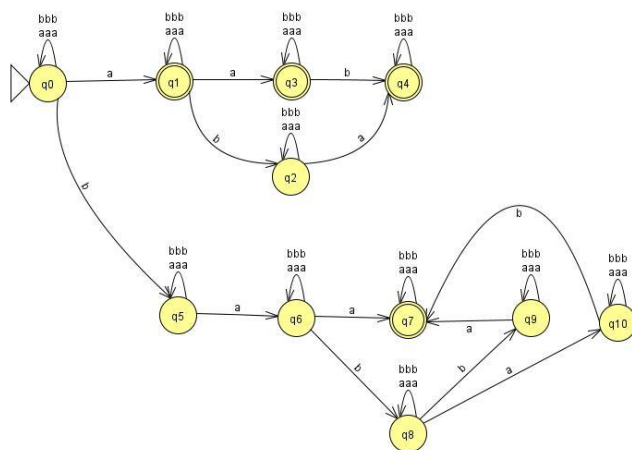
iv) (Bono 2.5%) La gramática lineal-izquierda (CFG Stanford).

b) (7.5%) $L = \{w \in \{a,b\}^* \mid w = n_a(w) \bmod 3 > n_b(w) \bmod 3\}$.

i) DFA:



Modificado para más cadenas:



ii) Gramática Lineal a la Derecha:

Primera Gramática:

Start symbol: **S**

S → a**A** | b**E** | **GS** | **GP** | **GT**

A → aaa**A** | bbb**A** | a**B** | b**D**

E → aaa**E** | bbb**E** | a**F**

B → aaa**B** | bbb**B** | b**C**

D → aaa**D** | bbb**D** | a**C**

C → aaa**C** | bbb**C** | ε

F → aaa**F** | bbb**F** | a**G**

G → aaa**G** | bbb**G** | ε

P → a**G**

T → a**GR**

R → a**G**

Segunda Gramática:

Start symbol: **S**

S → aaa**S** | b**E** | bbb**S** | a**A**

$E \rightarrow aF \mid aaaE \mid bbbE$
 $A \rightarrow \varepsilon \mid aC \mid aaaA \mid bB \mid bbbA$
 $D \rightarrow \varepsilon \mid aaaD \mid bbbD$
 $C \rightarrow \varepsilon \mid aaaC \mid bD \mid bbbC$
 $G \rightarrow \varepsilon \mid aaaG \mid bbbG$
 $H \rightarrow bI \mid aaaH \mid aJ \mid bbbH$
 $I \rightarrow aaaI \mid aG \mid bbbI$
 $F \rightarrow bH \mid aaaF \mid aG \mid bbbF$
 $J \rightarrow bG \mid aaaJ \mid bbbJ$
 $B \rightarrow aD \mid aaaB \mid bbbB$

iii) Expresión Regular y Práctico:

Expresión Regular:

$r = (aaa+bbb)^* ((a(aaa+bbb)^* + b(aaa+bbb)^*) (a(aaa+bbb)^* + b(aaa+bbb)^*))^* ((a(aaa+bbb)^* + b(aaa+bbb)^*))^*$

Expresión Práctica:

$\wedge (aaa \mid bbb)^* ((a(aaa \mid bbb)^*) \mid (a(aaa \mid bbb)^* (a(aaa \mid bbb)^*) \mid (a(aaa \mid bbb)^* (a(aaa \mid bbb)^* b(aaa \mid bbb)^*) \mid (b(aaa \mid bbb)^* a(aaa \mid bbb)^*))) \mid (b(aaa \mid bbb)^* a(aaa \mid bbb)^*)))^* ((a(aaa \mid bbb)^*) \mid (b(aaa \mid bbb)^*))^*)) \$$

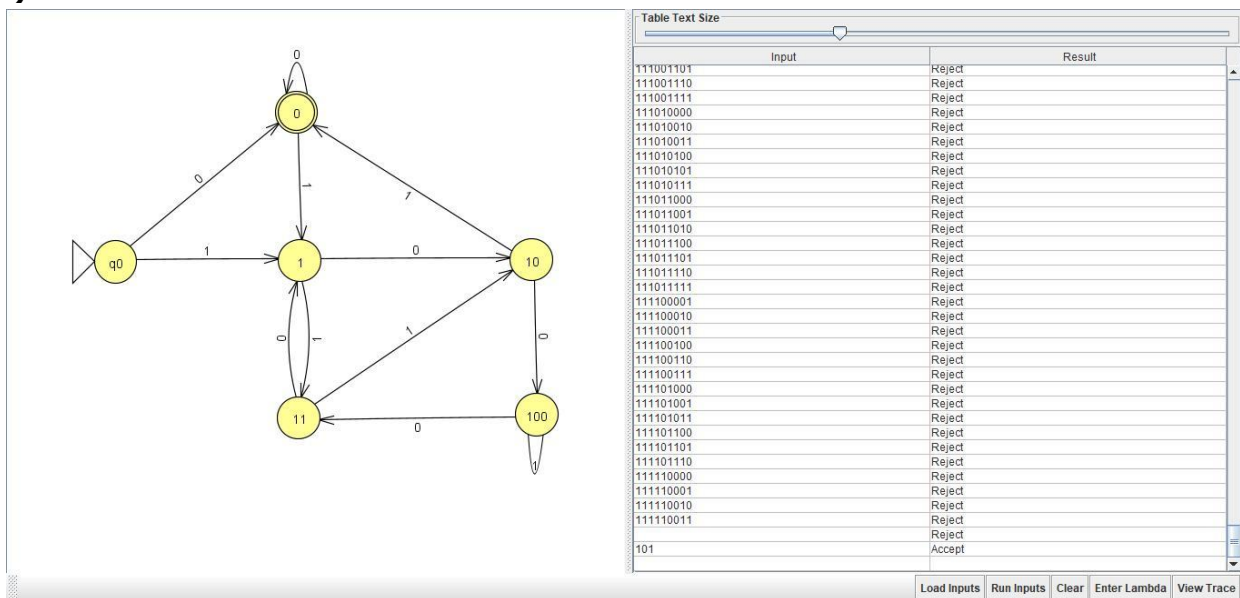
The screenshot shows the regex101 website interface. The main area displays a regular expression: `^(aaa|bbb)*((a(aaa|bbb)*|b(aaa|bbb)*)(a(aaa|bbb)*|b(aaa|bbb)*a(aaa|bbb)*|b(aaa|bbb)*a(aaa|bbb)*a(aaa|bbb)*))$`. The test string contains several lines of text, including `aaabbbbaaa`, `bbba`, `aaaabbbbaaa`, `bbbaaaaaaaa`, `bbbaaaaaa`, `aaabaaa`, `aaaaa`, `aaaa`, `abaaaa`, `bbba`, `bbb`, `bb`, and `b`. The matches are highlighted in the test string. The right panel shows the explanation of the regex, including the match information for the first match: `Full match` (0-11) is `aaabbbbaaa`, `Group 1` (6-9) is `aaa`, and `Group 2` (9-11) is `aa`. The quick reference panel on the right lists various tokens and their meanings.

iv) (Bono 2.5%) La gramática lineal-izquierda (CFG Stanford).

2) Considere los **números binarios** sin formato w generados sobre el alfabeto $\Sigma = \{0,1\}$. Encuentre i) el dfa, ii) la gramática lineal-derecha (CFG Stanford), iii) la expresión regular formal y práctica (regex101.com) a partir del autómata simplificado para los siguientes lenguajes. Pista 1: Agregar un cero al final de w significa multiplicarlo por 2. Agregar un uno al final de w significa multiplicarlo por 2 y sumarle 1. Pista 2: Tras agregar un dígito al final de w y realizar la respectiva operación indicada en la Pista 1, se saca el valor del módulo para determinar la transición al siguiente estado con este dígito.

a) (7.5%) $L = \{w \in \{0,1\}^+ \mid w \bmod 5 = 0\}$ con 6 estados: $q_0, 0, 1, 10, 11$ y 100 .

i)DFA:



5				1	0	1
10				1	0	1
15				1	1	1
20			1	0	1	0
25			1	1	0	0
30			1	1	1	1
35	1	0	0	0	1	1
40	1	0	1	0	0	0
45	1	0	1	1	0	1
50	1	1	0	0	1	0
55	1	1	0	1	1	1
60		1	1	1	1	0
65	1	0	0	0	0	1
70	1	0	0	0	1	1
75	1	0	0	1	0	1
80	1	0	1	0	0	0

ii)Gramática lineal a la Derecha:

Start symbol: S

$S \rightarrow 0A \mid 1B$

$A \rightarrow \varepsilon \mid 1B \mid 0A$

$B \rightarrow 1D \mid 0C$

$E \rightarrow 0D \mid 1E$

$D \rightarrow 1C \mid 0B$

C → 1A | 0E

Test

To test the CFG above, input test strings here, one per line. An empty line corresponds to the empty string. Results will be shown automatically.

```
111100000
111100101
111101010
111101111
111110100
111111001
111111001
111111110
```

Test Results for CFG

#	String	Matches
1	"0"	Yes See Derivation
2	"101"	Yes See Derivation
3	"1010"	Yes See Derivation
4	"1111"	Yes See Derivation
5	"10100"	Yes See Derivation
6	"11001"	Yes See Derivation
7	"11110"	Yes See Derivation
8	"100011"	Yes See Derivation
9	"101000"	Yes See Derivation
10	"101101"	Yes See Derivation
11	"110010"	Yes See Derivation
12	"110111"	Yes See Derivation
13	"111100"	Yes See Derivation
14	"1000001"	Yes See Derivation

iii) Expresión Formal Regular y Práctica

Expresión Formal Regular:

$r =$

$(0+101+11(01)^*(1+00)1+(100+11(01)^*(1+00)0)(1+0(01)^*(1+00)0)^*0(01)^*(1+00)1)(0+101+11(01)^*(1+00)1+(100+11(01)^*(1+00)0)(1+0(01)^*(1+00)0)^*0(01)^*(1+00)1)^*$

Práctico (Regex101):

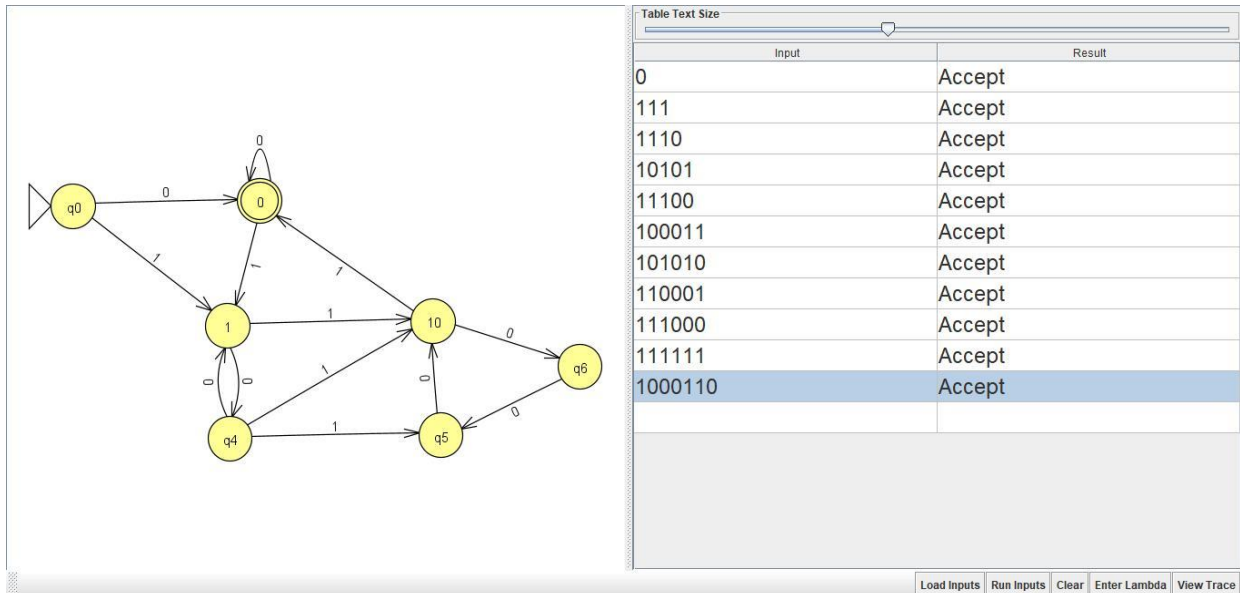
$^((0|101|11(01)^*(1|00)1|(100|11(01)^*(1|00)0)(1|0(01)^*(1|00)0)^*0(01)^*(1|00)1)(0|101|11(01)^*(1|00)1|(100|11(01)^*(1|00)0)(1|0(01)^*(1|00)0)^*0(01)^*(1|00)1)^*$$

The screenshot shows the regex101.com website. The 'REGULAR EXPRESSION' field contains a complex regex: `^(0|101|11(01)* (1|00)1|(100|11(01)* (1|00)0)(1|0(01)* (1|00)0)^*0(01)* (1|00)1)(0|101|11(01)* (1|00)1|(100|11(01)* (1|00)0)(1|0(01)* (1|00)0)^*0(01)* (1|00)1)^*$`. The 'TEST STRING' field contains several binary strings. The 'EXPLANATION' panel on the right shows the match details for the first string, including the full match and the first capturing group.

iv) (Bono 2.5%) La gramática lineal-izquierda (CFG Stanford).

b) (7.5%) $L = \{w \in \{0,1\}^+ \mid w \bmod 7 = 0\}$ con 8 estados: $q_0, 0, 1, 10, 11, 100, 101$ y 110 .

i) DFA:



ii) Gramática lineal a la Derecha

Start symbol: S

$S \rightarrow 1B \mid 0A$

$B \rightarrow 1C \mid 0D$

$A \rightarrow 1B \mid \varepsilon \mid 0A$

$F \rightarrow 0E$

$E \rightarrow 0C$

$D \rightarrow 1C \mid 1E \mid 0B$

$C \rightarrow 0F \mid 1A$

iii) Expresión Regular y Práctica

Expresión Regular: $r =$

$(0+111+10(00)^*(1+01)1+10(00)^*101+(110+10(00)^*(1+01)0+10(00)^*100)(000)^*001)(0+111+10(00)^*(1+01)1+10(00)^*101+(110+10(00)^*(1+01)0+10(00)^*100)(000)^*001)^*$

Práctica (Regex101):

iv) (Bono 2.5%) La gramática lineal-izquierda (CFG Stanford).