

$$1) L = \{0^i 1^j 2^k \mid i=j \text{ ou } j=k, \text{ com } i, j, k > 0\}$$

Sol:

$$G = (\{S, A, B, C, D\}, \{0, 1, 2\}, P, S)$$

onde:

$$P = \{ S \rightarrow A2 \mid 0B$$

$$A \rightarrow A2 \mid C$$

$$B \rightarrow 0B \mid D$$

$$C \rightarrow 0C1 \mid 01$$

$$D \rightarrow 1D2 \mid 12$$

Nota: A gramática é ambígua.

(Dica: Testar "012")

$$2) G = \{N, \Sigma, P, S\}$$

$$N = \{S, A, B, C, D\} \quad \Sigma = \{0, 1\}$$

$$P = \{ S \rightarrow 0S1 \mid 0A \mid D$$

$$A \rightarrow ASC \mid 1C \mid 1$$

$$B \rightarrow 0B1 \mid 01$$

$$C \rightarrow 0D1$$

$$D \rightarrow 01C$$

Sol

$$\text{Símbolos Geradores} = \{0, 1, A, B, S\}$$

$$P_{SG} = \{ S \rightarrow 0S1 \mid 0A$$

$$A \rightarrow 1$$

$$B \rightarrow 0B1 \mid 01$$

$$\text{Símbolos Alcançáveis} = \{S, A\}$$

$$P_{SA} = \{ S \rightarrow 0S1 \mid 0A$$

$$A \rightarrow 1$$

$$3) G = (N, \Sigma, P, E)$$

$$N = \{E\} \quad \Sigma = \{+, *, id, (,)\}$$

$$P = \{E \rightarrow E + E \mid E * E \mid (E) \mid id\}$$

a) Ambigüidade:

$$E \Rightarrow E + E \Rightarrow_{im} id + E \Rightarrow_{im} id + E * E \quad \downarrow$$

$$E \Rightarrow E * E \Rightarrow_{im} E + E * E \Rightarrow_{im} id + E * E \quad \downarrow$$

b) Dica: Estabelecer prioridade.

$$P = \{E \rightarrow T \mid E + T \mid$$

$$T \rightarrow F \mid T * F$$

$$F \rightarrow (E) \mid id$$

$$4) G = (N, \Sigma, P, S)$$

$$N = \{S, A, B\} \quad \Sigma = \{a, b\}$$

$$P = \{S \rightarrow AB \mid aBB \mid aS Ba$$

$$A \rightarrow a \mid aB \mid aSb$$

$$B \rightarrow \epsilon \mid bB \mid aSB$$

}

(Dica: Primeiro simplificar produções vazias)

Sol:

$$P = \{S \rightarrow A \mid AB \mid aB \mid aBB \mid \underline{aS a} \mid \underline{aSB a}$$

$$A \rightarrow a \mid aB \mid \underline{aS b}$$

$$B \rightarrow b \mid bB \mid \underline{aS} \mid \underline{aSB} \quad \}$$

(Dica: Reemplazar aS com variável X)

$$P = \{S \rightarrow A \mid AB \mid aB \mid aBB \mid Xa \mid XBa$$

$$A \rightarrow a \mid aB \mid Xb$$

$$B \rightarrow b \mid bB \mid X \mid XB$$

$$X \rightarrow aS$$

(Dica: Reemplazar S por Y que X comporta como S)

$$P = \{S \rightarrow A \mid AB \mid aB \mid aBB \mid Xa \mid XBa$$

$$A \rightarrow a \mid aB \mid Xb$$

$$B \rightarrow b \mid bB \mid X \mid XB$$

$$X \rightarrow aY$$

$$Y \rightarrow A \mid AB \mid aB \mid aBB \mid Xa \mid XBa \quad \}$$

$$5) G = (N, \Sigma, P, \langle \text{cad} \rangle)$$

$$N = \{ \langle \text{cad} \rangle, \langle \text{meio} \rangle \} \quad \Sigma = \{ a, b \}$$

$$P = \{ \langle \text{cad} \rangle \rightarrow ab \mid a \langle \text{meio} \rangle b, \langle \text{meio} \rangle \rightarrow a \langle \text{meio} \rangle \mid \langle \text{meio} \rangle b \mid a \mid b \}$$

Sol:

$$L = \{ ab, aab, abb, aabb, aaab, abbb, \dots \}$$

então:

$$L = \{ awb \mid w \in \{ a, b \}^* \}$$

Para demonstrar ambigüidade testar a cadeia "aabb"

$$\langle \text{cad} \rangle \Rightarrow_{lm} a \langle \text{meio} \rangle b \Rightarrow_{lm} a a \langle \text{meio} \rangle b \Rightarrow_{lm} aabb$$

$$\langle \text{cad} \rangle \Rightarrow_{lm} a \langle \text{meio} \rangle b \Rightarrow_{lm} a \langle \text{meio} \rangle b b \Rightarrow_{lm} aabb \quad \checkmark$$

$$6) G = \{ N, \Sigma, P, S \}$$

$$N = \{ S, A, B, C \} \quad \Sigma = \{ a, b \}$$

$$P = \{ S \rightarrow \cancel{AB} \mid CA$$

$$A \rightarrow a$$

$$\cancel{B \rightarrow BC \mid AB}$$

$$C \rightarrow \cancel{aB} \mid b \}$$

Sol: (Dica: Não tem produções vazias, nem uniões)

$$\text{Símbolos Geradores} = \{ a, b, A, C, S \}$$

$$\text{Símbolos Alcançáveis} = \{ S, C, A, a, b \}$$

(Nota: De 1,5 pts)

$$P = \{ S \rightarrow CA$$

$$A \rightarrow a$$

$$C \rightarrow b \}$$



7) $S \rightarrow XY$

$Y \rightarrow \epsilon$

$A \rightarrow AA \mid C \mid D$

$D \rightarrow 1$

$X \rightarrow B$

$B \rightarrow Y \Delta$

$C \rightarrow \emptyset$

$E \rightarrow X$

Sol:

a) Vazias:

~~$S \rightarrow XY \mid X$~~

~~$A \rightarrow AA \mid C \mid D$~~

~~$D \rightarrow 1$~~

~~$X \rightarrow B$~~

~~$B \rightarrow \Delta$~~

~~$C \rightarrow \emptyset$~~

~~$E \rightarrow X$~~

b) Unitarias:

~~$(S, S) \emptyset$~~

~~$(A, A) A \rightarrow AA$~~

~~$(B, B) \emptyset$~~

~~$(E, C) C \rightarrow \emptyset$~~

~~$(D, D) D \rightarrow 1$~~

~~$(X, X) \emptyset$~~

~~$(E, E) \emptyset$~~

~~$(S, X) \emptyset$~~

~~$(S, B) \emptyset$~~

~~$(S, A) S \rightarrow AA$~~

~~$(S, C) S \rightarrow \emptyset$~~

~~$(S, D) S \rightarrow 1$~~

~~$(X, B) \emptyset$~~

~~$(X, A) X \rightarrow AA$~~

~~$(A, C) A \rightarrow \emptyset$~~

~~$(A, D) A \rightarrow 1$~~

~~$(B, A) B \rightarrow \Delta \Delta$~~

~~$(B, C) B \rightarrow \emptyset$~~

~~$(B, D) B \rightarrow 1$~~

~~$(X, C) X \rightarrow \emptyset$~~

~~$(X, D) X \rightarrow 1$~~

~~$S \rightarrow AA \mid \emptyset \mid 1$~~

~~$A \rightarrow AA \mid \emptyset \mid 1$~~

~~$B \rightarrow AA \mid \emptyset \mid 1$~~

~~$C \rightarrow \emptyset$~~

~~$D \rightarrow 1$~~

~~$X \rightarrow AA \mid \emptyset \mid 1 \quad E \rightarrow \Delta \Delta \mid \emptyset \mid 1$~~

~~$(E, X) \emptyset$~~

~~$(E, B) \emptyset$~~

~~$(E, A) E \rightarrow \Delta \Delta$~~

~~$(E, C) E \rightarrow \emptyset$~~

~~$(E, D) E \rightarrow 1$~~

c) Não geradores:

Simbolos geradores: $\{\emptyset, 1, S, A, B, C, D, X\}$
Todos.

d) Não alcançáveis:

Simbolos alcançáveis: $\{S, A, \emptyset, 1\}$

$S \rightarrow AA \mid \emptyset \mid 1$

$A \rightarrow \Delta \Delta \mid \emptyset \mid 1$

$$8) G = (N, \Sigma, P, S)$$

$$N = \{S, T, L\} \quad \Sigma = \{a, b, +, -, *, /, [,]\}$$

$$P = \left\{ \begin{array}{l} S \rightarrow T + S \mid T - S \mid T \\ T \rightarrow L * T \mid L / T \mid L \\ L \rightarrow a \mid b \mid [S] \end{array} \right\}$$

Sol:

$$L = \{ a, b, a+b, a-b, [a], [b], [a+b], [a-b], a * a + b - \}$$

$L = \{ \}$ é o linguagem que define o formato de operações aritméticas $+$, $-$, $*$, $/$; de ~~os~~ identificadores a e b onde $*$ e $/$ têm a mesma prioridade entre eles e têm maior prioridade que $+$ e $-$. Embora $[]$ tem a maior prioridade de resolução?

FNC:

a) Variáveis: Não tem.

b) uniterminais:

$$S \rightarrow T + S \mid T - S \mid L * T \mid L / T \mid a \mid b \mid [S]$$

$$T \rightarrow L * T \mid L / T \mid a \mid b \mid [S]$$

$$L \rightarrow a \mid b \mid [S]$$

c) ^{não} Geradores:

$$\text{Símbolos geradores: } \{ a, b, L, T, S \}$$

d) Não alcançáveis:

$$\text{Símbolos alcançáveis: } \{ S, T, L, a, b \}$$

e) FNC:

$$S \rightarrow TC_1 \mid TC_3 \mid LC_5 \mid LC_7 \mid a \mid b \mid [C_9 C_{10}]$$

$$C_1 \rightarrow C_0 S$$

$$C_5 \rightarrow C_4 T$$

$$C_9 \rightarrow C_8 S$$

$$C_0 \rightarrow +$$

$$C_4 \rightarrow *$$

$$C_8 \rightarrow [$$

$$C_3 \rightarrow C_2 S$$

$$C_7 \rightarrow C_6 T$$

$$C_{10} \rightarrow]$$

$$C_2 \rightarrow -$$

$$C_6 \rightarrow /$$

$$T \rightarrow LC_5 \mid LC_7 \mid a \mid b \mid C_9 C_{10}$$

$$L \rightarrow a \mid b \mid C_9 C_{10}$$

$$9) G = (N, \Sigma, P, S)$$

$$N = \{S\}$$

$$P = \{S \rightarrow S\}$$

$$S, L = \{S\}$$

$$L = \{S\}$$

$$L = \{S\}$$

FNC:

a) Variáveis:

b) Uniterminais:

c) Não geradores:

d) Não alcançáveis:

e) FNC:

$$S \rightarrow S$$

$$X \rightarrow X$$

$$Y \rightarrow Y$$

9) $G = (N, \Sigma, P, S)$
 $N = \{S\}$ $\Sigma = \{P, \sim, \Rightarrow, [, \cdot\}$
 $P = \{S \Rightarrow P \mid \sim S \mid [S \Rightarrow S] \}$

Sol:
 $L = \{P, \sim P, [P \Rightarrow P], [P \Rightarrow [P \Rightarrow P]], \dots\}$

L é o fecho das combinações de w ou $\sim w$ onde w pode ser P ou a estrutura $[w \Rightarrow w]$

FN 6:

- a) vazios: Não tem
- b) Unitários: Não tem
- c) Não geradores: Não tem
- d) Não elimináveis: Não tem

2) FN 6:

$$S \rightarrow P \mid \sim S \mid [S X S Y]$$

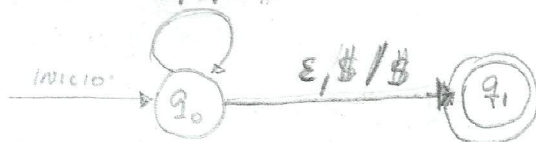
$$X \rightarrow \Rightarrow$$

$$Y \rightarrow]$$

10.a) $L1 = \{w \in \{0,1\}^* \mid w \text{ contém o mesmo número de } 0\text{'s e } 1\text{'s}\}$

1, 0 / ϵ
 1, 1 / 11
 0, 0 / 00
 0, 1 / ϵ
 1, ϵ / 1\$
 0, ϵ / 0\$

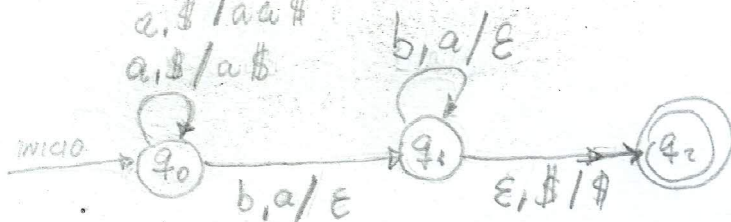
$PDA_F = (\{q_0, q_1\}, \{0, 1\}, \{\$, \epsilon\}, S_F, q_0, S, q_1)$



10.b) $L2 = \{a^m b^m \mid m \leq n \leq 2^m \text{ e } m, n > 0\}$

$PDA_F = (\{q_0, q_1, q_2\}, \{a, b\}, \{\$, \epsilon\}, S_F, q_0, S, q_2)$

a, a / aaa
 a, a / aa
 a, ϵ / aa\$
 a, ϵ / a\$

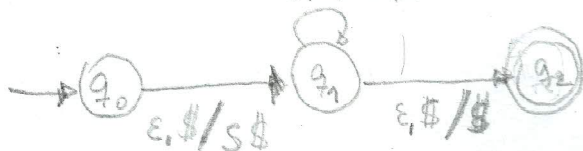


10.c) $L3 = L(6) \Rightarrow G = (\{S, A\}, \{a, b\}, P, S)$

onde: $P = \{S \rightarrow aAA, A \rightarrow bS \mid aS \mid a\}$

$PDA_F = (\{q_0, q_1, q_2\}, \{a, b\}, \{\$, S, a, b, A\}, S_F, q_0, \$, q_2)$

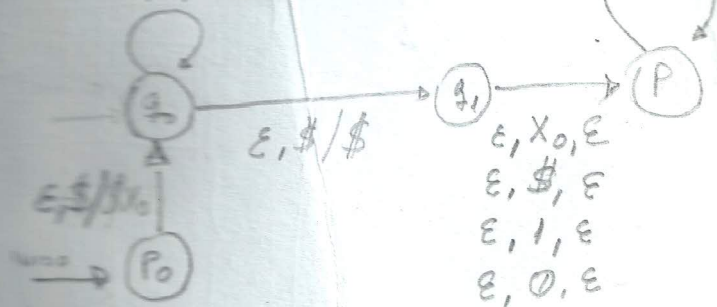
b, b / ϵ
 a, a / ϵ
 $\epsilon, A / a$
 $\epsilon, A / aS$
 $\epsilon, A / bS$
 $\epsilon, S / aAA$



11.2)

1, 0 / ϵ
 1, 1 / 1
 0, 0 / 00
 0, 1 / ϵ
 1, 3 / 13
 0, 3 / 03

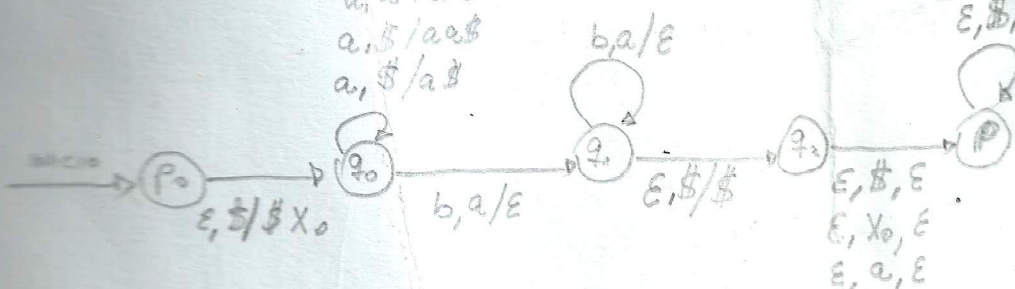
$\epsilon, 1, \epsilon$
 $\epsilon, 0, \epsilon$
 ϵ, X_0, ϵ
 $\epsilon, \$, \epsilon$



11.3)

a, a / a a a
 a, a / a a
 a, \$ / a a \$
 a, \$ / a \$

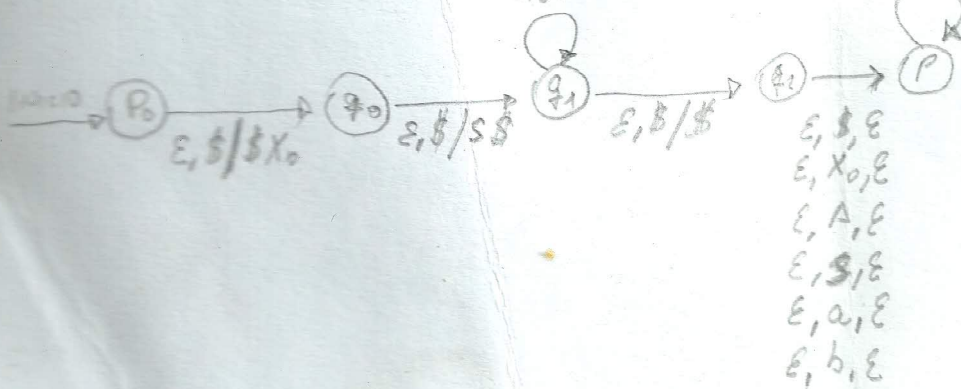
ϵ, a, ϵ
 ϵ, X_0, ϵ
 $\epsilon, \$, \epsilon$



11.4)

b, b / ϵ
 a, a / ϵ
 $\epsilon, A / a$
 $\epsilon, A / a S$
 $\epsilon, A / b S$
 $\epsilon, S / a A A$

ϵ, b, ϵ
 ϵ, a, ϵ
 ϵ, S, ϵ
 ϵ, A, ϵ
 ϵ, X_0, ϵ
 $\epsilon, \$, \epsilon$



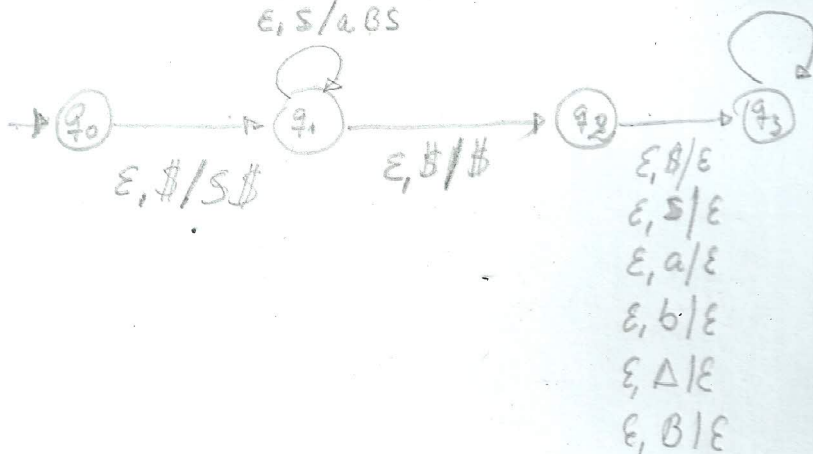
12) $G = (N, \Sigma, P, S)$

$N = \{S, A, B\}$ $\Sigma = \{a, b\}$

$P = \{ S \rightarrow aBS \mid aB \mid bAS \mid bA$
 $A \rightarrow bAA \mid a$
 $B \rightarrow aBB \mid b \}$

$b, b \mid \epsilon$
 $a, a \mid \epsilon$
 $\epsilon, B \mid b$
 $\epsilon, B \mid aBB$
 $\epsilon, A \mid a$
 $\epsilon, A \mid bAA$
 $\epsilon, S \mid bA$
 $\epsilon, S \mid bAS$
 $\epsilon, S \mid aB$
 $\epsilon, S \mid aBS$

$\epsilon, b \mid \epsilon$
 $\epsilon, a \mid \epsilon$
 $\epsilon, \epsilon \mid \epsilon$
 $\epsilon, A \mid \epsilon$
 $\epsilon, S \mid \epsilon$
 $\epsilon, \epsilon \mid \epsilon$



13) Regras para $N(M) = (\{q_0, q_1, \dots, q_n\}, \{0, 1\}, \{z_0, X\}, S, q_0, z_0, F)$

• Início:

$S \rightarrow [q_0, z_0, q_0] \mid [q_0, z_0, q_1]$

• POP DA PILHA: $\delta(q_i, \{0, 1\}, \{z_0, X\}) = \{(q_j, \epsilon)\}$

$[q_i, \{z_0, X\}, q_j] \rightarrow \{0, 1\}$

• PUSH DA PILHA: $\delta(q_i, \{0, 1\}, \{z_0, X\}) = \{(q_j, \{z_0, X\}^+)\}$

$[q_i, A, _] \rightarrow \{0, 1\} [q_j, B, _] [_, C, _] [_, D, _]$

Toda combinação
citadas

$$M = (Q, \Sigma, T, \delta, q_0, z_0, F) \quad Q = \{q_0, q_1\} \quad \Sigma = \{0, 1\} \quad T = \{z_0, x\}$$

$$\delta = \delta \chi(q_0, 1, z_0) = \{(q_0, \chi z_0)\} \oplus \delta(q_0, 1, x) = \{(q_0, \chi x)\}$$

$$\textcircled{2} \delta(q_0, \varepsilon, z_0) = \{(q_0, \varepsilon)\} \quad \textcircled{4} \delta(q_0, 0, x) = \{(q_1, x)\}$$

$$\textcircled{E} \phi(q, 0, z_0) = \{(q_0, z_0)\} \quad \textcircled{F} \phi(q, 1, X) = \{(q_1, \varepsilon)\}$$

$$G(M) = (N, \Sigma, P, S)$$

$$N = \{s, [z_0, z_0, q_0], [z_0, z_0, q_1], [z_0, x, q_0], [z_0, x, q_1], [z_1, z_0, q_1], [z_1, x, q_0], [z_1, x, q_1], [z_1, z_0, q_0]\}$$

$$\Sigma = \{0, 1\}$$

$$\Sigma = \{0, 1\}$$

$$P = \{ s \rightarrow [q_0, z_0, q_0] \mid [q_0, z_0, q_1] \}$$

$$[q_0, z_0, g_0] \rightarrow 1 [q_0, X, g_0] [q_0, z_0, g_0]$$

$$[g_0, z_0, q_0] \rightarrow 1 [q_0, X, q_1] [q_1, z_0, q_0]$$

$$[q_0, z_0, q_1] \rightarrow 1 [q_0, x, q_0] [q_0, z_0, q_1]$$

$$[g_0, z_0, g_1] \rightarrow_1 [g_0, x, g_1] [g_1, z_0, g_1]$$

$$[q_0, x, q_0] \rightarrow 1[q_0, x, q_0][q_0, x, q_0]$$

$$[g_0, x, g_0] \rightarrow 1 [g_0, x, g_1] [g_1, x, g_0]$$

$$[g_0, X, g_1] \rightarrow 1 \quad [g_0, X, g_0] [g_0, X, g_1]$$

$$[g_0, x, g_1] \rightarrow 1 [g_0, x, g_1] [1, x, g_1]$$

$$[q_0, z_0, q_0] \rightarrow \epsilon \quad \text{---} \rightarrow \textcircled{3}$$

$$[q_0, x, q_0] \rightarrow \textcircled{1} [q_1, x, q_0] \quad \textcircled{4}$$

$$[g_0, x, g_1] \rightarrow \odot [g_1, x, g_1]$$

$$[g_1, z_1, g_0] \rightarrow \textcircled{1} [g_0, z_0, g_0]$$

$$[g_1, z_0, g_1] \rightarrow 0 [g_0, z_0, g_1]$$

$$[q_1, X, q_1] \rightarrow 1 \longrightarrow \rightarrow (6)$$