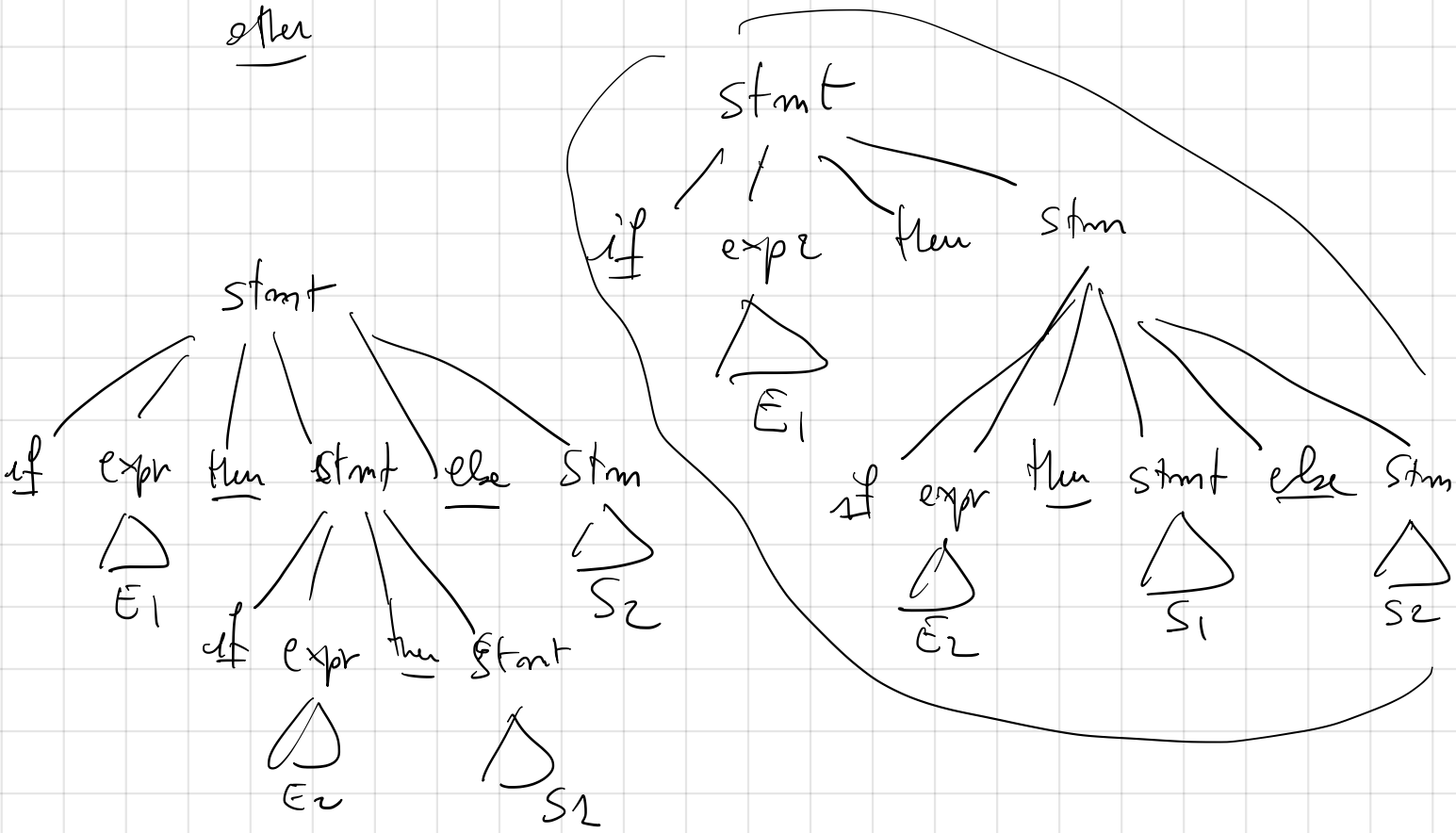
if E_1 then if E_2 then S_1 else S_2

stmt → if expr then stmt |

if expr then stmt else stmt |

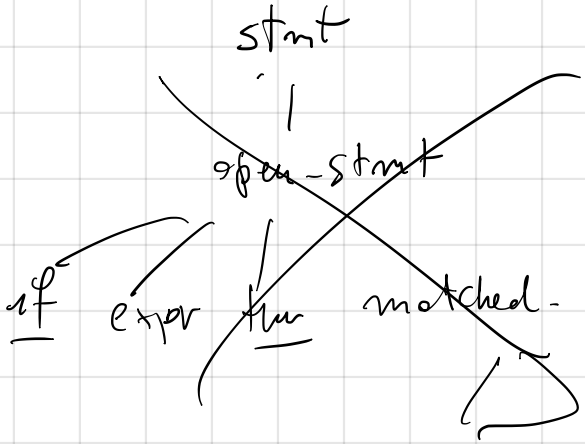
other

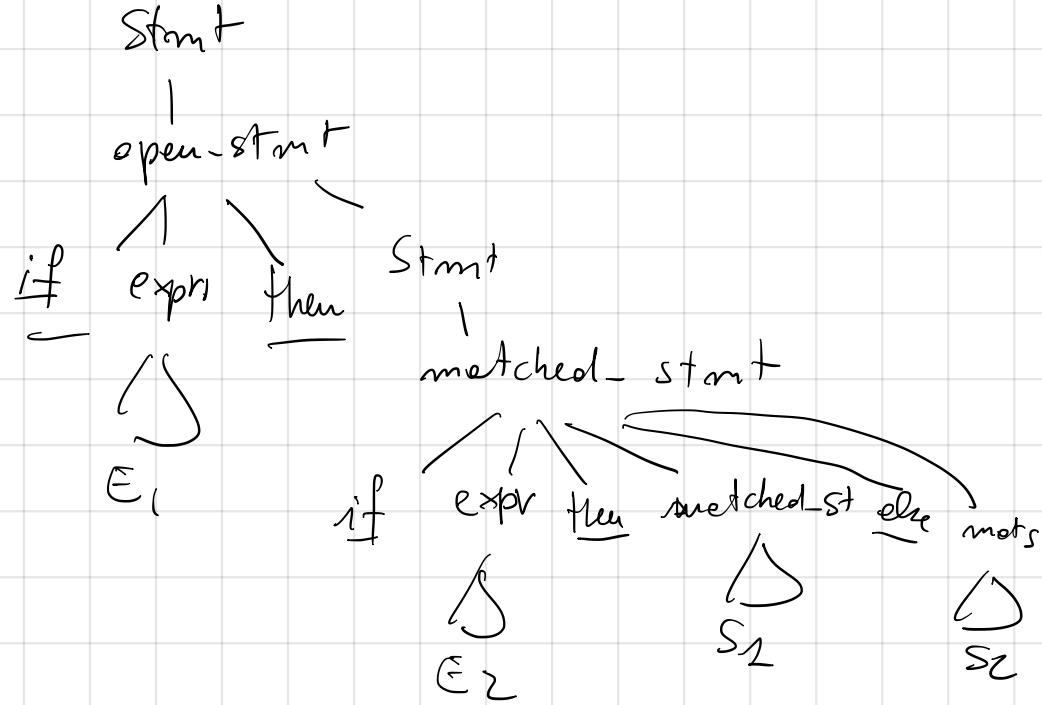


stmt → matched_stmt | open_stmt

matched_stmt → other | if expr then matched_stmt
else matched_stmt

open_stmt → if expr then stmt |
if expr then matched_stmt else open_stmt





Regular Expressions

$\Sigma = \{a, b\}$

*			
1	+	left	S
2	·	left	T
3	*	/	R
4	atoms	/	B

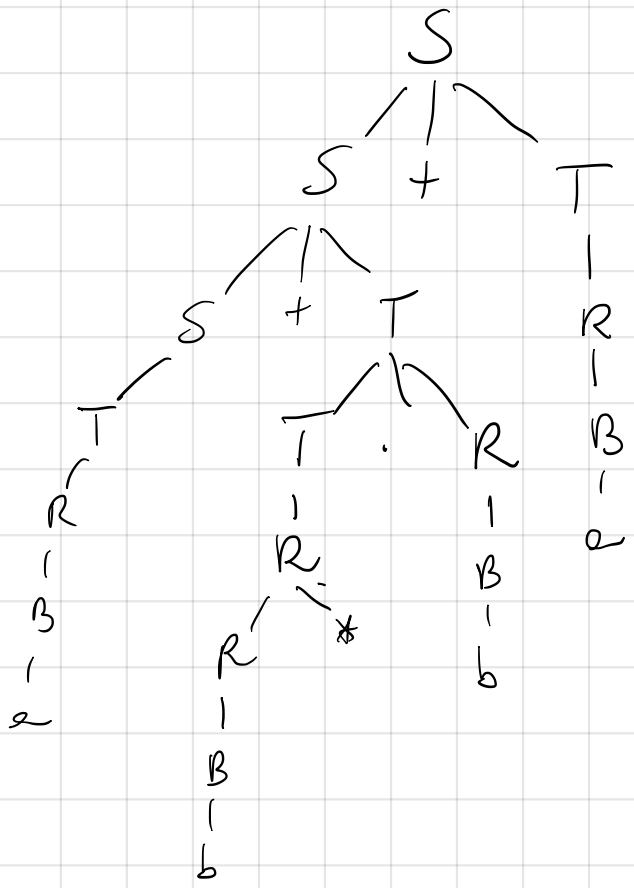
$S \rightarrow S + T \mid T$

$T \rightarrow T \cdot R \mid R$

$R \rightarrow R^* \mid B$

$B \rightarrow a \mid b \mid \underline{eps} \mid (S)$

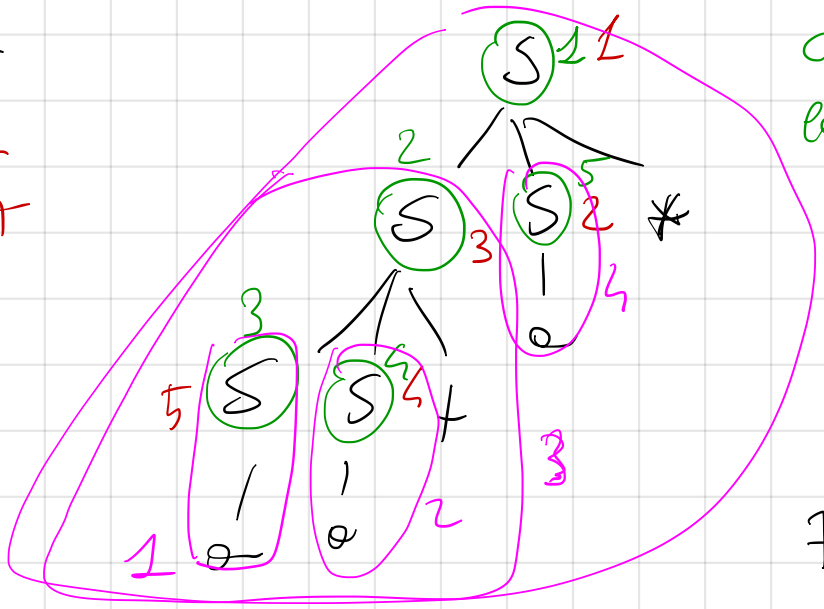
$a + b^* b + a$



$S \to SS+ \mid SS* \mid a$

aa+a*

depth-first
right-first



depth-first
left-first

5

7 + 9 * 5

7 9 + 5 *

the grammar is not ambiguous

sentential forms

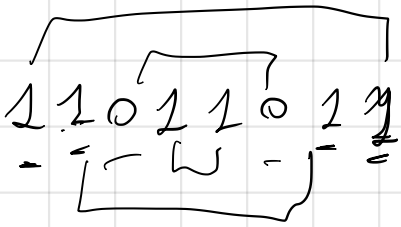
$S \underset{1}{\Rightarrow}_{lm} SS* \underset{2}{\Rightarrow}_{lm} SS+S* \underset{3}{\Rightarrow}_{lm} aS+S* \underset{4}{\Rightarrow}_{lm} aa+S*$

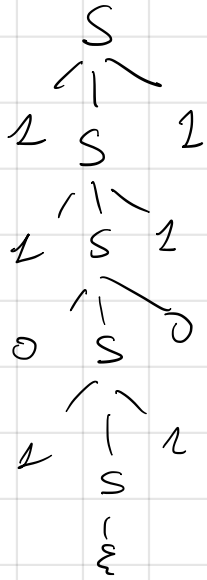
$\underset{5}{\Rightarrow}_{lm} aa+a*$

$S \underset{5}{\Rightarrow}_{rm} SS* \underset{4}{\Rightarrow}_{rm} Sa* \underset{3}{\Rightarrow}_{rm} SS+a* \underset{2}{\Rightarrow}_{rm} Sa+a* \underset{1}{\Rightarrow}_{rm} aa+a*$

$L = \{ w \in \{0,1\}^* \mid w \text{ is palindrom} \}$

$S \to 0S0 \mid 1S1 \mid \varepsilon$

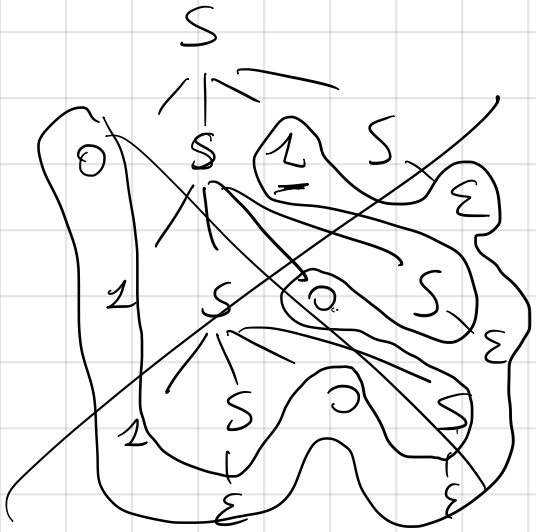


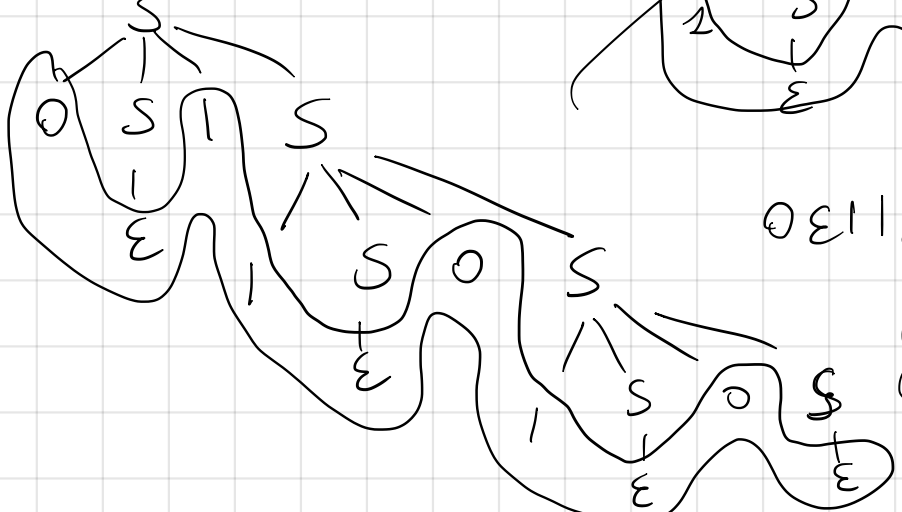


$L = \{ w \in \{0,1\}^* \mid$ the number of 1's in w equals the number of 0's in w $\}$

$S \to 1S0S \mid 0S1S \mid \varepsilon$

0 1 1 0 1 0

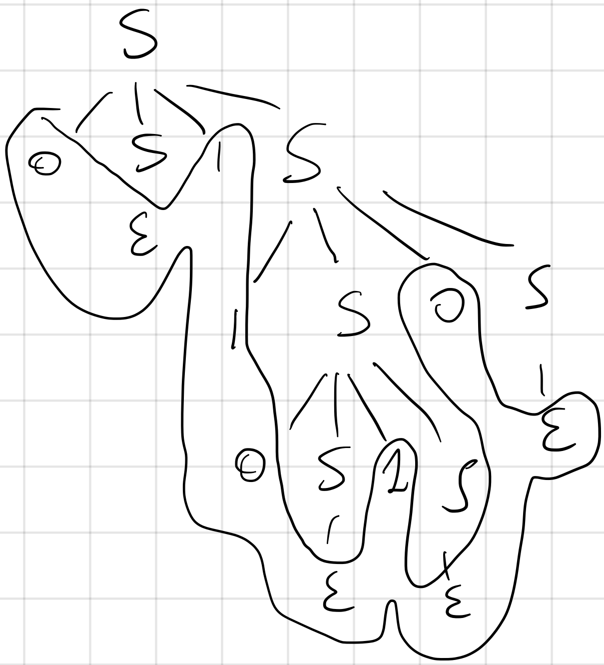




0110i0
()(())

0ε110ε1ε0ε

0110(0



$L = \{ x \in \{(,)\}^* \mid x$ is a string of balanced parentheses $\}$

$S \to (S)S \mid \varepsilon$

$$L = \{ a^n b^m c^k \mid n = m \ \underline{OR} \ m = k \ , \ n, m, k \geq 0 \}$$

$S \rightarrow S_1 C \mid A S_2$

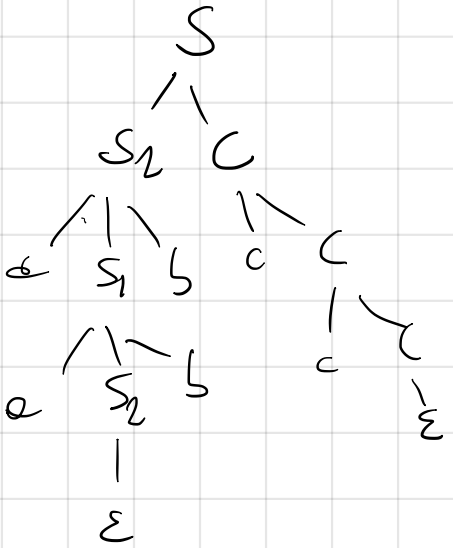
$C \rightarrow cC \mid \varepsilon$

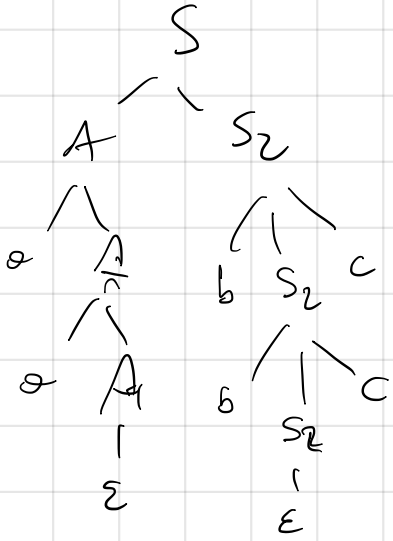
$A \rightarrow aA \mid \varepsilon$

$S_1 \rightarrow a S_1 b \mid \varepsilon$

$S_2 \rightarrow b S_2 c \mid \varepsilon$

aabbcc





$S \to Aa \mid b$

$A \to Ac \mid Sd \mid \varepsilon$

$A \to A\alpha \mid \beta$

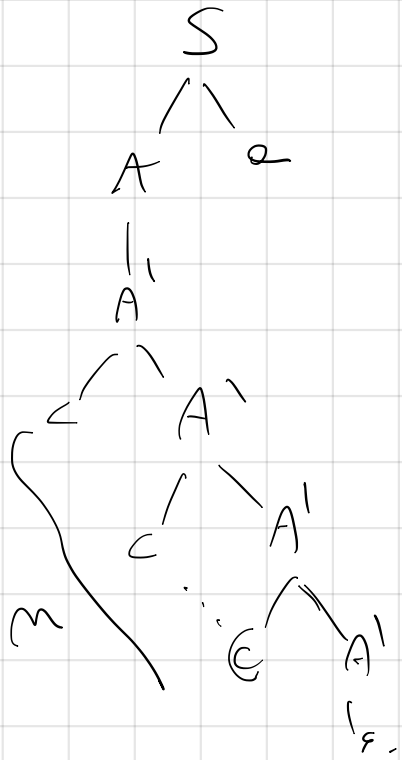
$A \to \beta A'$

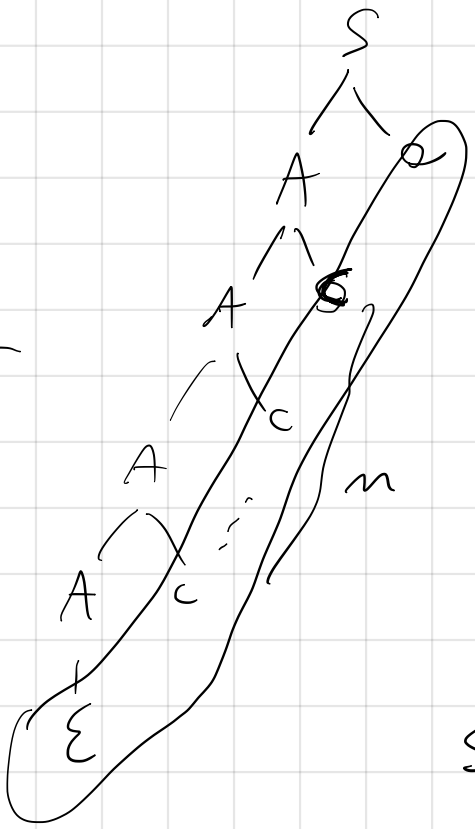
$A' \to \alpha A' \mid \varepsilon$

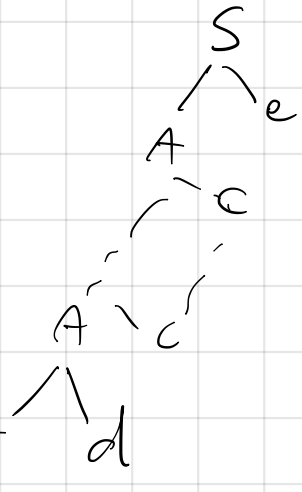
$S \to Aa \mid b$

$A \to SdA' \mid \cancel{\varepsilon} A'$

$A' \to cA' \mid \varepsilon$







$S \Rightarrow Aa \Rightarrow Sa \cdots$

$E \to E + T \mid T$

$T \to T * F \mid F$

$F \to id \mid (E)$

$\mapsto$

$E \to TE'$

$E' \to +TE' \mid \varepsilon$

$T \to FT'$

$T' \to *FT' \mid \varepsilon$

$F \to id \mid (E)$

$A \to A\alpha \mid \beta$

$\Downarrow$

$A \to \beta A'$

$A' \to \alpha A' \mid \varepsilon$

$id + id * id$

Abstract Syntax Tree