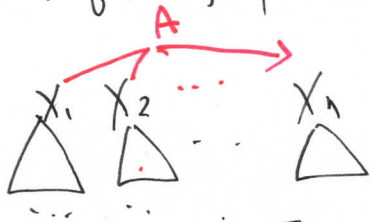


M1102 - PDA(I) & Properties of CFL

Recursive def of parse tree



$$X_i \in \Sigma \cup \{ \epsilon \}$$

Red. def. of \Rightarrow^π $\pi \in P^*$

$\Rightarrow_{lm}^{\pi_L}$ $\pi_L \in P^*$ left parse

— Top down.

$\Rightarrow_{rm}^{\pi_R}$ $\pi_R \in P^*$ right parse
 in reversed order

— Bottom up

Parse tree vs Abstract syntax tree

AST

P.T.
 $\forall A \rightarrow \alpha \in P \dots$ subtree

$$P' \subseteq P, \Sigma' \subseteq \Sigma$$

$a \in \Sigma \dots$ leaf
 nonterminal, variable, syntactic category.

Ex) $E \rightarrow E + E \mid E * E \mid a \mid (E)$

G_{E1} Non. amb.

$$G_{E2}: E \rightarrow E + T \mid T * F \mid a \mid (E)$$

$$T \rightarrow$$

$$F \rightarrow$$

$$T * F \mid a \mid (E)$$

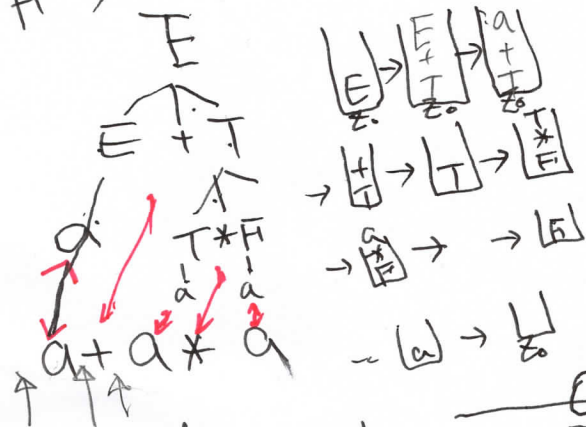
$$a \mid (E)$$

$$E \Rightarrow_{lm}^{\pi} a + a * a$$

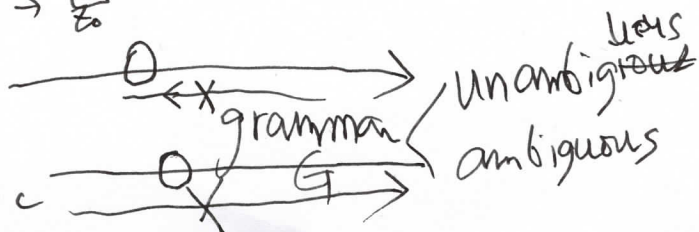
$$|a| + |a|$$

↑ verify $a \in \Sigma$

guess A as α ($A \rightarrow \alpha \in P$)
 (left parse)

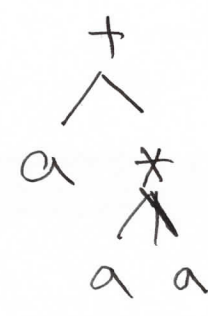
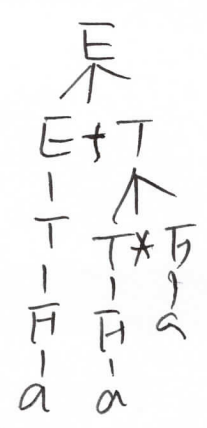


Parser of G
 deterministic
 nondeterministic



G_{E3} : $\alpha \in \Sigma^*$ unit production $|G_{E3}| = 14 + 10 + 6 = 30$ $G = (N, \Sigma, P, S)$

$E \rightarrow E + T$
 $T \rightarrow T * F$
 $F \rightarrow a \mid (E)$



$|G| \triangleq \sum_{P \in P} |P|$
 $|P| = |A \rightarrow \alpha|$
 $= |A| + |\alpha|$
 $= |a| + 1$

AST $P' = \{E \rightarrow E + T, T \rightarrow T * F\}$
 $\Sigma' = \{a\}$

Top down (LL) parsing $\xrightarrow{\text{guess-verify parsing}} \boxed{E} \xrightarrow{*} \boxed{a}$ guess $A \rightarrow \alpha$ Bottom-up parsing $\boxed{a} \xrightarrow{*} \boxed{E}$

$A \rightarrow \alpha \in P$ $(A, \epsilon) \xrightarrow{L} (\alpha, \epsilon)$ $\xrightarrow{R} (a, \epsilon) \dots \text{shift } a$
 $a \in \Sigma$ $(a, a) \xrightarrow{L} (\epsilon, \epsilon)$ $\xrightarrow{R} (\alpha^R, \epsilon) \xrightarrow{R} (A, \epsilon) \dots \text{reduce } \alpha^R \text{ to } A$

Bottom parsing for $a + a * a$ in G_{E3}

```

    E
   / \
  E+T
 /  \
a  T
   / \
  T * F
 / \ / \
a + a * a
  
```

$\boxed{a} \rightarrow \boxed{a} \rightarrow \boxed{E}$
 $\rightarrow \boxed{+} \rightarrow \boxed{+} \rightarrow \boxed{+}$
 $\rightarrow \boxed{E} \rightarrow \boxed{E} \rightarrow \boxed{E}$

$a + a * a$
 $\uparrow \uparrow \uparrow$