1) 11/13(木) ~~chap4 Context-free Grammar~~

NFA $\Rightarrow$ DFA

Review

NFA $\rightarrow$ DFA

1. subset construction : NFA: $Q_N \times \Sigma \rightarrow 2^{Q_N}$ DFA: $2^{Q_N} \times \Sigma \rightarrow 2^{Q_N}$

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad Q_D \times \Sigma \rightarrow Q_D$

2. ε-closure (ε^*) NFA: $Q_N \times (\Sigma \cup \{\varepsilon\}) \rightarrow 2^{Q_N}$

Thm 3.30 증명 $w = a_1 \cdots a_n$ $1 \le i \le n$: $a_i \in \Sigma$

$$\delta^*_w = \delta^*_{a_1 a_2 \cdots a_n} = \delta^*_\varepsilon \delta_{a_1} \delta^*_\varepsilon \delta^*_\varepsilon \delta_{a_2} \delta^*_\varepsilon \cdots \delta_{a_n}$$

$$= \varepsilon^* \delta_{a_1} \underbrace{\varepsilon^* \varepsilon^*} \delta_{a_2} \underbrace{\varepsilon^* \cdots} \cdots \underbrace{\varepsilon^*} \delta_{a_n} \varepsilon^* \quad \begin{cases} 2n\ \varepsilon^* \\ n\ \delta_{a_i} \end{cases}$$

$$= \varepsilon^* \delta_{a_1} \cdot \varepsilon^* \delta_{a_2} \varepsilon^* \cdots \varepsilon^* \delta_{a_n} \varepsilon^*$$

n개

$\underline{n+1개}\ \varepsilon^*$ $\ne 2n+1$

$$\hat{\delta}_a \triangleq \varepsilon^* \delta_a$$

$$\delta^*_{a_1 a_2 \cdots a_n} = \varepsilon^* \hat{\delta}_{a_1} \underbrace{\hat{\delta}_{a_2} \cdots \hat{\delta}_{a_n}}_{n+1}$$

eg. in TP 2쪽 p.

RE $\rightarrow$ FA

DFA $\subseteq$ NFA, NFA $\rightarrow$ DFA

Regular Expression $\equiv$ DFA $\equiv$ NFA $\equiv$ Regular Grammar

Three Language Descriptions

N. Chomsky's type 3 language

type 2 language

text 8쪽 p

Example

pumping lemma p17 in TP

- non-regular language

Ex $\{0^n 1^n \mid n \ge 0\}$

Chap 4. Context-free Grammar

Context-free Grammar $G=(V,P)$ rewriting system.

where $V=N\cup\Sigma$, $N\cap\Sigma=\phi$, $S\in N$

$G=(N,\Sigma,P,S)$ where $P\subseteq N\times V^* = N\times(N\cup\Sigma)^*$

$A\in N$, $\alpha\in(N\cup\Sigma)^*$

we write $\underline{A\to\alpha\in P}$ if $(A,\alpha)\in P$.

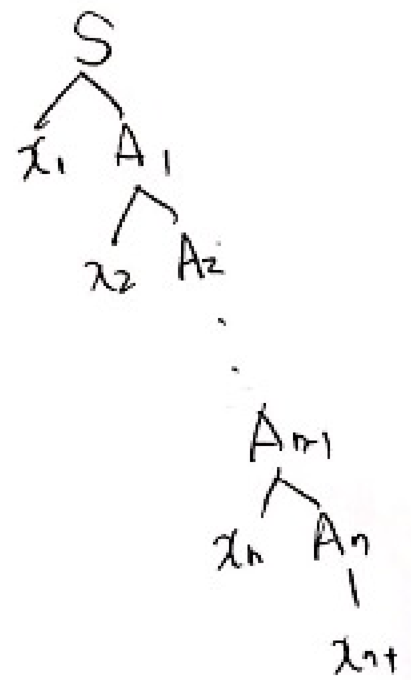
Compare regular grammar $G=(N,\Sigma,P,S)$ $P\subseteq N\times(\Sigma^*\cdot(N\cup\{\epsilon\}))$ .. right linear gr.

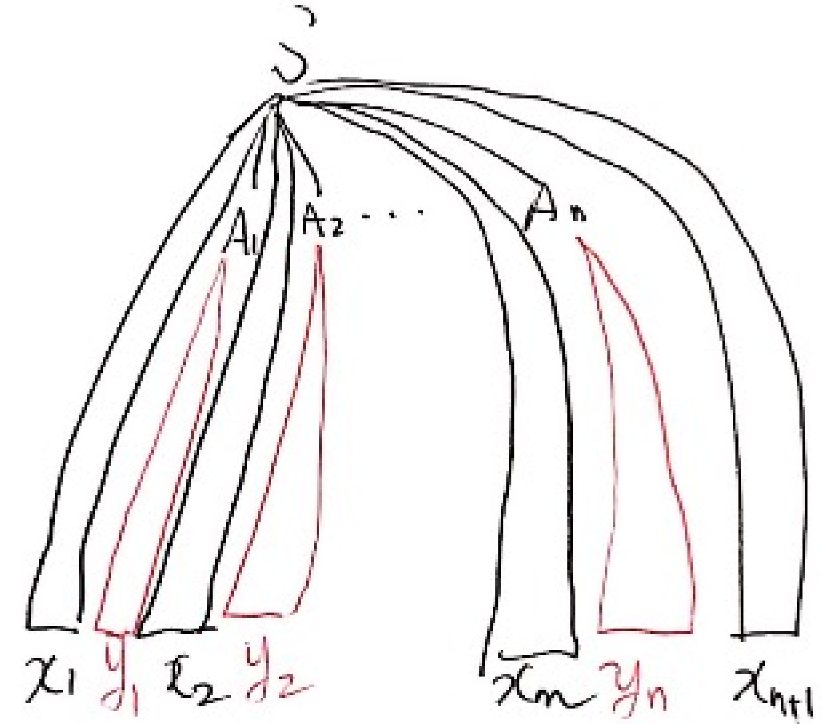
r.l.g

$A\to xB$ or $A\to y$ $A,B\in N$, $x,y\in\Sigma^*$ or $N\times((N\cup\{\epsilon\})\cdot\Sigma^*)$ .. left linear gr.

l.l.g

$A\to Bx$ or $A\to y$ " "





(right) skewed tree
= linear list

$\forall 1\le i\le n+1: x_i\in\Sigma^*$, $\forall 1\le i\le n: A_i\in N$

$S\overset{*}{\Rightarrow} x_1x_2\cdots x_iA_i \Rightarrow x_1\cdots x_ix_{i+1}A_{i+1} \Rightarrow x_1x_2\cdots x_nA_n \Rightarrow x_1\cdots x_nx_{n+1}\in\Sigma^*$

single (unique) rightmost (left) $\boxed{\text{nonterminal}}$ if any ... sentential form of r.l.g. (l.l.g)

$S\overset{*}{\Rightarrow} x_1A_1x_2A_2x_3\cdots x_nA_nx_{n+1}$ $\forall x_i\in\Sigma^*$, $A_i\in N$

many $\boxed{\text{nonterminals}}$

→ leftmost nonterminal, first ⇒ leftmost derivation (lm)

rightmost " , " ⇒ rightmost " (rm)

Ex1) $E \to E+T \mid T$ $\quad (N=\{E,T,F\},\ \Sigma=\{a,+,*,(,)\})$

G: $T \to T*F \mid F$

$F \to a \mid (E)$

Ex $a+a*a \in L(G)$

$\in \Sigma^*$

$E\to T,\ T\to F$

unit-production

$E \xRightarrow[lm]{E\to E+T} E+T \xRightarrow[lm]{E\to T} T+T \xRightarrow[lm]{T\to F} F+T \xRightarrow[lm]{F\to a} a+T \xRightarrow[lm]{T\to T*F} a+T*F$

$\xRightarrow[lm]{T\to F} a+F*F \xRightarrow[lm]{F\to a} a+a*F \xRightarrow[lm]{F\to a} a+a*a$

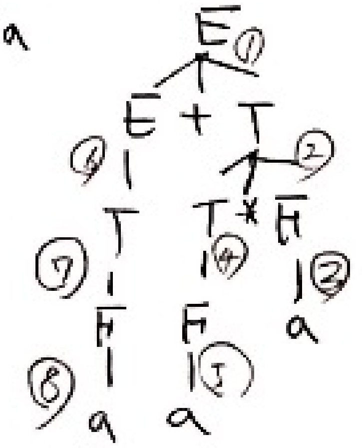
left parse of the sentence a+a*a

$\pi_L = (E\to E+T)\cdot(E\to T)\cdots(F\to a) \in P^*$

$\cancel{T\to T*F}$

$E \xRightarrow[rm]{E\to E+T} E+T \xRightarrow[rm]{T\to T*F} E+T*F \xRightarrow[rm]{F\to a} E+T*a \xRightarrow[rm]{T\to F} E+F*a$

$\xRightarrow[rm]{F\to a} E+a*a \xRightarrow[rm]{E\to T} T+a*a \xRightarrow[rm]{T\to F} F+a*a \xRightarrow[rm]{F\to a} a+a*a$



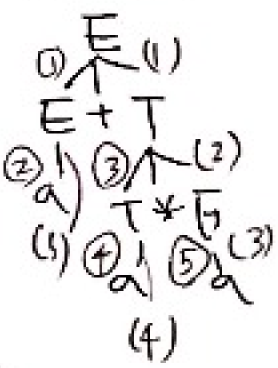
Ex2) $E \to E+T \mid T*F \mid a \mid (E)$

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

$F \to \quad a \mid (E)$

Ex1, Ex2: prec(*) > prec(+)

unit-production free



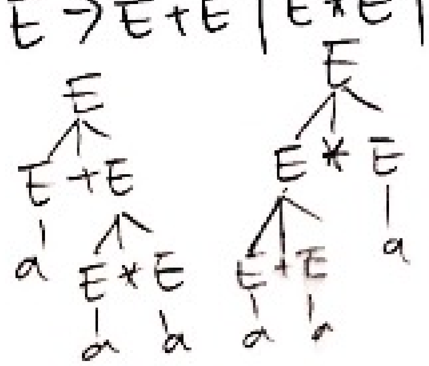
(생각문제) a+a+a? a*a*a

+, * .. left asso.

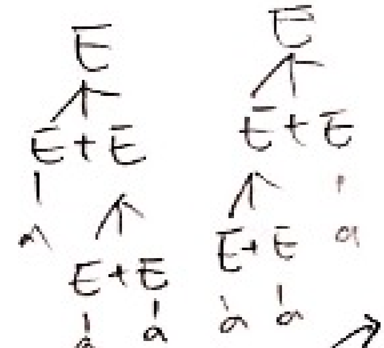
$\pi_R = (E\to E+T)(T\to T*F)\cdots(F\to a) \in P^*$

right parse of the sentence a+a*a

Ex3) $E \to E+E \mid E*E \mid a \mid (E)$



ambiguous grammar



amb. gr.

left/right parse

Parsing: ① sentence $x \in L(G)$ $\Longrightarrow$ parse tree of x the sentence

Given $x\in\Sigma^*$ ② $x \notin L(G)$ $\Longrightarrow$ Say No! — Error detection

nonsentence

(syntactic) Error recovery

repair

$$S \underset{lm}{\overset{*}{\Rightarrow}} x A \gamma \underset{lm}{\overset{A \to \beta}{\Rightarrow}} x \beta \gamma \underset{lm}{\overset{*}{\Rightarrow}} x y z \;\Big|\; S \underset{rm}{\overset{*}{\Rightarrow}} \alpha A z \underset{rm}{\overset{A \to \beta}{\Rightarrow}} \alpha \beta z \overset{*}{\Rightarrow} x y z$$