

Foundations of Computation

Parser Coursework Part A

December 13, 2021

Convert the grammar G to an equivalent grammar G_0 in Chomsky normal form.

The terminals Σ are given by $\Sigma := \{+, *, (,), 1, 0, x\}$

The variables V are given by $V := \{S, T, F\}$, where S is the start symbol

The rules R of the grammar are given by

$S \rightarrow S + T \mid T$

$T \rightarrow T * F \mid F$

$F \rightarrow (S) \mid 1 \mid 0 \mid x$

1. *Add new start variable S_0*

Rewrite grammar:

$S_0 \rightarrow S$

$S \rightarrow S + T \mid T$

$T \rightarrow T * F \mid F$

$F \rightarrow (S) \mid 1 \mid 0 \mid x$

2. *Eliminate ϵ -rules $A \rightarrow \epsilon$*

Not applicable in our case

3. *Eliminate all unit rules $A \rightarrow B$*

Remove $T \rightarrow F$. Add $T \rightarrow (S) \mid 1 \mid 0 \mid x$

Rewrite grammar:

$S_0 \rightarrow S$

$S \rightarrow S + T \mid T$

$T \rightarrow T * F \mid (S) \mid 1 \mid 0 \mid x$

$F \rightarrow (S) \mid 1 \mid 0 \mid x$

Remove $S \rightarrow T$. Add $S \rightarrow T * F \mid (S) \mid 1 \mid 0 \mid x$

Rewrite grammar:

$S_0 \rightarrow S$

$S \rightarrow S + T \mid T * F \mid (S) \mid 1 \mid 0 \mid x$

$T \rightarrow T * F \mid (S) \mid 1 \mid 0 \mid x$

$F \rightarrow (S) \mid 1 \mid 0 \mid x$

Remove $S_0 \rightarrow S$. Add $S_0 \rightarrow S + T \mid T * F \mid (S) \mid 1 \mid 0 \mid x$

Rewrite grammar:

$S_0 \rightarrow S + T \mid T * F \mid (S) \mid 1 \mid 0 \mid x$

$S \rightarrow S + T \mid T * F \mid (S) \mid 1 \mid 0 \mid x$

$T \rightarrow T * F \mid (S) \mid 1 \mid 0 \mid x$

$F \rightarrow (S) \mid 1 \mid 0 \mid x$

4. *Eliminate rules of form $A \rightarrow u_1 u_2 \dots u_k$ for $k \geq 3$*

Remove $S \rightarrow S + T$, then add the rules:

$S \rightarrow ST_1$
 $T_1 \rightarrow +T$
 Remove $S_0 \rightarrow S + T$, then add the rules:
 $S_0 \rightarrow ST_1$
 $T_1 \rightarrow +T$

Remove $S_0 \rightarrow T * F$, then add the rules:
 $S_0 \rightarrow TF_1$
 $F_1 \rightarrow *F$
 Remove $S \rightarrow T * F$, then add the rules:
 $S \rightarrow TF_1$
 $F_1 \rightarrow *F$
 Remove $T \rightarrow T * F$, then add the rules:
 $T \rightarrow TF_1$
 $F_1 \rightarrow *F$

Remove $S_0 \rightarrow (S)$, then add the rules:
 $S_0 \rightarrow (S_1$
 $S_1 \rightarrow S)$
 Remove $S \rightarrow (S)$, then add the rules:
 $S \rightarrow (S_1$
 $S_1 \rightarrow S)$
 Remove $T \rightarrow (S)$, then add the rules:
 $T \rightarrow (S_1$
 $S_1 \rightarrow S)$
 Remove $F \rightarrow (S)$, then add the rules:
 $F \rightarrow (S_1$
 $S_1 \rightarrow S)$

In summary, remove $S + T$, $T * F$ and (S)
 Introduce the following:
 $T_1 \rightarrow +T$
 $F_1 \rightarrow *F$
 $S_1 \rightarrow S)$

Rewrite grammar:
 $S_0 \rightarrow ST_1 \mid TF_1 \mid (S_1 \mid 1 \mid 0 \mid x$
 $S \rightarrow ST_1 \mid TF_1 \mid (S_1 \mid 1 \mid 0 \mid x$
 $T \rightarrow TF_1 \mid (S_1 \mid 1 \mid 0 \mid x$
 $F \rightarrow (S_1 \mid 1 \mid 0 \mid x$
 $T_1 \rightarrow +T$
 $F_1 \rightarrow *F$
 $S_1 \rightarrow S)$

5. *Replace terminals with variables*

Replace $T_1 \rightarrow +T$ with $T_1 \rightarrow PT$. Add $P \rightarrow +$
 Replace $F_1 \rightarrow *F$ with $F_1 \rightarrow MF$. Add $M \rightarrow *$
 Replace $S_1 \rightarrow S)$ with $S_1 \rightarrow SR_1$. Add $R_1 \rightarrow)$
 Replace $S_0 \rightarrow (S_1$ with $S_0 \rightarrow L_1S_1$, $S \rightarrow (S_1$ with $S \rightarrow L_1S_1$, $T \rightarrow (S_1$ with $T \rightarrow L_1S_1$,
 $F \rightarrow (S_1$ with $F \rightarrow L_1S_1$. Add $L_1 \rightarrow ($

Rewrite grammar:
 $S_0 \rightarrow ST_1 \mid TF_1 \mid L_1S_1 \mid 1 \mid 0 \mid x$
 $S \rightarrow ST_1 \mid TF_1 \mid L_1S_1 \mid 1 \mid 0 \mid x$
 $T \rightarrow TF_1 \mid L_1S_1 \mid 1 \mid 0 \mid x$
 $F \rightarrow L_1S_1 \mid 1 \mid 0 \mid x$

$$\begin{aligned}
T_1 &\rightarrow PT \\
F_1 &\rightarrow MF \\
S_1 &\rightarrow SR_1 \\
P &\rightarrow + \\
M &\rightarrow * \\
R_1 &\rightarrow) \\
L_1 &\rightarrow (
\end{aligned}$$