

Chomsky Normal form Lecture - 19 (1)

27/05/20

Let $G = (V, T, P, S)$

G is said to be in CNF if all productions are of the form

$$A \rightarrow BC \quad \text{or} \quad A \rightarrow a$$

where A, B and $C \in V$ and $a \in T$.

\therefore if a grammar is in CNF, the RHS of the production should contain two symbols or one symbol.

if there are two symbols \Rightarrow non-terminal
 if there are one symbol \Rightarrow terminal.

A grammar is in this form if there are no ϵ productions and unit productions

$$\begin{aligned} S &\rightarrow 0A \mid 1B \\ A &\rightarrow 0AA \mid 1S \mid 1 \\ B &\rightarrow 1BB \mid 0S \mid 0 \end{aligned}$$

Obtain the CNF of this grammar.

Given Production	Action	Resulting Production
$S \rightarrow 0A \mid 1B$	Replace 0 by B_0 and $B \rightarrow 0$ Replaced 1 by B_1 , $B_1 \rightarrow 1$	$S \rightarrow B_0A \mid B_1B$ $B_0 \rightarrow 0 \quad B_1 \rightarrow 1$
$A \rightarrow 0AA \mid 1S$	replace 0 by B_0 and introduce $B_0 \rightarrow 0$ replace 1 by B_1 and $B_1 \rightarrow 1$	$A \rightarrow B_0AA \mid B_1S$ $B_0 \rightarrow 0 \quad B_1 \rightarrow 1$
$B \rightarrow 1BB \mid 0S \mid 0$	Replace 0 by B_0 and $B_0 \rightarrow 0$ $B_1 \rightarrow 1$ and combine the	$B \rightarrow B_1BB \mid B_0S$ productions.

$$V_1 = \{S, A, B, B_0, B_1\}$$

$$T_1 = \{2, 1\}$$

$$P_1 = \begin{cases} S \rightarrow \text{not } A \mid B, B \\ A \rightarrow \text{not } A \mid B, S \mid 1 \\ B \rightarrow B, B \mid \text{not } B \mid 0 \\ B_0 \rightarrow 0 \\ B_1 \rightarrow 1 \end{cases}$$

S is start symbol.

step 2

Restrict # of variables in the RHS of the production to 2.

$$S \rightarrow B, A \mid B, B$$

$$A \rightarrow B, S \mid 1$$

$$B \rightarrow B, S \mid 0$$

$$B_0 \rightarrow 0$$

$$B_1 \rightarrow 1$$

Add these productions to P_1 .

Productions which are not in CNF are

$$A \rightarrow \text{not } A$$

$$B \rightarrow B, B$$

change these to CNF as given below

Left	Right
$A \rightarrow B_0 A A$	replace AA by B_1
$B \rightarrow B_0 A A$	replace AA by B_2

Result / Product
$A \rightarrow B_0 B_1$
$B_1 \rightarrow AA$
$B_2 \rightarrow B_0 B_2$
$B_2 \rightarrow AB$

add the productions to G'

$$G' = (V', T', P', S)$$

$$V' = \{ S, A, B, B_0, B_1, B_2, D_1, D_2 \}$$

$$T' = \{ 0, 1 \}$$

$$P' = \{ S \rightarrow B_0 A \mid \epsilon, \emptyset$$

$$A \rightarrow B_1 0 \mid 1 \mid B_0 B_1$$

$$B \rightarrow B_0 0 \mid 0 \mid B_1 B_2$$

$$B_0 \rightarrow \epsilon$$

$$B_1 \rightarrow 1$$

$$D_1 \rightarrow AA$$

$$D_2 \rightarrow BB$$

S is the start symbol

1.51

In a CFG, there is no restriction on the RHS of a production. (4)

The restrictions once imposed on the RHS of the productions result in ~~various~~ 2 normal forms.

Two are

- Chomsky Normal form (CNF)

- Greibach Normal form (GNF)

More exercises with GNF.

Reason

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For converting grammar into GNF, we first need to convert into CNF.