Eliminating Immediate Left-Recursion

From

$$A \longrightarrow A\,\alpha_1 \mid A\,\alpha_2 \mid \cdots \mid A\,\alpha_m \mid \beta_1 \mid \beta_2 \mid \cdots \mid \beta_n$$

where

1. β_i does not start with A.

2. $\alpha_i \neq \varepsilon$

To

$$
\begin{aligned}
A &\longrightarrow \beta_1\,A' \mid \beta_2\,A' \mid \cdots \mid \beta_n\,A' \\
A' &\longrightarrow \alpha_1\,A' \mid \alpha_2\,A' \mid \cdots \mid \alpha_m\,A' \mid \varepsilon
\end{aligned}
$$

Compare $G2$ ▶ and G_3 ▶.

Eliminating Left-Recursion

Algorithm 4.19: Eliminating left recursion.

INPUT: Grammar G with no cycles or ϵ-productions.

OUTPUT: An equivalent grammar with no left recursion.

```
1)   arrange the nonterminals in some order A₁, A₂, ... , Aₙ.
2)   for ( each i from 1 to n ) {
3)        for ( each j from 1 to i − 1 ) {
4)             replace each production of the form Aᵢ → Aⱼγ by the
                  productions Aᵢ → δ₁γ | δ₂γ | ··· | δₖγ, where
                  Aⱼ → δ₁ | δ₂ | ··· | δₖ are all current Aⱼ-productions
5)        }
6)        eliminate the immediate left recursion among the Aᵢ-productions
7)   }
```

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