Convert Context-free to Chomsky normal I

A procedure to summarize what we have done in the example

- Add

$$S_0 \to S$$

  So start state not on the right
- Remove $A \to \epsilon$, where A is not the start state:

Convert Context-free to Chomsky normal II

For any rule of

$$\cdots \rightarrow uAv$$

add

$$\cdots \rightarrow uv$$

We discuss the issue of a possible infinite loop later

Convert Context-free to Chomsky normal III

- Remove

$$A \to B$$

because the right hand cannot have a single variable. For any

$$B \to u, \text{ where } u \text{ is a string of variables and terminals}$$

we

$$\text{remove } A \to B \text{ and } B \to u, \text{ and add } A \to u$$

Convert Context-free to Chomsky normal IV

unless $A \to u$ is a unit rule previously removed (this setting avoids the possible infinite loop)

- After this, we have either

$$A \to u_1 \cdots u_k, u_i \in V \text{ or } \Sigma;$$

and

$$\text{if } k = 1, \text{ then } u_i \in \Sigma$$

Convert Context-free to Chomsky normal V

- Replace the right side with

$$A \to u_1 A_1$$
$$A_1 \to u_2 A_2$$
$$\ldots$$

- Replace any u_i in the above rules with U_i
- Add

$$U_i \to u_i \text{ if } u_i \in \Sigma$$

Infinite loop in the above procedure I

- Original rules

$$S \to B \mid \epsilon$$
$$B \to S \mid \epsilon$$

- Add S_0

$$S_0 \to S$$
$$S \to B \mid \epsilon$$
$$B \to S \mid \epsilon$$

Infinite loop in the above procedure II

- Remove $S \to \epsilon$

$$
\begin{aligned}
S_0 &\to S \mid \epsilon \\
S &\to B \\
B &\to S \mid \epsilon
\end{aligned}
$$

- Remove $B \to \epsilon$

$$
\begin{aligned}
S_0 &\to S \mid \epsilon \\
S &\to B \mid \epsilon \\
B &\to S
\end{aligned}
$$

Infinite loop in the above procedure III

- No need to add $S \rightarrow \epsilon$
- Reason: $S \rightarrow \epsilon$ has been handled; see line -8 of p109 in the textbook.