

CFG:
 $A \rightarrow \alpha, A \in V, \alpha \in (V \cup T)^*$

CNF:
 $A \rightarrow BC, A, B, C \in V$
 or $A \rightarrow x, x \in T$

tools for CFG \rightarrow CNF conversion.

substitution:

1. $A \rightarrow x_1 B x_2$
2. $B \rightarrow y_1 | y_2 | y_3 | \dots | y_n$

\equiv

ex $A \rightarrow x_1 y_1 x_2 | x_1 y_2 x_2 | x_1 y_3 x_2 | \dots | x_1 y_n x_2$

ex $G = (\{A, B\}, \{a, b, c\}, A, P)$

P:
 $A \rightarrow a | aaA | abBc$
 $B \rightarrow abbA | b$

$\equiv A \rightarrow a | aaA | ababbAc | abbe$

useless productions:

1. can not reach production from start symbol
2. does not generate a terminal string

ex 1. $S \rightarrow A$
 $A \rightarrow a | \lambda$
 ~~$B \rightarrow bA | b$~~

ex 2. $S \rightarrow aSb | \lambda | A$
 ~~$A \rightarrow aA$~~

ex. $G = (\{S, A, B, C\}, \{a, b\}, S, P)$

P:
 1. $S \rightarrow aS | A | \lambda$
 2. $A \rightarrow a$ ✓
 3. $B \rightarrow qa$ ✗
 4. $C \rightarrow aCb$ ✗

unit productions:

use substitution to remove single variable to single variable.

ex $S \rightarrow Aa | B$
 $B \rightarrow A | bb$
 $A \rightarrow a | bc | \lambda$

$S \rightarrow Aa | A | bb$
 $B \rightarrow a | bc | B | bb$
 $A \rightarrow a | bc | A | bb$

$S \rightarrow Aa | a | bc | bb$
 $A \rightarrow a | bc | bb$
 $B \rightarrow a | bc | bb$

lambda productions: removed using substitution.

~~$S \rightarrow aA | \lambda$~~
 $A \rightarrow aA | \lambda$

$S \rightarrow aA | A$
 $A \rightarrow aA | \lambda | B$
 $B \rightarrow \lambda$

$S \rightarrow A \rightarrow \lambda = \text{empty string}$

$S \rightarrow A \rightarrow B \rightarrow \lambda = \text{empty string}$

ex $S \rightarrow aA$
 $A \rightarrow aA | \lambda$

$L(G) = \{a, aa, aaa, aaaa, \dots\}$

\equiv
 $S \rightarrow aA | a$
 $A \rightarrow aA | a$

ex. $S \rightarrow ABaC$
 $A \rightarrow BC \rightarrow \dots \lambda$
 $B \rightarrow b | \lambda$
 $C \rightarrow D | \lambda$
 $D \rightarrow d$

\equiv
 $S \rightarrow ABaC | BaC | AaC | ABa | aC | Aa | Ba | a$

\vdots

$B \rightarrow b$

— continue next time —