Example of CNF Conversion

Starting Grammars

- $L = \{ a^i b^j c^k \mid i=j \text{ or } j=k \}$
- G = ({S,A,<B=C>,C,<A=B>}, {a,b}, R, S)
- R:
  - S → A | C
  - A → a A | <B=C>
  - <B=C> → b <B=C> c | λ
  - C → C c | <A=B>
  - <A=B> → a <A=B> b | λ

Remove Null Rules

- **Nullable = {<B=C>, <A=B>, A, C, S}**
  - **S' → S | λ // S' added to V**
  - **S → A | C**
  - **A → a A | a |<B=C>**
  - **<B=C> → b <B=C> c | b c**
  - **C → C c | c | <A=B>**
  - **<A=B> → a <A=B> b | ab**

Remove Unit Rules

- **Chains= {[S':S',S,A,C,<A=B>,<B=C>], [S:S,A,C,<A=B>,<B=C>], [A:A,<B=C>],[C:C,<B=C>], [<B=C>:<B=C>], [<A=B>:<A=B>]}**
  - **S' → λ | aA | a | b<B=C>c | bc | Cc | c | a<A=B>b | ab**
  - **S → aA | a | b<B=C>c | bc | Cc | c | a<A=B>b | ab**
  - **A → aA | a | b<B=C>c | bc**
  - **<B=C> → b<B=C>c | bc**
  - **C → Cc | c | a<A=B>b | ab**
  - **<A=B> → a<A=B>b | ab**

Remove Useless Symbols

- **All symbols are productive (lead to terminal string)**

- **S is useless as it is inaccessible from S' (new start). All others symbols are accessible from S'.**

Normalize rhs as CNF

- S’ → λ | <a>A | a | <b><<B=C><c>> | <b><c> | C<c> | c | <a><<A=B><b>> | <a><b>
- A → <a>A | a |<b><<B=C><c>> | <b><c>
- <B=C> → <b><<B=C><c>> | <b><c>
- C → C<c> | c | <a><<A=B><b>> | <a><b>
- <A=B> → <a> <<A=B><b>> | <a><b>
- <<B=C><c>> → <B=C><c>
- <<A=B><b>> → <A=B><b>
- <a> → a
- <b> → b
- <c> → c