INT201 Decision, Computation and Language

Tutorial 6

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1. Consider language A with CFG $G = (V, \Sigma, R, S)$
   Variables $V = \{S, C, D\}$
   Terminals $\Sigma = \{a, b\}$
   Rules:
   $S \rightarrow CDa \mid CD$
   $C \rightarrow aD$
   $D \rightarrow Sb \mid b$

Derivation for string $s = ababbba$:

2. Give context-free grammars that generate the following languages

$$L = \{w \in \{0, 1\}^* \mid w \text{ contains at least three 1s } \}$$

3. Convert the following CFG into an equivalent CFG in Chomsky normal form

$$S \rightarrow BSB \mid B \mid \varepsilon$$
$$B \rightarrow 00 \mid \varepsilon$$

Solution

1. $S \Rightarrow CDa \Rightarrow aDDa \Rightarrow abDa \Rightarrow abSba \Rightarrow abCDba \Rightarrow abaDDba \Rightarrow ababDba \Rightarrow ababbba$

2. $G = (V, \Sigma, R, S)$ with set of variables $V = \{S,X\}$, where S is the start variable; set of terminals $\Sigma=\{0, 1\}$; and rules

$$S \rightarrow X1X1X1X$$
$$X \rightarrow 0X \mid 1X \mid \varepsilon$$

3.

1st step. introduce new start variable S_0 and the new rule $S_0 \rightarrow S$

$$S_0 \rightarrow S$$
$$S \rightarrow BSB \mid B \mid \varepsilon$$
$$B \rightarrow 00 \mid \varepsilon$$

2nd step. remove ε rules

Removing $B \rightarrow \varepsilon$

$$S_0 \rightarrow S$$
$$S \rightarrow BSB \mid BS \mid SB \mid S \mid B \mid \varepsilon$$
$$B \rightarrow 00$$

Solution

2nd step. remove ε rules

Removing $S \rightarrow \varepsilon$

$$S_0 \rightarrow S \mid \varepsilon$$
$$S \rightarrow BSB \mid BS \mid SB \mid S \mid B \mid BB$$
$$B \rightarrow 00$$

3rd step. remove unit rules

Removing $S \rightarrow S$

$$S_0 \rightarrow S \mid \varepsilon$$
$$S \rightarrow BSB \mid BS \mid SB \mid B \mid BB$$
$$B \rightarrow 00$$

Removing $S \rightarrow$
B

$$S_0 \rightarrow S \mid \varepsilon$$
$$S \rightarrow BSB \mid BS \mid SB \mid 00 \mid BB$$
$$B \rightarrow 00$$

Solution

3rd step. remove unit rules

Removing $S_0 \rightarrow S$

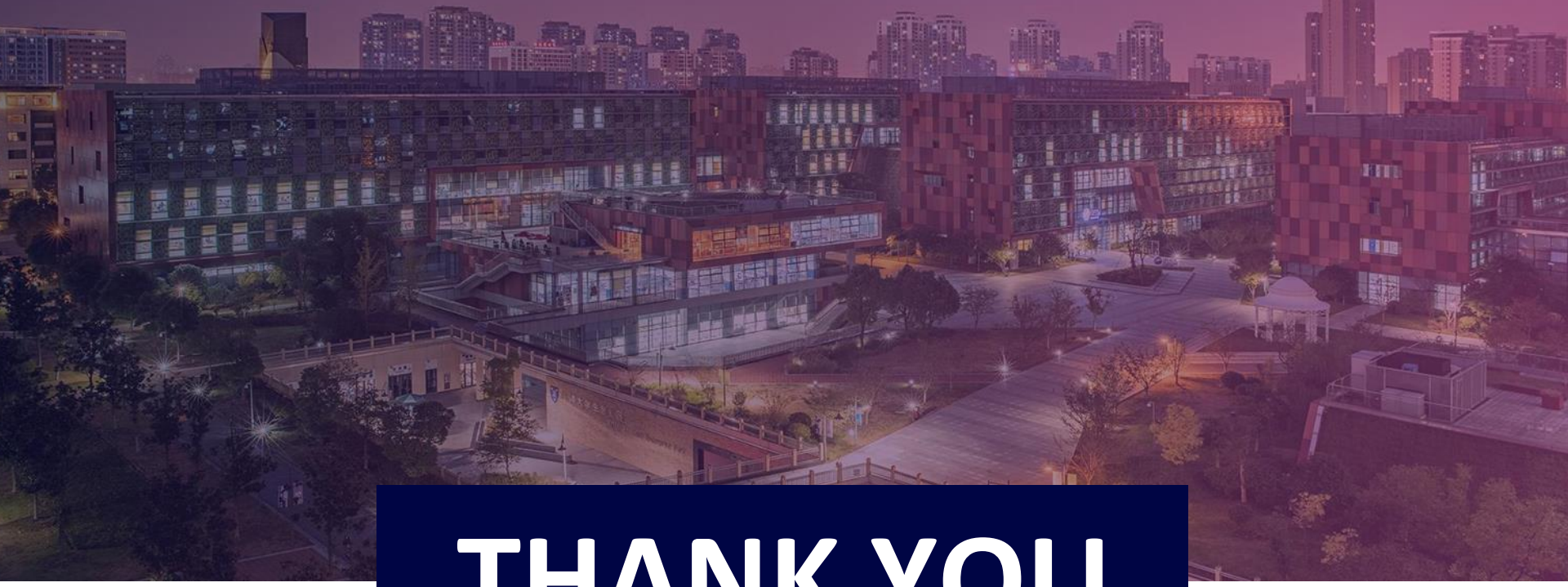
$$S_0 \rightarrow BSB \mid BS \mid SB \mid 00 \mid BB \mid \varepsilon$$
$$S \rightarrow BSB \mid BS \mid SB \mid 00 \mid BB$$
$$B \rightarrow 00$$

4th step. replaced ill-placed terminals 0 by variable U

$$S_0 \rightarrow BSB \mid BS \mid SB \mid UU \mid BB \mid \varepsilon$$
$$S \rightarrow BSB \mid BS \mid SB \mid UU \mid BB$$
$$B \rightarrow UU$$
$$U \rightarrow 0$$

5th step. eliminate all rules having more than two symbols

$$S_0 \rightarrow BA_1 \mid BS \mid SB \mid UU \mid BB \mid \varepsilon$$
$$S \rightarrow BA_2 \mid BS \mid SB \mid UU \mid BB$$
$$B \rightarrow UU$$
$$U \rightarrow 0$$
$$A_1 \rightarrow SB$$
$$A_2 \rightarrow SB$$



THANK YOU

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