

HW5

1. 1. $S \Rightarrow TaS \mid TaT$
 $T \Rightarrow aTbT \mid bTaT \mid \varepsilon$
2. $S \Rightarrow bA \mid Aa \mid aSb$
 $A \Rightarrow aA \mid bA \mid \varepsilon$

2. $S \rightarrow S_1 \mid S_2$

For $i = j$:

$$S \rightarrow aAbB \mid \varepsilon$$

$$A \rightarrow aAb \mid \varepsilon$$

$$B \rightarrow cB \mid \varepsilon$$

For $j = k$:

$$S_2 \rightarrow bA_2cB_2 \mid \varepsilon$$

$$A_2 \rightarrow bA_2c \mid \varepsilon$$

$$B_2 \rightarrow aB_2 \mid \varepsilon$$

Yes, this grammar is ambiguous because we can use S or S_2 to generate the language.

Two left most derivations for $a^2b^2c^2$:

$$S \rightarrow aAbB \rightarrow aaAbbB \rightarrow aa\varepsilonbbcB \rightarrow aabbccB \rightarrow aabbcc\varepsilon$$

$$S_2 \rightarrow bA_2cB_2 \rightarrow bA_2ccB_2 \rightarrow bb\varepsilonccB_2 \rightarrow bbccaB_2 \rightarrow bbccaaB_2 \rightarrow bbccaa\varepsilon$$

3. Add start symbol

$$S \rightarrow A$$

Removing ε -productions

$$S \rightarrow A \mid \varepsilon$$

$$A \rightarrow BAB \mid BB \mid AB \mid B \mid BA$$

$$B \rightarrow 00$$

Removing unit productions

$$S \rightarrow BAB \mid BB \mid AB \mid 00 \mid BA \mid \varepsilon$$

$$A \rightarrow BAB \mid BB \mid AB \mid B \mid BA$$

$$B \rightarrow 00$$

Chomsky normal form

$$S \rightarrow BD \mid BB \mid AB \mid CC \mid BA \mid \varepsilon$$

$$A \rightarrow BD \mid BB \mid AB \mid CC \mid BA$$

$$B \rightarrow CC$$

$$C \rightarrow 0$$

$$D \rightarrow AB$$