Tutorial-05

1) Explain Simplification of grammer ? Mention it use. Elaborate the steps that are followed In Simplification process ?

A) . Simplification of grammer means reduction of grammar by removing useless symbols.

. It use Includes facilitating language learning making text more accessible to Individuals with language difficulties, and Improving reading Comprehension for language learners

The Steps followed In automated Simplification Proce

1) Inputting the Original text Into the Software
2) Running algorithms to Identify Complex Sentence Vocabulary, and Structures.
3) Modifying the text According to Predefined rules or guidelines for grammar Simplific
4) Evaluating the output for accuracy and Clarity
5) Making further adjustments as necessary to ensure that the Simplified text Conveys the Same meaning as the Original

2) Find a reduced grammar equivalent to the grammar G, having Production rules:

$S \rightarrow AC \mid B$

$A \rightarrow a$

$C \rightarrow C \mid BC$

$E \rightarrow aA \mid e$

Phase 1: $T_{ex} = \{a, C, C\}$

$W_1 = \{A, C, E\}$

$W_2 = \{A, C, E, S\}$

$W_3 = \{A, C, E, S\}$

$G^1 = \{(A, C, E, S), \{a, c, e\}, R_1(S)\}$

P: $S \rightarrow AC$

$A \rightarrow a$

$C \rightarrow C$

$E \rightarrow aA \mid e$

Phase 2:

$Y_1 = \{S\}$

$Y_2 = \{S, A, C\}$

$Y_3 = \{S, A, C, a, C\}$

$Y_4 = \{S, A, C, a, C\}$

$G'' = \{(A, C, S), \{a, c\}, P_1(S)\}$

P: $S \rightarrow AC$, $A \rightarrow a$, $C \rightarrow C$

In Tutorial

1) Remove Unit Productions from the following grammar

$S \to AC,\ A \to a,\ C \to X/b,\ X \to Y,\ Y \to Z,\ Z \to a$

Sol

Procedure for Removal

Step 1: To remove $A \to B$, add production $A \to X$ to the grammar rule whenever $B \to X$ occurs in the grammar

Step 2: Delete $A \to B$ from the grammar.

Step 3: Repeat from Step 1 until all Unit Productions are Removed.

The given grammar is

$P: S \to AC,\ A \to a,\ C \to X/b,\ X \to Y,\ Y \to Z,\ Z \to a$

Unit productions

$C \to X$, $X \to Y$, $Y \to Z$.

$Y \to Z$, $Z \to a$ from Step 1 add $Y \to a$

1) $\therefore P: S \to AC,\ A \to a,\ C \to X/b,\ X \to Y,\ Y \to a,\ Z \to a$

2) Since $Y \to a$, we add $X \to a$

$P: S \to AC,\ A \to a,\ C \to X/b,\ X \to a,\ Y \to a,\ Z \to a$

3) Since $X \to a$, we add $C \to a$

$P: S \to AC, A \to a, C \to a/B, X \to a, Y \to a, Z \to a$

Remove the Unreachable Symbols:

$\therefore P: S \to AC, A \to a, C \to a/b$

2) A grammar G is defined with rules
$S \to XA/BB, B \to b/SB, X \to b, A \to a$.
Write the Productions obtained after normalized GNF of G.

Steps to Convert a given CFG to GNF:

Step 1: Check if the given CFG has any Unit Productions (or) Null Productions and Remove If there are any

Step 2: Check whether the CFG is already in Chomsky Normal Form (CNF) and Convert it to CNF if it is not.

Step 3: Change the names of the Non-Terminal Symbols Into Same A_i in ascending order of i

The given grammar with rules

$S \to XA / BB$

$B \to b / SB$

$X \to b$

$A \to a$

Replace:

S with A_1

X with A_2

A with A_3

B with A_4

we get

$A_1 \to A_2A_3 / A_4A_4$

$A_4 \to b / A_1A_4$

$A_2 \to b$

$A_3 \to a$

Step 4: After the rules so that the Non-Terminals are in ascending order, such that,

If the Production is of the form $A_i \to A_jX$, then, $i < j$ and should never be $i \geq j$

GNF

$A \to b$

$A \to bC_1C_2 \cdots C_n$

$A_4 \to b / A_1A_4$

$A_4 \to b / A_2A_3A_4 / A_4A_4A_4$

$A_4 \to b / bA_3A_4 / A_4A_4A_4$

Left Recursion

Step 5: Remove Left Recursion

$Z \rightarrow A_4 A_4 Z \mid A_4 A_4$

$A_4 \rightarrow b \mid bA_3 A_4 \mid bZ \mid bA_3 A_4 Z$

Now the grammar is:

$A_1 \rightarrow A_2 A_3 \mid A_4 A_4$

$A_4 \rightarrow b \mid b A_3 A_4 \mid bZ \mid bA_3 A_4 Z$

$Z \rightarrow A_4 A_4 \mid A_4 A_4 Z$

$A_2 \rightarrow b$

$A_3 \rightarrow a$

In GNF we are not allow to have variable in the beginning we need to modify A_1

$A_1 \rightarrow bA_3 \mid bA_4 \mid bA_3 A_4 A_4 \mid bZA_4 \mid bA_3 A_4 Z A_4$

$A_4 \rightarrow b \mid bA_3 A_4 \mid bZ \mid bA_3 A_4 Z$

$Z \rightarrow bA_4 \mid bA_3 A_4 A_4 \mid bZA_4 \mid bA_3 A_4 Z A_4 \mid$
$bA_4 Z \mid bA_3 A_4 A_4 Z \mid bZA_4 Z \mid bA_3 A_4 Z A_4 Z$

$A_2 \rightarrow b$

$A_3 \rightarrow a$

Post Tutorial:

1) Convert the following

a) CFG into CNF

$S \to ASA \mid aB$, $A \to B \mid S$, $B \to b \mid \epsilon$

Sol

Step 1) Since S appears in RHS, we add a new State S' and $S' \to S$ is added to the production

$P: S' \to S$, $S \to ASA \mid aB$, $A \to B \mid S$, $B \to b \mid \epsilon$

Step 2: Remove the Null Productions:

$B \to \epsilon$ and $A \to \epsilon$:

After Removing $B \to \epsilon$: $P: S' \to S$, $S \to ASA \mid aB \mid a$, $A \to B \mid S \mid \epsilon$, $B \to b$

After Removing $A \to \epsilon$: $P: S' \to S$, $S \to ASA \mid aB \mid a \mid AS \mid SA \mid S$, $A \to B \mid S$, $B \to b$

Step 3:

Remove the Unit Productions : $S \to S$, $S' \to S$, $A \to B$ and $A \to S$:

After Removing $S \to S$:

P: $S' \to S$, $S \to ASA|aB|a|AS|SA$, $A \to B|S$, $B \to b$

After Removing $S' \to S$:

P: $S' \to ASA|aB|a|AS|SA$,
$S \to ASA|aB|a|AS|SA$,
$A \to B|S$, $B \to b$

After Removing $A \to B$:

P: $S' \to ASA|aB|a|AS|SA$,
$S \to ASA|aB|a|AS|SA$,
$A \to b|S$, $B \to b$

After Removing $A \to S$:

P: $S' \to ASA|aB|a|AS|SA$,
$S \to ASA|aB|a|AS|SA$,
$A \to b|ASA|aB|a|AS|SA$,
$B \to b$

Step 4:

Now find out the Productions that has more than TWO Variables in RHS

$S' \to ASA$, $S \to ASA$ and $A \to ASA$

After removing these, we get

P: $S' \to AX \mid aB \mid a \mid AS \mid SA$,
$S \to AX \mid aB \mid a \mid AS \mid SA$,
$A \to b \mid AX \mid aB \mid a \mid AS \mid SA$,
$B \to b$,
$X \to SA$.

Step 5:

Now Change the Productions

$S' \to aB$, $S \to aB$ and $A \to aB$

Finally we get

P: $S' \to AX \mid YB \mid a \mid AS \mid SA$,
$S \to AX \mid YB \mid a \mid AS \mid SA$,
$A \to b \mid AX \mid YB \mid a \mid AS \mid SA$,
$B \to b$,
$X \to SA$,
$Y \to a$.

Which is the required Chomsky Normal form for the given CFG.

2) Write the Steps for removing null Productions and Unreachable Symbols? Explain with an Example of your own.

Sol

1) Remove null Productions:

- A production is considered null if its right-hand side is Empty.
- For Example, Consider a CFG with the following production: $A \rightarrow \in$. This Production. Can be removed.

2) Remove unreachable Symbols:

- A Symbol is considered unreachable if it Can never appear in any String generated by the CFG.
- To Identify unreachable Symbols, Start from the Start Symbol and mark all the Symbols reachable from it.
- Then remove all the Symbols that were not marked as reachable.

Example:

Consider the following CFG:

$G = (N, T, P, S)$

where $N = \{S, A, B\}$

$T = \{a, b\}$

$P = \{S \to \epsilon, S \to A, A \to B, B \to a\}$.

$S = S$

1) Remove the null Production:

The null Production $(S \to \epsilon)$ can be removed

New grammar:

$G = (N, T, P, S)$

where $N = \{S, A, B\}$

$T = \{a, b\}$

$P = \{S \to A, A \to B, B \to a\}$

$S = S$

2) Remove Unreachable Symbols:

Starting from the Start Symbol "S", we can reach "A", "B", and "a". So, "A", "B", and "a" are reachable Symbols.

The unreachable symbols can be removed

New grammar:

$G = (N, T, P, S)$

where $N = \{S, B\}$

$T = \{a, b\}$

$P = \{S \to A,\ B, a\}$

$S = S$.