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* Context-Sensitive Grammar:

=> Context-Sensitive Grammar is a Type-1 Grammar

This Grammar is recognized by Linear Bound Automata.

Type-1 Grammar is only contains transformation of symbol which is α and β

A Context-Sensitive Grammar is an Unrestricted Grammar.

In this Grammar α and β are strings of non-terminals and terminals.

$$\alpha \rightarrow \beta$$

where $\alpha, \beta \in (V \cup T)^+$ and $|\alpha| \leq |\beta|$

Context-sensitive Grammers are more powerful than Context-Free Grammars.

* Linear Bounded Automata:

=> Linear Bounded Automata is used to recognized Context-Sensitive Grammar.

LBA can be defined with Eight Tuples.

$$M = \{Q, T, E, q_0, M_L, M_R, S, F\}$$

where,

- Q -> Finite set of states
- T -> Tape Alphabet
- E -> Input Symbol
- q_0 -> Initial state
- M_L -> Left Bound of tape
- M_R -> Right Bound of tape
- S -> Transition Function
- F -> Final states

M_L					M_R

* Pumping Lemma :

=> Pumping Lemma is used to prove that a language is NOT Regular.

IF A is a Regular Language then A has a Pumping Length P such that any String s may be divided into 3 Parts s = XYZ

This are the Condition :

(i) $XY^iZ \in A$ for every $i \geq 0$
(ii) $|Y| > 0$
(iii) $|XY| \leq P$

IF this Three condition is True then This Language is Regular Language else NOT Regular Language.

Ex. Prove that Language $A = \{a^n b^n / n \geq 0\}$ is Not Regular.

=> Assume that, Here A is a Regular Language and Pumping Length P = 7

$\therefore S = a^7 b^7 = aaaaaaabbbbbbb$

We have to Divide This S string into three parts.

So, $X = aaaaaa$
$Y = aab$
$Z = bbbbbbb$

We have to check Three Pumping Lema Condition

(i) $XYZ \in A$

Here, XYZ is always ~~belongs to the~~ part of the A Regular Language.

(ii) $|Y| > 0$

Here, we have to take Y' and check with S string

Here, we take $Y = 2$

$\therefore XY^2Z = aaaaaaaabaab$
$bbbbbbb$

$\therefore XYZ = aaaaaaaabbbbbb$

Here, $XY^2Z \neq XYZ$

So, This Condition is False.

(iii) $|xy| \leq P$

We have to add x and y string character.

$x + y = 8$

$\therefore |xy| = 8 \nleq P, \quad P = 7$

So, This Condition is False.

Hence, $A = \{a^n b^n \mid n \geq 0\}$ is a NOT Regular Language.

Ex Prove that $A = \{yy \mid y \in (0,1)^*\}$ is not Regular.

$\Rightarrow$ Here, Assume that A is a Regular Language and Pumping Lemma Length $= P = 7$

Here, $S = 0^P 1 0^P 1$ or $0 1^P 0 1^P$

We take $S = 0^P 1 0^P 1$

$\therefore S = 0^7 1 0^7 1$

We have to divide this S String into three part

$\therefore$ $x = 00$
$y = 0000$
$z = 0100000001$

We have to check Three Pumping Lemma Condition.

(i) $xyz \in A$

Here, String x, y and z is part of A Regular Language.

(ii) $|y| > 0$

Here, We have to take x^i and compare with Strings.

Here, We take $y = 2$

$\therefore$ $xy^2z = 00000000000100000001$

$\therefore$ $xyz = 00\,00000100000001$

$\therefore$ $xyz \neq xy^2z$

So, This Condition is False

So, This condition is False

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$\therefore |xy| = 8 \nleq P, \quad P = 7$

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Ex. Prove that $A = \{yy \mid y \in (0,1)^*\}$ is not Regular.

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We have to divide this S String into three part

$\therefore X = 00$
$Y = 0000$
$Z = 0100000001$

We have to check Three Pumping Lemma Condition.

(iii)

(i) $X\cancel{Y}Z \in A$

Here, String X, Y and Z is part of A Regular Language.

(ii) $|Y| > 0$

Here, We have to take Y^i and compare with Strings.

Here, We take $Y = 2$

$\therefore XY^2Z = 00000000000100000001$

$\therefore XYZ = 00000000100000001$

$\therefore XYZ \neq XY^2Z$

So, This Condition is False.

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(iii) $|xy| \leq P$

We have to add x and y string character

$x + y = 6$

$\therefore |6| \leq 7$

This Condition is True.

For Pumping Lemma Not Regular Language all the condition is must be true.

Hence, $A = \{yx \mid y \in \{0,1\}^*\}$ is Not Regular Language.