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Given language is

"The set of strings over the alphabet $\{a,b\}$ with more a's than b's"

The context – free grammar generating the given language is

$$S \to Aa \mid BS \mid SBA$$
$$A \to Aa \mid \in$$
$$B \to \in \mid BB \mid bBa \mid aBb$$

In the above grammar S will generate all strings with as many a's as b's. R Forces an extra a which gives the required strings of the language.

Given language is

"The compliment of the language $\{a^n b^n : n \geq 0\}$"

Let L be the language that is a compliment of given language. L can be obtained as $L = \{a^n b^m : n \neq m\} \cup \{(a \cup b)^* ba (a \cup b)^*\}$

Let us conside

$$L_1 = \{a^n b^m : n \neq m\}$$

$$L_2 = \{(a \cup b)^* ba (a \cup b)^*\}$$

The context – free grammar generating the language L_1 is

$$S_1 \to aS_1 b \mid T \mid U$$
$$T \to aT \mid a$$
$$U \to Ub \mid a$$

The context – free grammar generating the language L_2 is

$$S_2 \to RbaR$$
$$R \to RR \mid a \mid b \mid \varepsilon$$

Therefore, the required context – free grammar generating the language L is given by

$$L = L_1 \cup L_2$$

$$S \to S_1 \mid S_2$$
$$S_1 \to aS_1 b \mid T \mid U$$
$$S_2 \to RbaR$$
$$T \to aT \mid a$$
$$U \to Ub \mid a$$
$$R \to RR \mid a \mid b \mid \varepsilon$$

Given language is

$$\left\{w\#x : w^R \text{ is a substring of } x \text{ for } w, x \in \{0,1\}^*\right\}$$

The context – free grammar generating the given language is

$$R \to SX$$
$$S \to 0S0 \mid 1S1 \mid \#X$$
$$X \to XX \mid 1 \mid 0 \mid \varepsilon$$

The nonterminal S ends only with $\#X$, S must generate a string whose beginning and end are mirror images. Since X generates $(0 \cup 1)^*$, the symbol S generates all strings of the form $w\#(0 \cup 1)^* w^R$. The above grammar generates all the substrings of x for $w, x \in \{0,1\}^*$.

Given language is

$$\left\{x_1 \# x_2 \# \cdots \# x_k \mid k \geq 1, \text{ each } x_i \in \{a,b\}^*, \text{ and for some } i \text{ and } j, x_i = x_j^R\right\}$$

The context – free grammar generating the given language is

$$R \to S \mid J\#S\#J \mid J\#S \mid S\#J$$
$$S \to aSa \mid bSb \mid \# \mid \#J\#$$
$$J \to aJ \mid bJ \mid \#J \mid \varepsilon$$

The strings in the language contain matching pair of strings with at least one # between them. Before, after and between the matching pairs there can be any number of strings of a's and b's separated by #. Because the strings can be of any length, the strech of the strings of a's,b's and #'s can be of any length. The symbol S generates a matching pair, with strings of a's,b's and #'s optionally inserted in the middle. The symbol J generates strings of a's,b's and #'s. The string generated by J may start or end with a or b, so rules for M and S must ensure that the symbol J is always separated properly from the two matching strings.