

Left Recursion

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$$it. \quad A \rightarrow A\alpha | B$$

i.e.

$$A \rightarrow A\alpha_1 | A\alpha_2 | A\alpha_3 | \dots | A\alpha_m | B_1 | B_2 | \dots | B_n$$

then

$$A \rightarrow B_1 Z | B_2 Z | \dots | B_n Z$$

$$Z \rightarrow \alpha_1 Z | \alpha_2 Z | \alpha_3 Z | \dots | \alpha_m Z | \epsilon$$

$$1) \quad S \rightarrow aABbCD | \epsilon$$

$$A \rightarrow ASd | \epsilon$$

$$B \rightarrow SAc | hC | \epsilon$$

$$C \rightarrow Sf | Cg$$

$$D \rightarrow aBD | \epsilon$$

$$5) \quad S \rightarrow (L) | a$$

$$L \rightarrow L, S | S$$

$$6) \quad S \rightarrow aAC | bB$$

$$A \rightarrow Abc | Abd | e$$

$$B \rightarrow t | g$$

$$C \rightarrow h | i$$

$$2) \quad S \rightarrow aWXh$$

$$W \rightarrow Wb | c$$

$$X \rightarrow YZ$$

$$Y \rightarrow m | \epsilon$$

$$Z \rightarrow n | \epsilon$$

$$7) \quad S \rightarrow A +$$

$$A \rightarrow Ad | aB | aC$$

$$C \rightarrow c | \epsilon$$

$$B \rightarrow bBC | r$$

$$3) \quad A \rightarrow AcB | cC | C$$

$$B \rightarrow bB | id$$

$$C \rightarrow CaB | BbB | B$$

$$8) \quad S \rightarrow YAR | +R$$

$$A \rightarrow Ap | w$$

$$R \rightarrow x$$

$$4) \quad A \rightarrow BCc | gDB$$

$$B \rightarrow bcDE | \epsilon$$

$$C \rightarrow DaB | ca$$

$$D \rightarrow e | dD$$

$$E \rightarrow Eatf | e$$

$$9) \quad S \rightarrow aBDh$$

$$B \rightarrow Bb | c$$

$$D \rightarrow EF$$

$$11) \quad S \rightarrow ScB | B$$

$$E \rightarrow g | \epsilon$$

$$B \rightarrow e | cbg | etCg$$

$$F \rightarrow t | \epsilon$$

$$C \rightarrow SdC | S$$

$$10) \quad S \rightarrow A$$

$$A \rightarrow Ad | Ae | aB | aC$$

$$B \rightarrow bBC | t$$

$$C \rightarrow g$$