

Tutorial 13

Q1] $S \rightarrow aAd$

$A \rightarrow aB \mid bAB$

$B \rightarrow b$

$D \rightarrow d$

Since there are no null/unit productions
thus

we will eliminate terminal with other
terminal / non-terminal

$S \rightarrow xAd$

$A \rightarrow xB \mid yAB$

$x \rightarrow a$

$y \rightarrow b$

$B \rightarrow b$

$D \rightarrow d$

Now eliminating RHS where more than two
non-terminals are present

$S \rightarrow xP$

$A \rightarrow xB \mid yQ$

$x \rightarrow a$

$y \rightarrow b$

$P \rightarrow AD$

$Q \rightarrow AB$

$B \rightarrow b$

$D \rightarrow d$

Q2] $S \rightarrow 1A \mid 0B$

$A \rightarrow 1AA \mid 0S \mid 0$

$B \rightarrow 0BB \mid 1S \mid 1$

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No unit & null production
Thus eliminates RHS with terminals with others.

$$S \rightarrow XA | YB$$

$$A \rightarrow XAA | YS | \emptyset$$

$$B \rightarrow YBB | XS | \epsilon$$

$$X \rightarrow 1$$

$$Y \rightarrow 0$$

Eliminates RH with more than 2 non terminals.

$$S \rightarrow XA | YB$$

$$A \rightarrow XP | YS | \emptyset$$

$$B \rightarrow YQ | XS | \epsilon$$

$$X \rightarrow 1$$

$$Y \rightarrow 0$$

$$P \rightarrow AA$$

$$Q \rightarrow BB$$

Q3] $S \rightarrow aX | y | bab$

$$X \rightarrow \epsilon | y$$

$$Y \rightarrow bb | bXb$$

$X \rightarrow \epsilon$ has null production

$$S \rightarrow aX | a | y | bab$$

$$X \rightarrow y$$

$$Y \rightarrow bb | bXb$$

$S \rightarrow y$, $X \rightarrow y$, are unit production thus remove them,

$$S \rightarrow aX | bab | bb | bXb | a$$

$$X \rightarrow bb | bXb$$

Now eliminating RHS with terminal.

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$$S \rightarrow PX|QPQ|QQ|QXQ|a$$

$$X \rightarrow QQ|QXQ$$

$$P \rightarrow a$$

$$Q \rightarrow b$$

eliminating RHS with more than 2 non terminals

$$S \rightarrow PX|QT|QQ|QU|a$$

$$X \rightarrow QQ|QU$$

$$P \rightarrow a$$

$$Q \rightarrow b$$

$$T \rightarrow PQ$$

$$U \rightarrow XQ$$

Q4]

$$S \rightarrow AB|BC$$

$$A \rightarrow AB|a$$

$$B \rightarrow AA|CBB$$

$$C \rightarrow a|b$$

After converting it to CNF

$$S \rightarrow AB|BC$$

$$A \rightarrow AB|a$$

$$B \rightarrow AA|CX$$

$$C \rightarrow a|b$$

$$X \rightarrow BT$$

$$Y \rightarrow a$$

$$T \rightarrow b$$

Eliminating left recursion

$$S \rightarrow AB|BC$$

$$A \rightarrow aA'$$

$$A' \rightarrow BA'|E$$

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$$B \rightarrow AA \mid CX$$

~~$C \rightarrow a \mid b$~~

$$X \rightarrow BT$$

~~$y \rightarrow a$~~

$T \rightarrow b$

$B \rightarrow AA$ Not in GNF thus substitution
 $A \rightarrow aA' / a$ in it.

$S \rightarrow AB/BC$

$$A \rightarrow aA' / a$$

$$A' \Rightarrow BA' \mid B$$

$B \rightarrow AaA' \mid Aa \mid CX$

$$\underline{c \rightarrow a \mid b}$$

$$X \rightarrow bT$$

$$y \rightarrow a$$

$$f \rightarrow b$$

$B \rightarrow Aa A' / Aa / CX$ in Not in GNF converting it in GNF by substitution A & C.

$$B \rightarrow aA'aA / aaA' / aA'a / aa / aX / bX$$

Now substituting $y \rightarrow a$ in it

$$B \rightarrow a A' y A' | a y A' | a A' y | a y | a x | b x$$

Substituting A & B in S, A'

$$S \rightarrow \epsilon \mid A'B \mid aB \mid aA'yA'c \mid ayA'c \mid aA'yc \mid$$

$$A' \rightarrow aA'yA'A' / ayA'A' / aA'yA' /$$

$$ayA' / axA' / bxA' / aA'yA' / ayA' /$$

$$aA'y / ay / ax / bx$$

Doing same for $X \rightarrow B$

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$$x \rightarrow \begin{matrix} aA'yA'T/ayAT/ \\ bXT \end{matrix} \quad aA'yT/ayT/aXT/$$

Finally we get

$$S \rightarrow aA'B/aB/aA'yA'c/ayA'c/aA'yc/ \\ ay c/aXC/bXC$$

$$A \rightarrow aA'a$$

$$A' \rightarrow aA'yA'A'/ayA'A'/aA'yA'/ \\ ayA'/aXA'/bXA'/aA'yA'/ayA'/ \\ aA'y/ay/aX/bX$$

$$B \rightarrow aA'yA'ayA'/aA'y/ay/aX/bX$$

$$C \rightarrow a/b$$

$$x \rightarrow \begin{matrix} aA'yA'T/ayA'T/aA'yT/ayT/aXT/ \\ bXT \end{matrix}$$

$$y \rightarrow a$$

$$T \rightarrow b$$

95]

$$S \rightarrow AB$$

$$A \rightarrow BAB/b$$

$$B \rightarrow SA/a$$

$$S \rightarrow AB$$

$$A \rightarrow BAB/b$$

$$B \rightarrow ABA/a$$

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$$S \rightarrow AB$$

$$A \rightarrow ABAB/aBAB$$

$$B \rightarrow aBA/a$$

Removing left recursion

$$A \rightarrow aBABC/bc$$

$$C \rightarrow BAABC/\epsilon$$

Removing null production

$$A \rightarrow aBABC/aBAB/bc/b$$

$$C \rightarrow BAABC/BAAB$$

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Now,

$S \rightarrow AB$
Not in GNF $B \rightarrow AB A$
substituting A

$S \rightarrow a B A B C B \mid a B A B B \mid b C B \mid b B \checkmark$

$A \rightarrow a B A B C \mid a B A B \mid b C \mid b \checkmark$

$C \rightarrow B A A B C \mid B A A B \quad \times$

$B \rightarrow a B A B C B A \mid a B A B B A \mid b C B A \mid b B A \checkmark$

$C \rightarrow B A A B C \mid B A A B$ not GNB substituting B

$C \rightarrow a B A B C B A A A B C \mid a B A B B A A A B C \mid$

$B C B A A A B C \mid b B A A A B C \mid a B A B C A A A B \mid$

$a B A B B A A A B \mid b C B A A A B \mid b B A A A B$

Finally

$S \rightarrow a B A B C B \mid a B A B B \mid b C B \mid b B \checkmark$

$A \rightarrow a B A B C \mid a B A B \mid a B A B \mid b C \mid b \checkmark$

$C \rightarrow a B A B C B A A A B C \mid a B A B B A A A B C \mid$
 $b C B A A A B C \mid b B A A A B C \mid a B A B C B A A A B$

$\mid a B A B B A A A B \mid b C B A A A B \mid b B A A A B$

$B \rightarrow a B A B C B A \mid a B A B B A \mid b C B A \mid b B A$

Q6] $S \rightarrow AA \mid 0 \quad \times$

$A \rightarrow SS \mid 1 \quad \times$

\Downarrow

$S \rightarrow AA \mid 0 \quad \times$

$A \rightarrow AA S \mid 0 S \mid 1 \quad \times$ Left recursion

\Downarrow

$S \rightarrow AA \mid 0$

$A \rightarrow 0 S B \mid 1 B$

$B \rightarrow A S B \mid \epsilon$

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Removing null production

$$A \rightarrow 0SB/0S/1B/1$$

$$B \rightarrow ASB/AS$$

Substituting A in B $\rightarrow ASB/AS$

$$B \rightarrow 0SB/0S/1B/1 \quad 0SB/0S/1B/1 \quad 0SB/0S/1B/1 \quad 0SB/0S/1B/1$$

$$S \rightarrow AA/0$$

$$A \rightarrow 0SB/0S/1B/1$$

$$B \rightarrow 0SB/0S/1B/1 \quad 0SB/0S/1B/1 \quad 0SB/0S/1B/1 \quad 0SB/0S/1B/1$$

Now substituting A in S $\rightarrow AA$

$$S \rightarrow 0SBA/0SA/1BA/1A/0 \quad \checkmark$$

$$A \rightarrow 0SB/0S/1B/1 \quad \checkmark$$

$$B \rightarrow 0SB/0S/1B/1 \quad 0SB/0S/1B/1 \quad 0SB/0S/1B/1 \quad 0SB/0S/1B/1 \quad \checkmark$$