※ HW 14 : Modeling Computation

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4. Let $G = (V, T, S, P)$ be the phrase-structure grammar with $V = \{0, 1, A, S\}$, $T = \{0, 1\}$, and set of production P consisting of $S \to 1S$, $S \to 00A$, $A \to 0A$, and $A \to 0$.

a) Show that 111000 belongs to the language generated by G.

$$L(G) = \{ w \in T^* \mid S \overset{*}{\Rightarrow} w \}$$

From start state S, we can derive using the production $S \to 1S$, $S \to 00A$, and $A \to 0$

$$S \to 1S \longrightarrow 11S \to 111S \to 111\,00A \to \underbrace{111\,000}_{T}$$

Thus, it proves that 111000 is $\in L(G)$. $\blacksquare$

b) Show that 11001 does not belong to the language generated by G.

From start state S, we can work using the production :

$$P = \{ S \to 1S,\ S \to 00A,\ A \to 0A,\ A \to 0 \}$$

We will start : $S \to 1S \to 11S \to 11\,00A$

A is not derivable to 1. So, $A \not\to 1$.

Thus, 11001 is $\notin L(G)$. $\blacksquare$

c) What is the language generated by G?

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For all the set from $L(G)$, we can use production to see all the possibilities. From point a, we already know that $L(G)$ have 111000. We will find other language by starting state of S.

- $S \to 00A \to 000$
- $S \to 1S \to 100A \to 1000$
- $S \to 1S \to 100A \to 100\,0A \to 10000A \to \ldots\ldots$

Infinity

Thus, the language that can be generated by G,

$L(G) = \{ 0^{2p+1}, 1^p 0^{2p+1}, 1^p 0^{2p+2}, p = 1, 2, 3 \ldots \}$ ▨

5. Let $G = (V, T, S, P)$ be the phrase-structure grammar with $V = \{0, 1, A, B, S\}$, $T = \{0, 1\}$, and $P = \{ S \to 0A, S \to 1A, A \to 0B, B \to 1A, B \to 1 \}$

a) Show that 10101 belongs to $L(G)$!

From start state of S, we can derive $1A$ using $S \to 1A$. From $1A$ the production $A \to 0B$ can be use to derive $10B$. Use $B \to 1A$ to derive $101A$ and use $A \to 0B$ to derive $1010B$. Finally, use $B \to 1$ to derive 10101.

Thus, 10101 is the language of G. ▨

b) Show that 10110 does not belong to the language generated by G

From start state S, we can derive $1A$ using production $S \to 1A$. From $1A$, we can use $A \to 0B$ to derive $10B$. Using $B \to 1A$ to derive $101A$. To change A into 1, is impossible to do that.

Thus, 10110 does not belong to the language generated by G, $10110 \notin L(G)$

c) What is the language generated by G ?

For all the set from L (G), we can use production to see all the possibilities. From point a, we already know that L(G) have 10101. We will find other language by starting state of S.

- •)
- $S \rightarrow 0A \rightarrow 00B \rightarrow 001$
- $S \rightarrow 1A \rightarrow 10B \rightarrow 101A \rightarrow 1010B \longrightarrow \ldots\ldots$

Infinity

Thus, the language that can be generated by G,

$L(G) = \{ 0^p 1, 1^p 0^p 1, 1^p (01)^p 1, p = 1, 2, 3 \ldots \}$ ▨

6 Let $V = \{S, A, B, a, b\}$ and $T = \{a, b\}$. Find the language generated by the grammar (V, T, S, P) when the set P of production consists of

a) $S \rightarrow AB$, $A \rightarrow ab$, $B \rightarrow bb$.

∴ Solution, with starting state S:

$S \rightarrow AB \rightarrow abB \rightarrow \underbrace{abbb}_{\text{Terminal}}$

$L(G) = \{abbb\}$

b) $S \rightarrow AB$, $S \rightarrow aA$, $A \rightarrow a$, $B \rightarrow ba$.

∴ Solution, with starting state S:

- $S \rightarrow AB \rightarrow aB \rightarrow \underbrace{aba}_{\text{Terminal}}$
- $S \rightarrow aA \rightarrow \underbrace{aa}_{\text{Terminal}}$

$L(G) = \{aba, aa\}$

c) $S \to AB$, $S \to AA$, $A \to aB$, $A \to ab$, $B \to b$

∴ Solution, with starting state S:

- $S \to AB \to abB \to abb$: Terminal
- $S \to AB \to aBB \to abB \to abb$: Terminal
- $S \to AA \to abA \to abab$: Terminal
- $S \to AA \to aBA \to abA \to abab$: Terminal
- $S \to AA \to abA \to abaB \to abab$: Terminal
- $S \to AA \to aBA \to abA \to abaB \to abab$: Terminal

$L(G) = \{ abb, abab \}$

d) $S \to AA$, $S \to B$, $A \to aaA$, $A \to aa$, $B \to bB$, $B \to b$.

∴ Solution, with starting state S:

- $S \to AA \to aaA \to aaaa$: Terminal
- $S \to AA \to aaAA \to aaaaA \to aaaaaaA \to \dots \to a^{4P}$
- $S \to B \to b$
- $S \to B \to bB \to bbB \to bbbB \to \dots\dots b^{P+1}$
- $P = 1, 2, 3, \dots$

$L(G) = \{ a^{4P}, b^{P+1}, P = 1, 2, 3, \dots \}$

e) $S \to AB$, $A \to aAb$, $B \to bBa$, $A \to \lambda$, $B \to \lambda$

∴ Solution, with starting state S:

- $S \to AB \to aAbB \to a\lambda b\lambda$

  $\to aaAbB \to aaAbbBa \to aa\lambda bb\lambda a$

  $\to aaaAbbBa \to aaa\lambda bb\lambda a$

$m = 1, 2, 3 \dots$; $n = 1, 2, 3, \dots$

$L(G) = \{ a^m b^n a, \ m = 1, 2, 3 \dots ; n = 1, 2, 3, \dots \}$

24 Let G be the grammar with $V = \{a, b, c, S\}$; $T = \{a, b, c\}$;

starting symbol S, and $P = \{ S \to abS, S \to bcS, S \to bbS, S \to a, S \to cb \}$

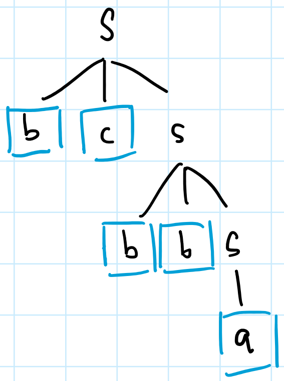
$\boxed{24}$ Let G be the grammar with $V = \{a, b, c, S\}$; $T = \{a, b, c\}$; starting symbol S; and $P = \{S \to abS,\ S \to bcS,\ S \to bbS,\ S \to a,\ S \to cb\}$. Construct derivation trees for:

a) bcbba b) bbbcbba.

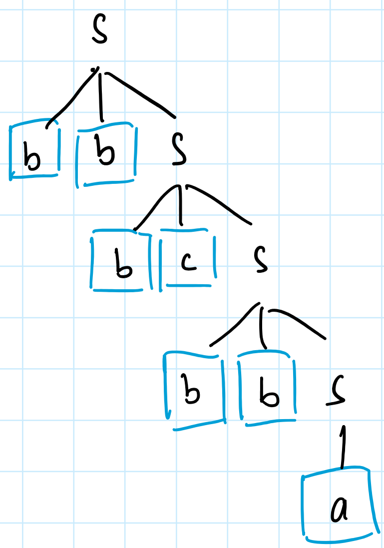
c) bcabbbbbbcb

✲ Solution :

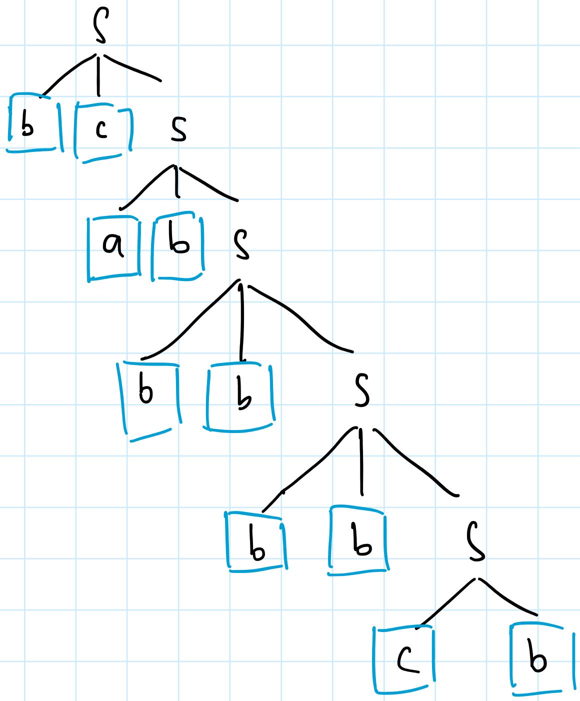
a) With Starting state symbol S :
bcbba :



b) With starting state symbol S :
bbbcbba :



c) With starting state symbol S :
bcabbbbbcb :


S
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c
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b