Tutorial 8

COMP 335: Introduction to Theoretical Computer Science

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Outline

Contents of the section

Derivation Trees

Question 1

Let G be:

$$S \rightarrow I|S+S|S\times S|(S) \quad (1)$$
$$I \rightarrow a|b|Ia|Ib|I0|I1 \quad (2)$$

1. Show the left most derivation of $a \times (a + b000)$ and draw its derivation tree.
2. Show the right most derivation of $a \times (a + b000)$ and draw its derivation tree.

Contents of the section

Simplifications of Context-Free Grammars

Recipe

1. Remove nullable variables and λ-productions
2. Remove Unit-productions
   - Remove repeated productions.
3. Remove Useless productions
   - Find every variable that produces strings with only terminals and keep them.
   - Find all the variables that are reachable from S and keep them.

Simplifications of Context-Free Grammars

Question 1

Simplify the following grammar:

$$S \rightarrow XYX \quad (1)$$
$$X \rightarrow 0X|\lambda \quad (2)$$
$$Y \rightarrow 1Y|\lambda \quad (3)$$

Simplifications of Context-Free Grammars

Question 2

Simplify the following grammar:

$$
\begin{aligned}
S &\rightarrow 0A0|1B1|BB && (1)\\
A &\rightarrow C && (2)\\
B &\rightarrow S|A && (3)\\
C &\rightarrow S|\lambda && (4)
\end{aligned}
$$

Question 3

Simplify the following grammar:

$$
\begin{aligned}
S &\rightarrow XY|W && (1)\\
X &\rightarrow aXb|\lambda && (2)\\
Y &\rightarrow cY|\lambda && (3)\\
W &\rightarrow aWc|Z && (4)\\
Z &\rightarrow bZ|\lambda && (5)
\end{aligned}
$$

Contents of the section

Chomsky Normal Form

Recipe

1. Remove nullable variables unit productions.
2. For every terminal t add a rule $T \to t$ and replace all occurrences of t with T.
3. Replace each production that leads to 3 or more variables by a production that leads to exactly 2 variables via introducing new variables.

Chomsky Normal Form

Question 1

Transform the following grammars into CNF:

$$S \rightarrow XYX \quad (1)$$
$$X \rightarrow 0X|\lambda \quad (2)$$
$$Y \rightarrow 1Y|1 \quad (3)$$

Chomsky Normal Form

Question 2

Transform the following grammars into CNF:

$$
\begin{aligned}
S &\rightarrow 0A0|1B1|B0B && (1)\\
A &\rightarrow C && (2)\\
B &\rightarrow S|A && (3)\\
C &\rightarrow S|\lambda && (4)
\end{aligned}
$$

Chomsky Normal Form

Question 3

Transform the following grammars into CNF:

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\begin{aligned}
S &\rightarrow XaY|Wb && (1)\\
X &\rightarrow aXb|\lambda && (2)\\
Y &\rightarrow cY|\lambda && (3)\\
W &\rightarrow aWc|Z && (4)\\
Z &\rightarrow bZ|\lambda && (5)
\end{aligned}
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