(DEEMED TO BE UNIVERSITY)

23MT2014

THEORY OF COMPUTATION

Topic:

CHOMSKY NORMAL FORM- PART-1

Session - 1

Department of CSE(H)

AUTOMATA THEORY AND FORMAL LANGUAGES
22CS2215A

Topic:

CHOMSKY NORMAL FORM-PART-1

Session - 16

AIM OF THE SESSION

Aim: The aim is the overall goal or purpose of studying context-free languages. It describes what you intend to achieve or learn through your study of this topic.

INSTRUCTIONAL OBJECTIVES

This Session is designed to:

1. Define the concept of context-free languages and explain their role in formal language theory.
2. Identify and describe the components of a context-free grammar, including terminals, non-terminals, production rules, and start symbols.
3. Construct context-free grammars for simple language structures, such as arithmetic expressions or nested parentheses.

LEARNING OUTCOMES

At the end of this session, you should be able to:

1. Understanding the fundamental concepts and properties of context-free languages.
2. Designing and analyzing context-free grammars.
3. Applying parsing techniques to analyze and generate sentences.

Normal Forms for Context-free Grammars

Chomsky Normal Form

Each productions has form:

$A \rightarrow BC$ or $A \rightarrow a$

Examples:

$$S \rightarrow AS$$
$$S \rightarrow a$$
$$A \rightarrow SA$$
$$A \rightarrow b$$

Chomsky Normal Form

$$S \rightarrow AS$$
$$S \rightarrow AAS$$
$$A \rightarrow SA$$
$$A \rightarrow aa$$

Not Chomsky Normal Form

Convertion to Chomsky Normal Form

Example:

$$S \rightarrow ABa$$

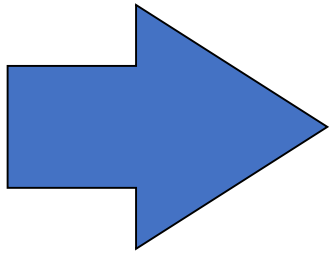
$$A \rightarrow aab$$

$$B \rightarrow Ac$$

Not Chomsky Normal Form

Introduce variables for terminals: T_a, T_b, T_c

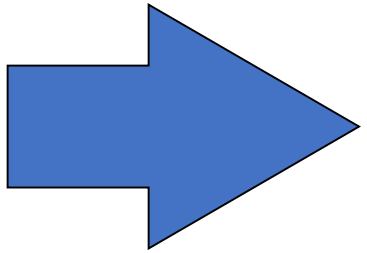
$$S \rightarrow ABa$$
$$A \rightarrow aab$$
$$B \rightarrow Ac$$



$$S \rightarrow ABT_a$$
$$A \rightarrow T_aT_aT_b$$
$$B \rightarrow AT_c$$
$$T_a \rightarrow a$$
$$T_b \rightarrow b$$
$$T_c \rightarrow c$$

Introduce intermediate variable: V_1

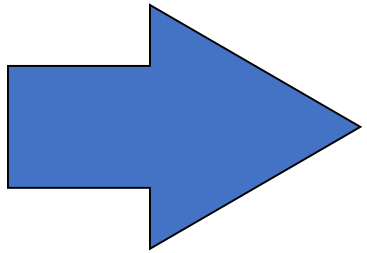
$$S \rightarrow ABT_a$$
$$A \rightarrow T_aT_aT_b$$
$$B \rightarrow AT_c$$
$$T_a \rightarrow a$$
$$T_b \rightarrow b$$
$$T_c \rightarrow c$$



$$S \rightarrow AV_1$$
$$V_1 \rightarrow BT_a$$
$$A \rightarrow T_aT_aT_b$$
$$B \rightarrow AT_c$$
$$T_a \rightarrow a$$
$$T_b \rightarrow b$$
$$T_c \rightarrow c$$

Introduce intermediate variable: V_2

$$S \rightarrow AV_1$$
$$V_1 \rightarrow BT_a$$
$$A \rightarrow T_aT_aT_b$$
$$B \rightarrow AT_c$$
$$T_a \rightarrow a$$
$$T_b \rightarrow b$$
$$T_c \rightarrow c$$



$$S \rightarrow AV_1$$
$$V_1 \rightarrow BT_a$$
$$A \rightarrow T_aV_2$$
$$V_2 \rightarrow T_aT_b$$
$$B \rightarrow AT_c$$
$$T_a \rightarrow a$$
$$T_b \rightarrow b$$
$$T_c \rightarrow c$$

Final grammar in Chomsky Normal Form:

Initial grammar

$$S \rightarrow ABa$$

$$A \rightarrow aab$$

$$B \rightarrow Ac$$

$$S \rightarrow AV_1$$

$$V_1 \rightarrow BT_a$$

$$A \rightarrow T_aV_2$$

$$V_2 \rightarrow T_aT_b$$

$$B \rightarrow AT_c$$

$$T_a \rightarrow a$$

$$T_b \rightarrow b$$

$$T_c \rightarrow c$$

MCQ

Question 1:

What is the main characteristic of a grammar in Chomsky Normal Form?

A) All non-terminals must have a unique start symbol.

B) All production rules must be in the form A -> BC or A -> a.

C) All production rules must be in the form A -> ε.

D) All non-terminals must be reachable from the start symbol.

Answer:

B) All production rules must be in the form A -> BC or A -> a.

Question 2:

What is the purpose of converting a context-free grammar to Chomsky Normal Form?

A) To eliminate ambiguity in the grammar.

B) To simplify the parsing process.

C) To reduce the number of production rules.

D) To ensure every non-terminal has at least one production rule.

Answer:

B) To simplify the parsing process.

MCQ

Question 3:

Which of the following is a step involved in converting a context-free grammar to Chomsky Normal Form?

A) Eliminating unit productions.

B) Removing unreachable symbols.

C) Factoring common prefixes in production rules.

D) Introducing new non-terminals.

Answer:

A) Eliminating unit productions.

Question 4:

In Chomsky Normal Form, how many symbols can be on the right-hand side of a production rule?

A) One symbol.

B) Two symbols.

C) Three symbols.

D) There is no restriction on the number of symbols.

Answer:

B) Two symbols.

Terminal question

Question 1: Explain the key properties and characteristics of Chomsky Normal Form (CNF) and how it differs from other grammar forms.

Question 2: Discuss the significance of Chomsky Normal Form in the field of formal language theory and parsing algorithms.

Question 3: Explain the process of transforming a context-free grammar (CFG) into Chomsky Normal Form. Provide a step-by-step explanation.

Question 4: Discuss the advantages and disadvantages of Chomsky Normal Form in terms of expressive power and grammar complexity.

Question 5: Explain how the conversion of a CFG into Chomsky Normal Form can aid in parsing algorithms and language recognition.

Question 6: Discuss the limitations of Chomsky Normal Form in representing certain language constructs or phenomena.

Question 7: Explain the relationship between Chomsky Normal Form and the pumping lemma for context-free languages.

Question 8: Explain how the conversion of a CFG into Chomsky Normal Form can aid in grammar analysis and language understanding.

Question 9: Explain the role of Chomsky Normal Form in the design and development of parsing algorithms for context-free grammars.

Question 10 : Explain the concept of variable elimination in the context of transforming a CFG into Chomsky Normal Form.

THANK YOU

Team – TOC