23MT2014

THEORY OF COMPUTATION

Topic:

Simplification of Context Free Grammer-Part1

Session – 12-b

Complex

Experiential Learning
(site visits)

Forum Theater

Jigsaw Discussion

Inquiry Learning

Role Playing

Active Review Sessions
(Games or Simulations)

Interactive Lecture

Hands-on Technology

Case Studies

Brainstorming

Groups Evaluations

Peer Review

Informal Groups

Triad Groups

Large Group
Discussion

Think-Pair-Share

Writing
(Minute Paper)

Self-assessment

Pause for reflection

Simple

Department of CSE(H)

AUTOMATA THEORY AND FORMAL LANGUAGES
22CS2215A

Topic:

Simplification of Context Free Grammer-Part1
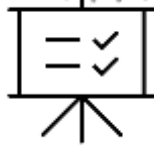
Session - 14

AIM OF THE SESSION

Aim: The aim of studying the simplification of context-free languages is to understand and apply techniques to simplify context-free grammars..

INSTRUCTIONAL OBJECTIVES

This Session is designed to:

1. Identify non-productive symbols and eliminate them from context-free grammars.
2. Recognize unreachable symbols and remove them from context-free grammars.
3. Perform grammar transformations, such as removing ε-productions and unit productions.

LEARNING OUTCOMES

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

1. Apply techniques to simplify context-free grammars by eliminating non-productive and unreachable symbols.
2. Transform context-free grammars by removing ε-productions and unit productions, and by converting them to Chomsky or Greibach normal forms.

Evaluate the impact of grammar simplification on language recognition, including the reduction of ambiguity and improvement in parsing efficiency.

A Substitution Rule

$S \rightarrow aB$

$A \rightarrow aaA$

$A \rightarrow abBc$

$B \rightarrow aA$

$B \rightarrow b$

Substitute

$B \rightarrow b$

$S \rightarrow aB \mid ab$

$A \rightarrow aaA$

$A \rightarrow abBc \mid abbc$

$B \rightarrow aA$

A Substitution Rule

$$S \rightarrow aB \mid ab$$

$$A \rightarrow aaA$$

$$A \rightarrow abBc \mid abbc$$

$$B \rightarrow aA$$

Substitute

$$B \rightarrow aA$$

$$S \rightarrow a\cancel{B} \mid ab \mid aaA$$

$$A \rightarrow aaA$$

$$A \rightarrow \cancel{ab}Bc \mid abbc \mid abaAc$$

Equivalent grammar

In general:

$$A \rightarrow xBz$$

$$B \rightarrow y_1$$

Substitute

$$B \rightarrow y_1$$

$$A \rightarrow xBz \mid xy_1z$$

equivalent grammar

Nullable Variables

$\lambda - production:$ $\qquad\qquad A \rightarrow \lambda$

Nullable Variable: $\qquad A \Rightarrow \dots \Rightarrow \lambda$

Removing Nullable Variables

Example Grammar:

$$S \rightarrow aMb$$

$$M \rightarrow aMb$$

$$M \rightarrow \lambda$$

Nullable variable

Final Grammar

$$S \to aMb$$

$$M \to aMb$$

~~$M \to \lambda$~~

Substitute
$$M \to \lambda$$

$$S \to aMb$$

$$S \to ab$$

$$M \to aMb$$

$$M \to ab$$

Unit Production: $A \rightarrow B$

(a single variable in both sides)

Removing Unit Productions

Observation:

$$A \rightarrow A$$

Is removed immediately

Example Grammar:

$$S \rightarrow aA$$

$$A \rightarrow a$$

$$A \rightarrow B$$

$$B \rightarrow A$$

$$B \rightarrow bb$$

$$S \rightarrow aA$$

$$A \rightarrow a$$

$$\cancel{A \rightarrow B}$$

$$B \rightarrow A$$

$$B \rightarrow bb$$

Substitute

$$A \rightarrow B$$

$$S \rightarrow aA \mid aB$$

$$A \rightarrow a$$

$$B \rightarrow A \mid B$$

$$B \rightarrow bb$$

$$S \rightarrow aA \,|\, aB$$

$$A \rightarrow a$$

$$B \rightarrow A \,|\, \cancel{B}$$

$$B \rightarrow bb$$

Remove
$$B \rightarrow B$$

$$S \rightarrow aA \,|\, aB$$

$$A \rightarrow a$$

$$B \rightarrow A$$

$$B \rightarrow bb$$

$$S \rightarrow aA \mid aB$$

$$A \rightarrow a$$

$$\cancel{B \rightarrow A}$$

$$B \rightarrow bb$$

Substitute
$$B \rightarrow A$$

$$S \rightarrow aA \mid aB \mid aA$$

$$A \rightarrow a$$

$$B \rightarrow bb$$

Question 1:

Which of the following is NOT a step in the simplification of a context-free grammar?

A) Removing useless symbols

B) Eliminating ε-productions

C) Introducing new non-terminals

D) Adding more production rules

Answer:

D) Adding more production rules

Question 2:

What is the purpose of removing useless symbols in a context-free grammar?

A) To reduce the number of production rules

B) To eliminate non-terminals that cannot be reached from the start symbol

C) To simplify the parsing process

D) To ensure all non-terminals have at least one production rule

Answer:

B) To eliminate non-terminals that cannot be reached from the start symbol

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Question 3:

Which of the following is a technique used to eliminate ε-productions in a context-free grammar?

A) Adding more non-terminals

B) Introducing new terminals

C) Removing non-terminals

D) Expanding existing production rules

Answer:

D) Expanding existing production rules

Question 4:

What is the role of introducing new non-terminals in the simplification of a context-free grammar?

A) To increase the complexity of the grammar

B) To make the grammar more ambiguous

C) To resolve conflicts or reduce redundancy

D) To generate additional strings in the language

Answer:

C) To resolve conflicts or reduce redundancy

Terminal question

Question 1: What is the purpose of removing unreachable symbols in a context-free grammar?

Question 2: How can ε-productions be eliminated in a context-free grammar?

Question 3: What is the significance of removing unit productions in a context-free grammar?

THANK YOU

Team - TOC