23MT2014

THEORY OF COMPUTATION

Topic:

DERIVATION TREES

Session - 12

AIM OF THE SESSION

Aim: The aim of studying derivation trees in context-free languages is to understand and apply the concept of derivation trees to represent the syntactic structure of sentences.

INSTRUCTIONAL OBJECTIVES

This Session is designed to:

1. Construct derivation trees for sentences derived from context-free grammars.
2. Identify and describe the components of a context-free grammar, including terminals, non-terminals, production rules, and start symbols.
3. Determine the validity of sentences by verifying if a derivation tree can be constructed for a given sentence and grammar.

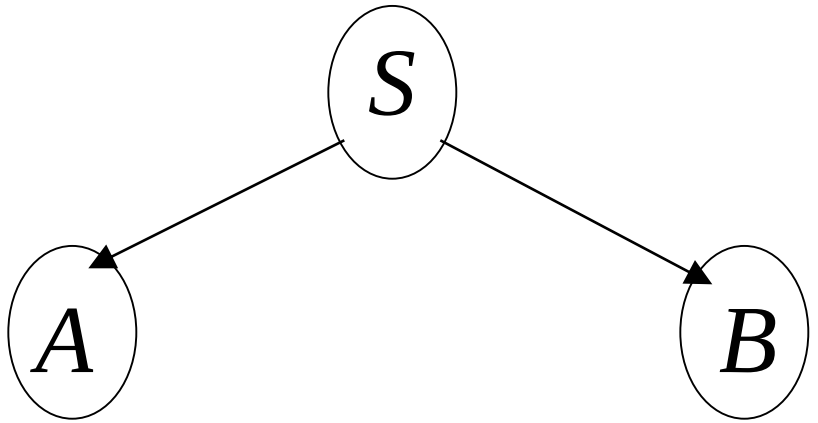
LEARNING OUTCOMES

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

1. Construct accurate derivation trees for sentences derived from context-free grammars.
2. Analyze and interpret the meaning and structure of derivation trees, identifying terminal and non-terminal symbols.
3. Compare and contrast leftmost and rightmost derivations.

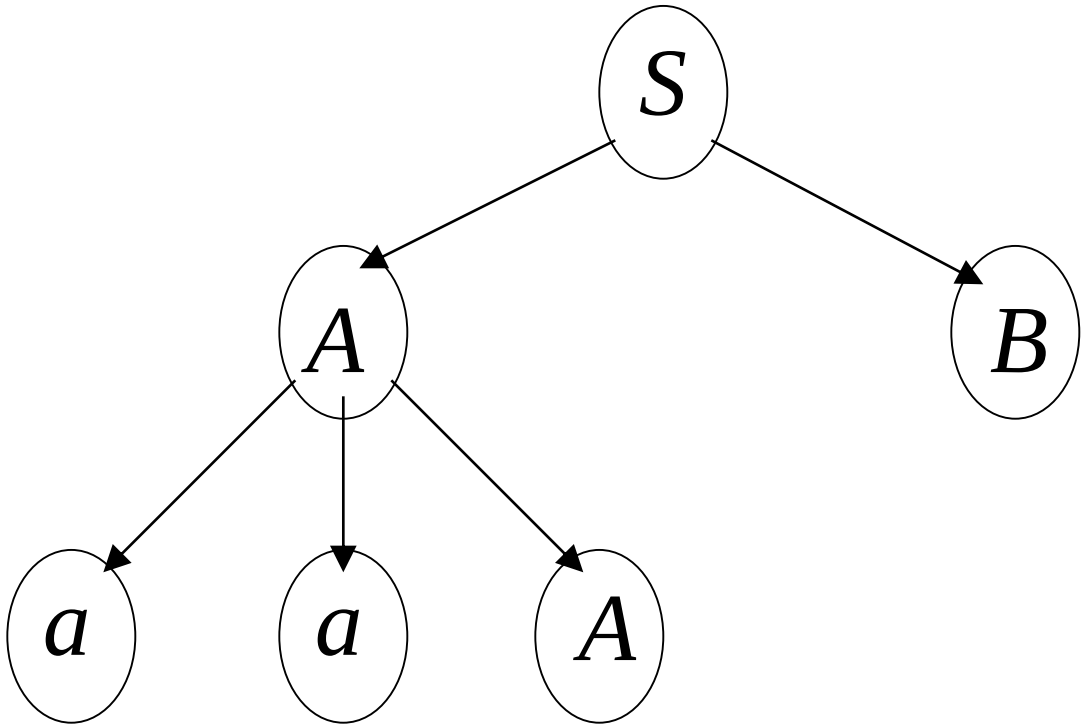
$$S \rightarrow AB \qquad A \rightarrow aaA \mid \lambda \qquad B \rightarrow Bb \mid \lambda$$

$$S \Rightarrow AB$$



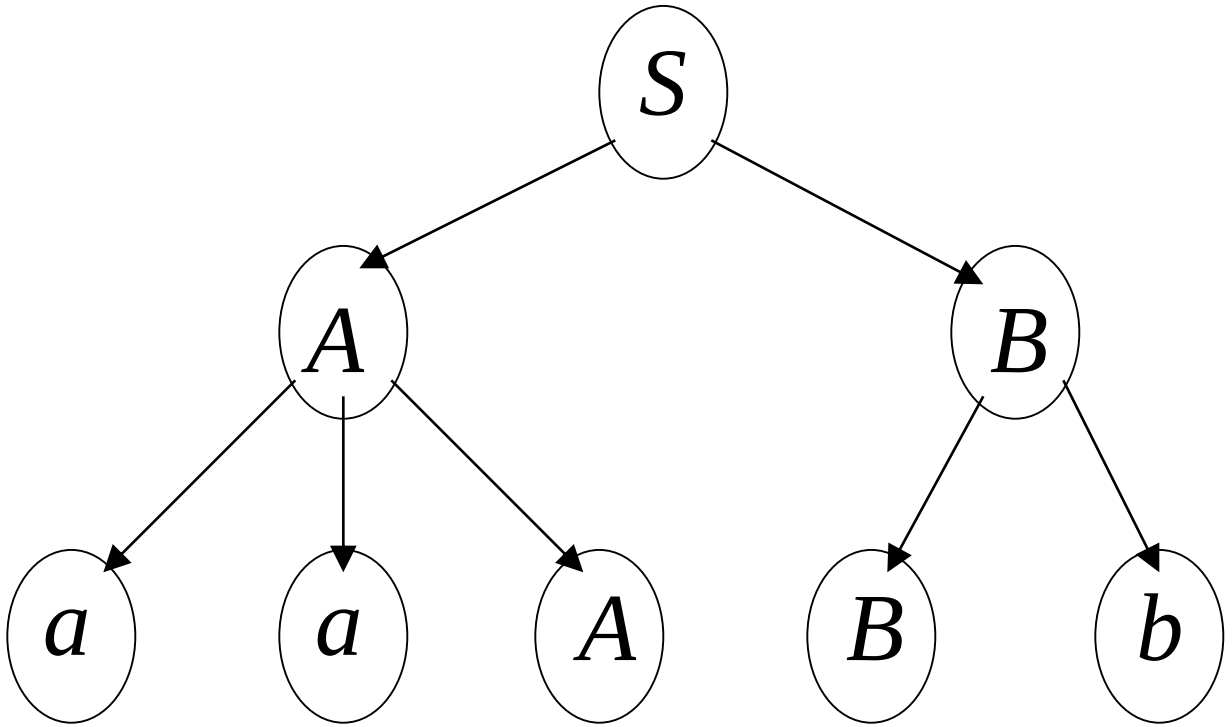
$S \rightarrow AB$ $A \rightarrow aaA \mid \lambda$ $B \rightarrow Bb \mid \lambda$

$$S \Rightarrow AB \Rightarrow aaAB$$



$$S \rightarrow AB \qquad A \rightarrow aaA \mid \lambda \qquad B \rightarrow Bb \mid \lambda$$

$$S \Rightarrow AB \Rightarrow aaAB \Rightarrow aaABb$$



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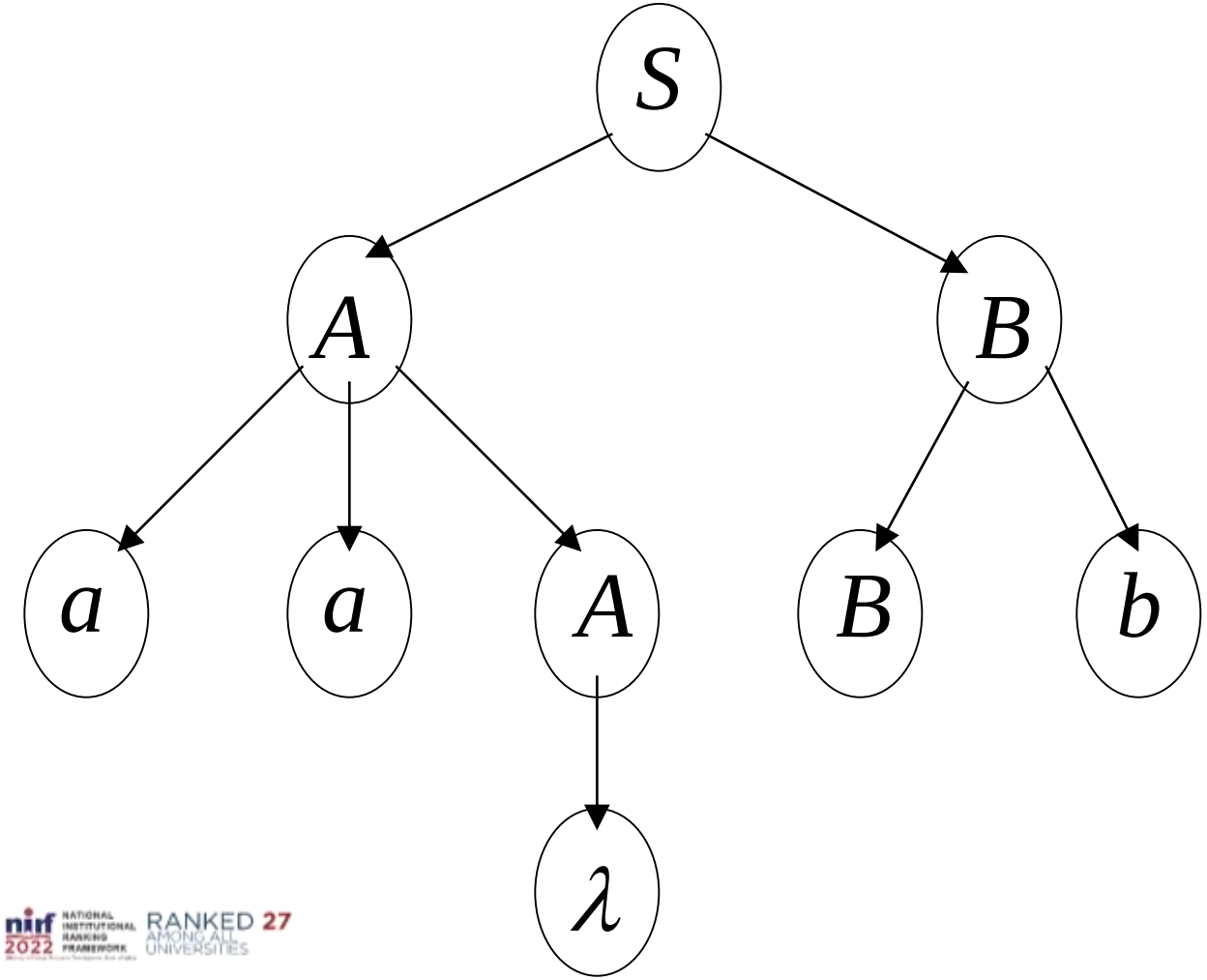
$$S \rightarrow AB \qquad A \rightarrow aaA \mid \lambda \qquad B \rightarrow Bb \mid \lambda$$

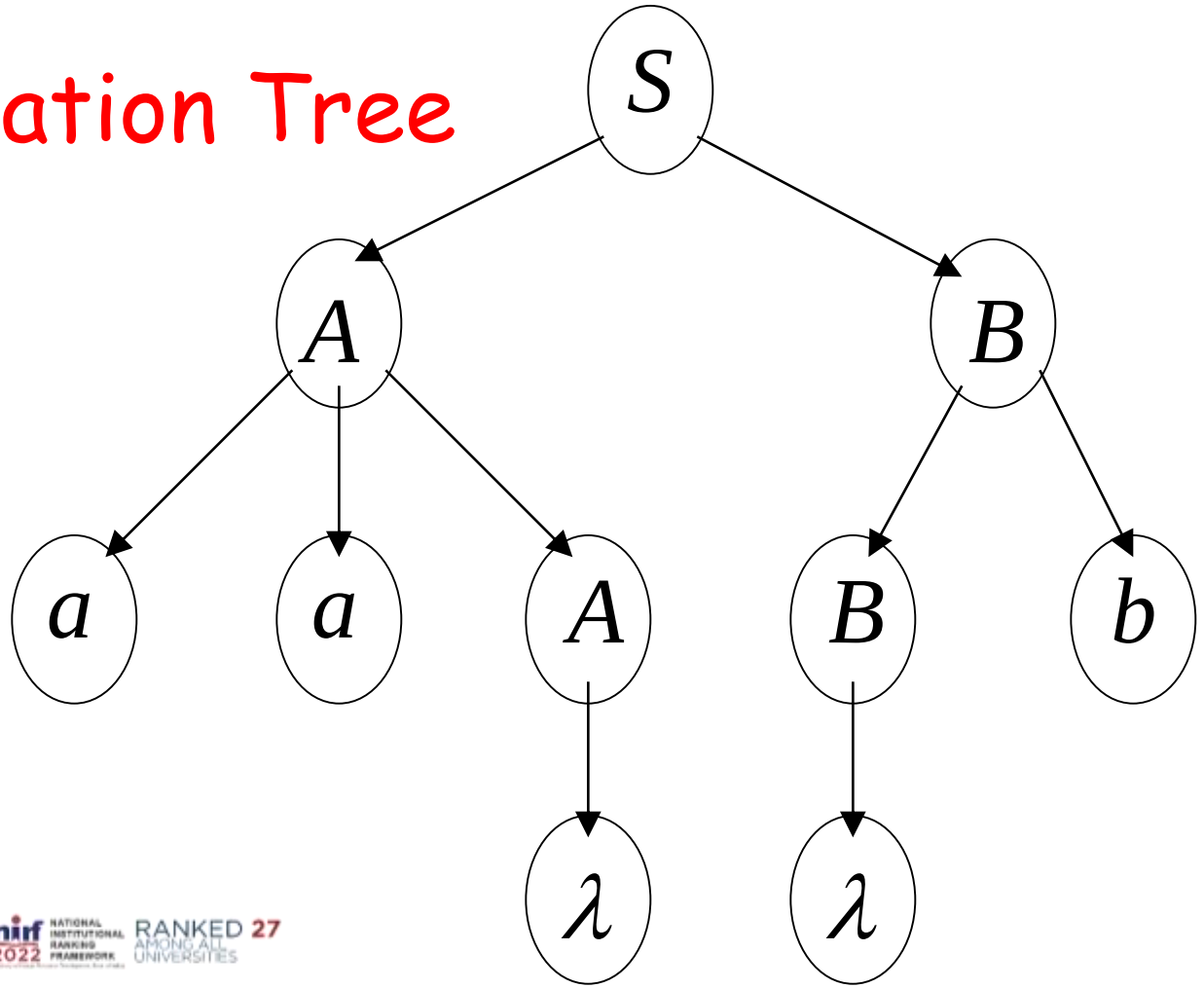
$$S \Rightarrow AB \Rightarrow aaAB \Rightarrow aaABb \Rightarrow aaBb$$



$$S \rightarrow AB \qquad A \rightarrow aaA \mid \lambda \qquad B \rightarrow Bb \mid \lambda$$

$$S \Rightarrow AB \Rightarrow aaAB \Rightarrow aaABb \Rightarrow aaBb \Rightarrow aab$$

Derivation Tree



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$$S \rightarrow AB \qquad A \rightarrow aaA \mid \lambda \qquad B \rightarrow Bb \mid \lambda$$

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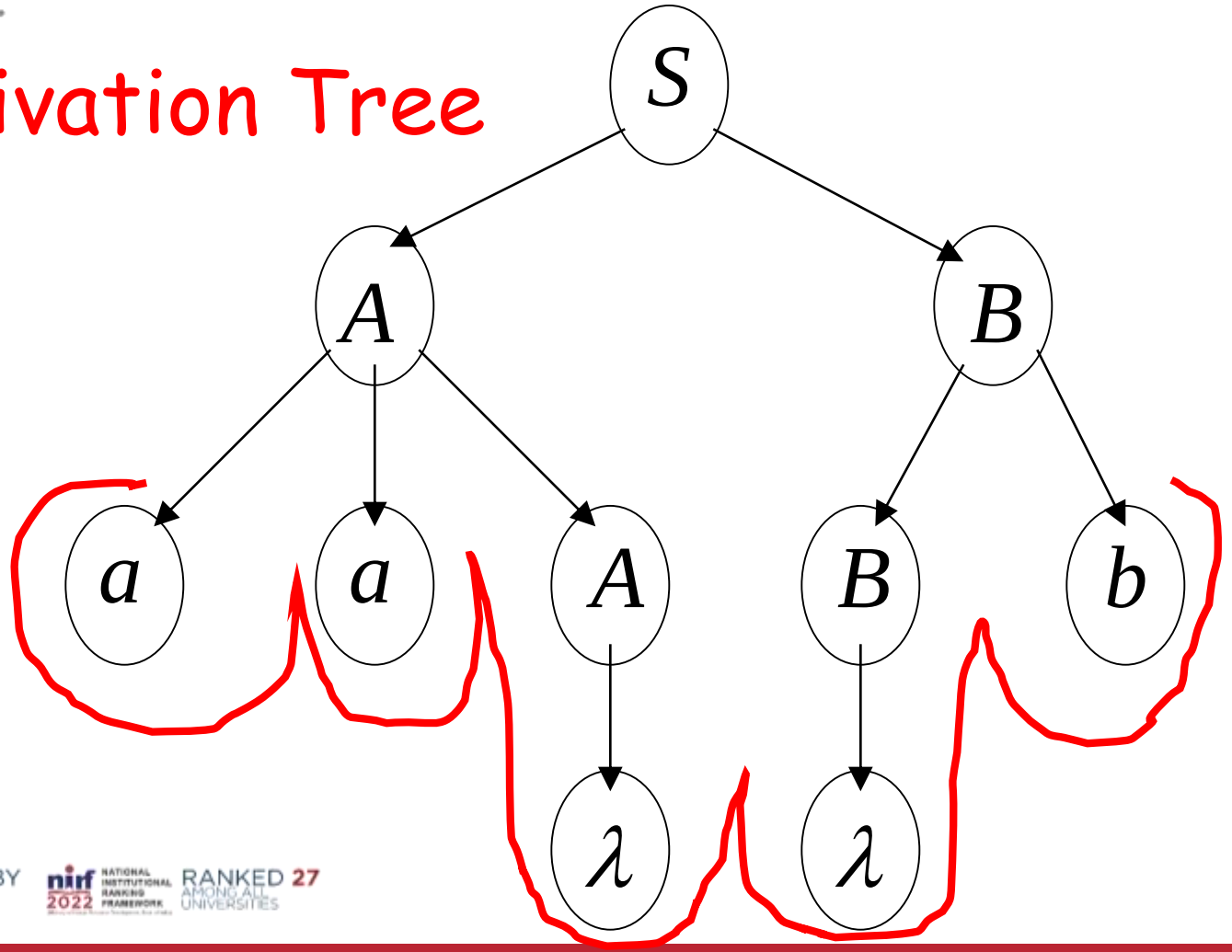
Derivation Tree



yield

$aa\lambda\lambda b$

$= aab$

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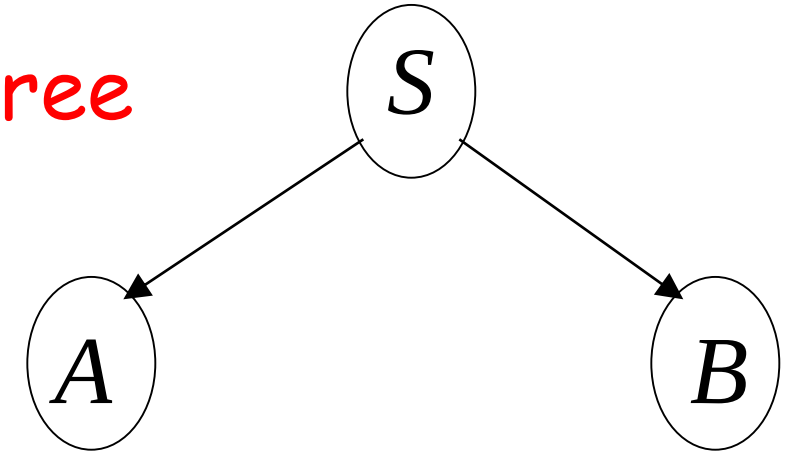
Partial Derivation Trees

$S \rightarrow AB$ $A \rightarrow aaA \mid \lambda$ $B \rightarrow Bb \mid \lambda$

$S \Rightarrow AB$

Partial derivation tree



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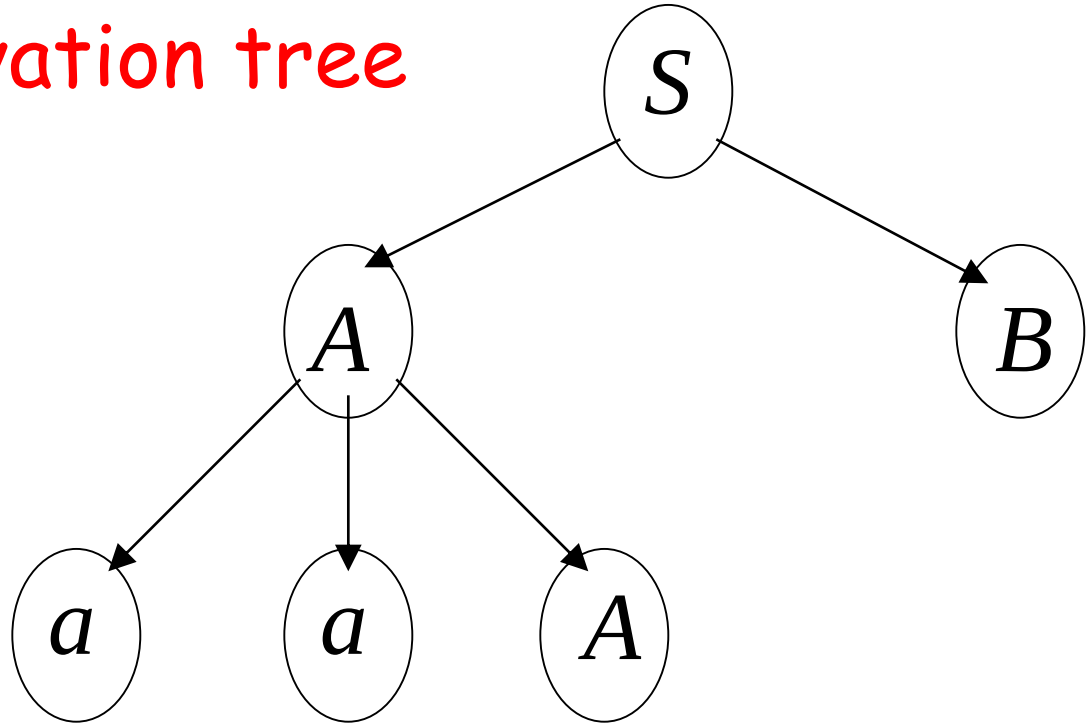
$$S \Rightarrow AB \Rightarrow aaAB$$

Partial derivation tree



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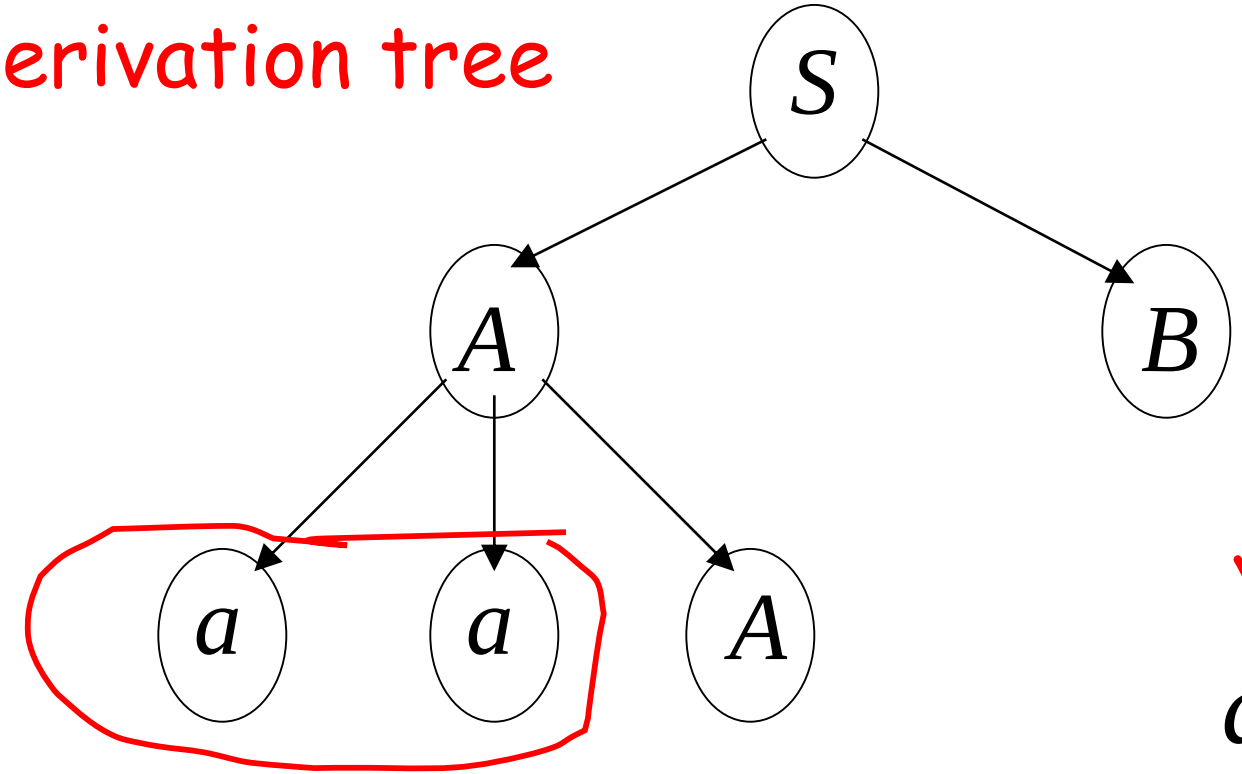
$$S \Rightarrow AB \Rightarrow aaAB$$

sentential form

Partial derivation tree



yield

$aaAB$

Sometimes, derivation order doesn't matter

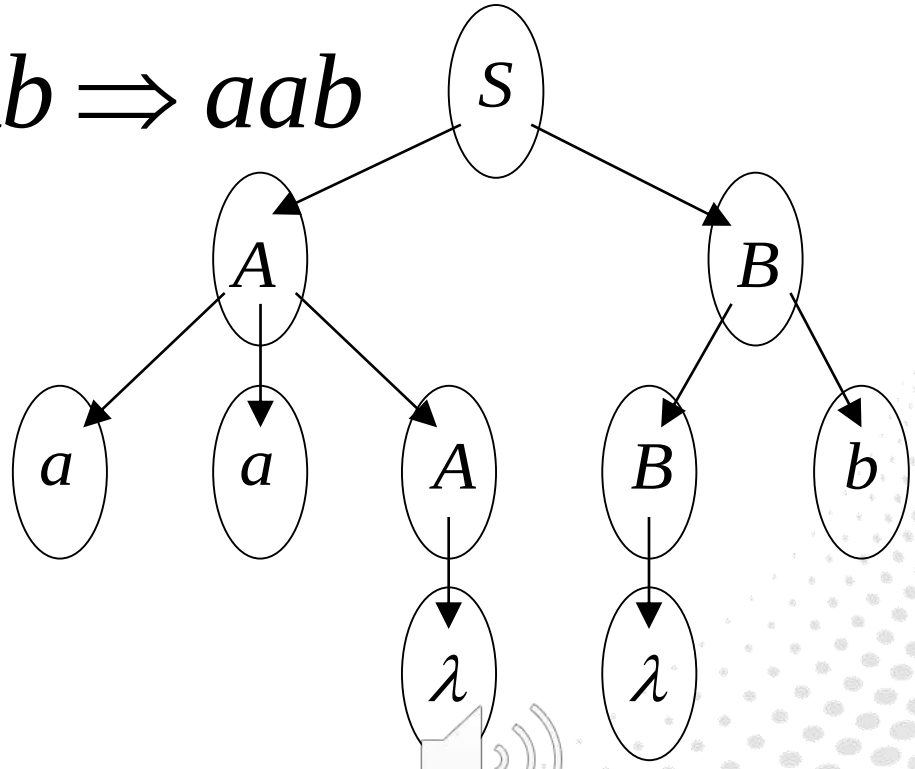
Leftmost:

$$S \Rightarrow AB \Rightarrow aaAB \Rightarrow aaB \Rightarrow aaBb \Rightarrow aab$$

Rightmost:

$$S \Rightarrow AB \Rightarrow ABb \Rightarrow Ab \Rightarrow aaAb \Rightarrow aab$$

Same derivation tree



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MCQ

- Question 1: In the derivation process of a Context-Free Grammar (CFG), which of the following is true?

A) The start symbol remains the same throughout the derivation.

B) Only non-terminals can be replaced during the derivation.

C) Terminals are expanded into non-terminals during the derivation.

D) The derivation process can only occur in a single step.

- Answer: B) Only non-terminals can be replaced during the derivation.

- Question 2: What is the purpose of the derivation process in a CFG?

A) To transform non-terminals into terminals.

B) To generate all possible strings in the language defined by the CFG.

C) To simplify the grammar by removing non-terminals.

D) To determine the start symbol of the CFG.

- Answer: B) To generate all possible strings in the language defined by the CFG.

- Question 3: Which of the following is true about the derivation order in a CFG?

A) The derivation must start from the rightmost non-terminal.

B) The derivation must start from the leftmost non-terminal.

C) The derivation order does not matter in a CFG.

D) The derivation order is determined randomly.

- Answer: B) The derivation must start from the leftmost non-terminal.

- Question 4: What happens when a production rule has multiple options during the derivation?

A) All options are expanded simultaneously.

B) Only the first option is expanded.

C) The options are expanded in a random order.

D) The options are expanded in a specified order.

- Answer: D) The options are expanded in a specified order.

Terminal question

1. Explain the concept of leftmost derivation in the context of a Context-Free Grammar (CFG). How does it relate to the construction of parse trees?
2. Describe the process of generating a rightmost derivation in the context of a CFG. How is it different from a leftmost derivation?
3. Discuss the relationship between parse trees and derivations in a CFG. How can a parse tree be constructed from a given derivation?
4. Provide a step-by-step explanation of the order of derivation through a CFG using the leftmost derivation strategy. Use a specific example to illustrate your explanation.
5. Compare and contrast top-down parsing and bottom-up parsing techniques. How do they differ in terms of the order of derivation through a CFG?
6. Explain the concept of ambiguity in CFGs and how it affects the order of derivation. Provide an example of an ambiguous grammar and discuss the multiple parse trees it can generate.
7. Discuss the concept of leftmost derivation versus rightmost derivation in relation to ambiguous grammars. How do these derivations help in exploring all possible parse trees?
8. Describe the process of constructing a parse tree from a given leftmost derivation. Use a concrete example to illustrate the step-by-step construction.
9. Explain how the concept of parse tree traversal can be used to determine the order of derivation in a CFG. Provide examples of different traversal techniques and their impact on the order of derivation.
10. Discuss the advantages and disadvantages of leftmost and rightmost derivations in terms of their computational efficiency and ease of understanding. Provide real-life scenarios where one derivation strategy might be preferred over the other.

THANK YOU

(DEEMED TO BE UNIVERSITY)

Team – TOC