23MT2014

THEORY OF COMPUTATION

Topic:

AMBIGUITY IN CONTEXT FREE LANGUAGE

Session – 12-a

Department of CSE(H)

AUTOMATA THEORY AND FORMAL LANGUAGES 22CS2215A

Topic:

AMBIGUITY IN CONTEXT FREE LANGUAGE

Session - 13

AIM OF THE SESSION

Aim: The aim of studying ambiguity in context-free languages is to understand and analyze situations where a context-free grammar can generate multiple distinct parse trees or interpretations for a given sentence.

INSTRUCTIONAL OBJECTIVES

This Session is designed to:

1. Define ambiguity in the context of context-free languages.
2. Identify and analyze ambiguous grammars and sentences.
3. Distinguish between intrinsic and extrinsic ambiguity and demonstrate an understanding of their causes and consequences.

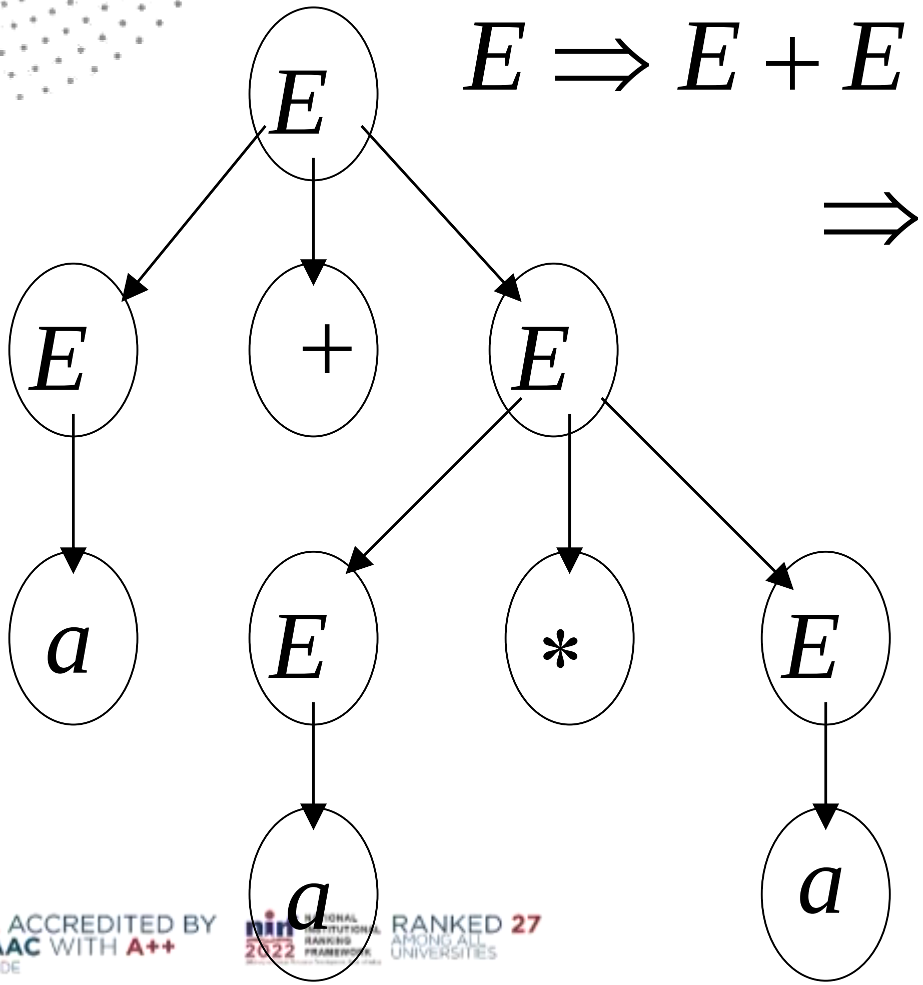
LEARNING OUTCOMES

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

1. Explain the concept of ambiguity in context-free languages and understand its significance.
2. Classify and differentiate between intrinsic and extrinsic ambiguity.
3. Apply techniques to resolve or reduce ambiguity in context-free grammars.

$$E \to E + E \;\mid\; E * E \mid (E) \mid a$$

$$a + a * a$$



$$E \Rightarrow E + E \Rightarrow a + E \Rightarrow a + E * E$$
$$\Rightarrow a + a * E \Rightarrow a + a * a$$

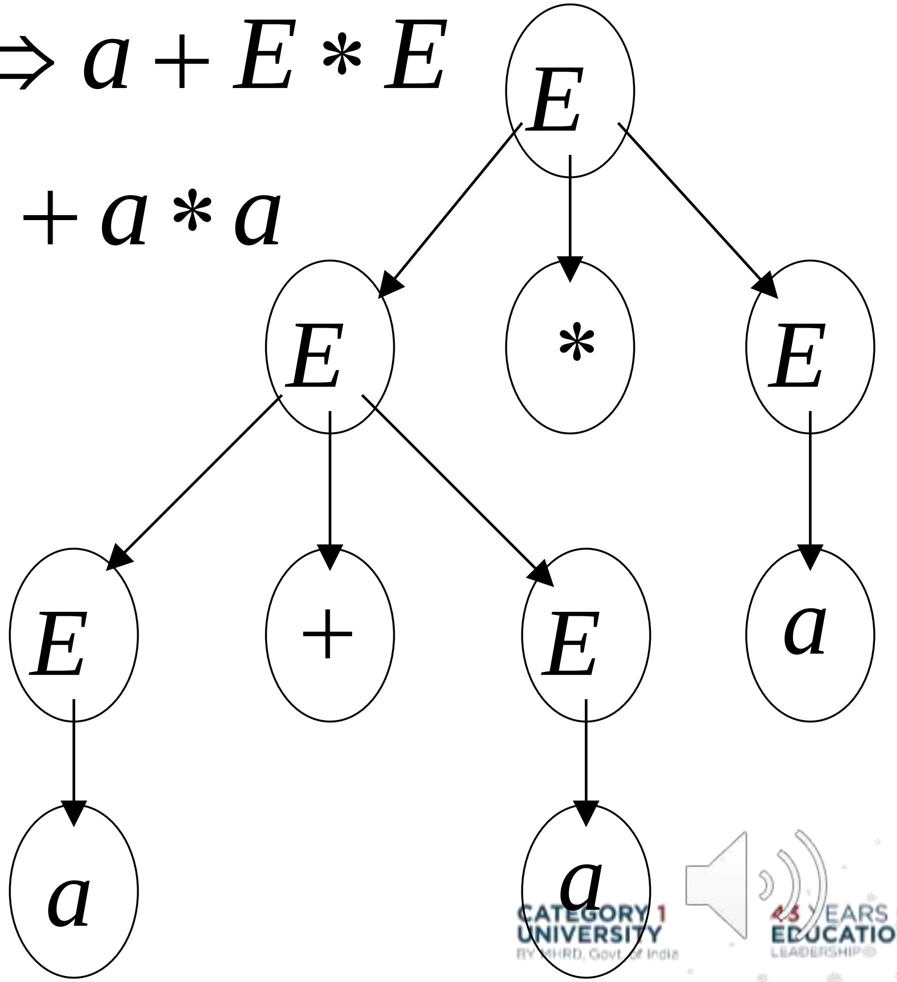
leftmost derivation

$$E \rightarrow E+E \;\mid E*E \mid (E) \mid a$$

$$a+a*a$$

$$E \Rightarrow E*E \Rightarrow E+E*E \Rightarrow a+E*E$$
$$\Rightarrow a+a*E \Rightarrow a+a*a$$

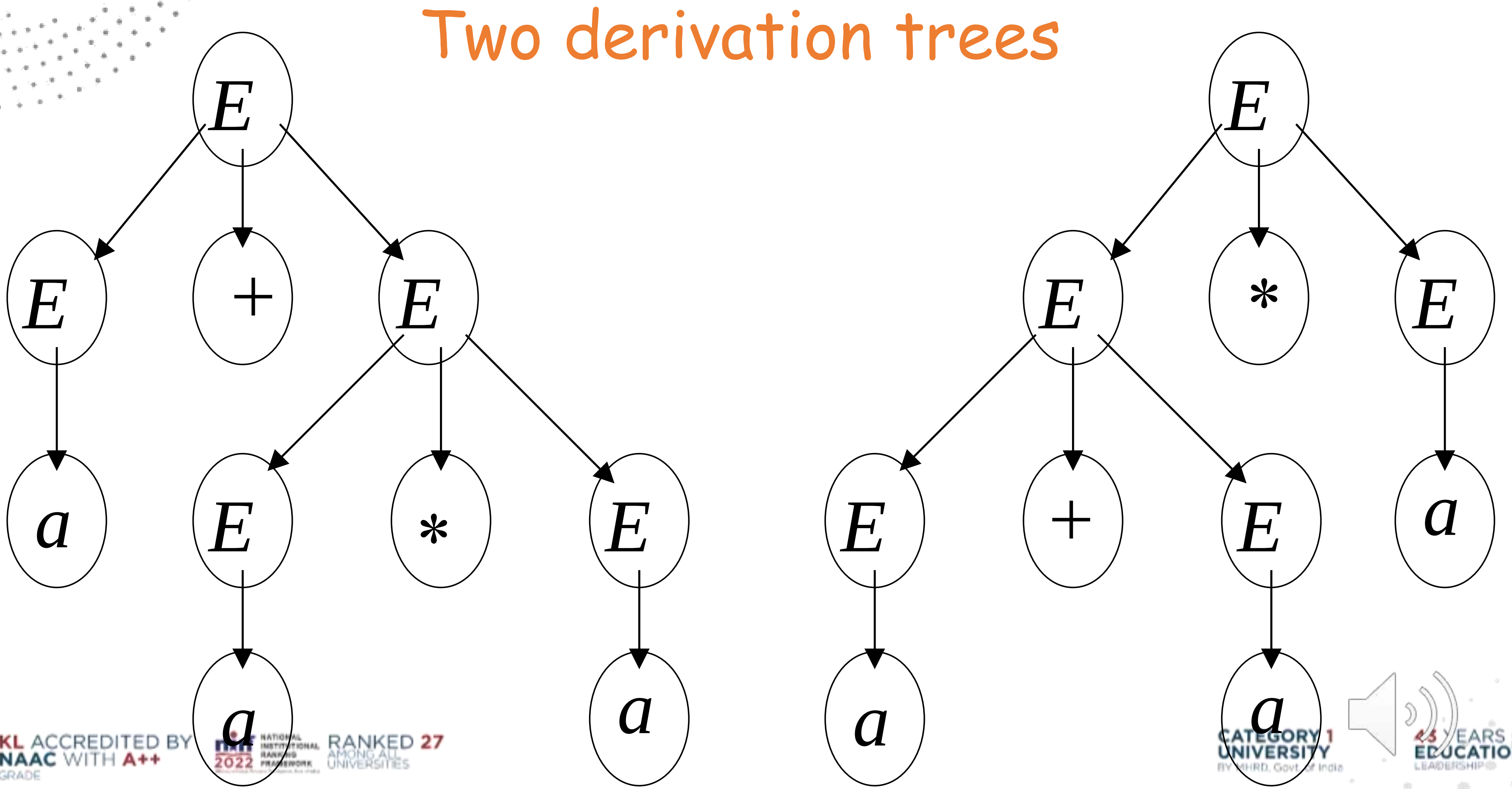
leftmost derivation



$$E \rightarrow E + E \ \mid E * E \mid (E) \mid a$$

$$a + a * a$$

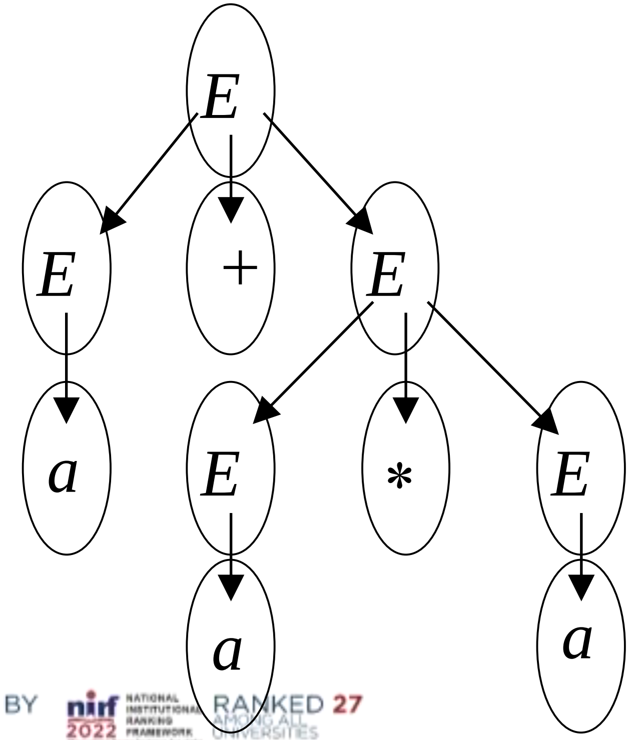
Two derivation trees

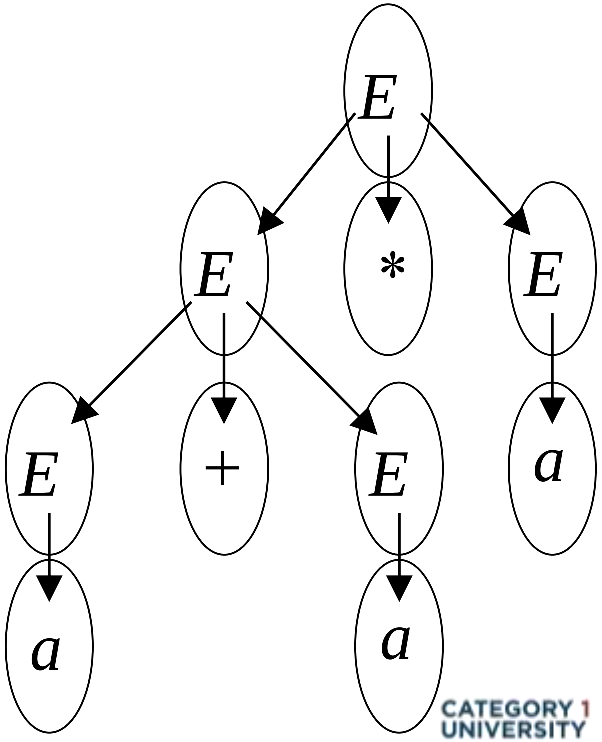


The grammar $E \to E + E \;\; | \; E * E \; | \; (E) \; | \; a$

is **ambiguous:**

string $a + a * a$ has two derivation trees





The grammar $E \to E+E \;|\; E*E \;|\; (E) \;|\; a$

is ambiguous:

string $a+a*a$ has two leftmost derivations

$$E \Rightarrow E+E \Rightarrow a+E \Rightarrow a+E*E$$

$$\Rightarrow a+a*E \Rightarrow a+a*a$$

$$E \Rightarrow E*E \Rightarrow E+E*E \Rightarrow a+E*E$$

$$\Rightarrow a+a*E \Rightarrow a+a*a$$

Definition:

A context-free grammar G is **ambiguous**

if some string $w \in L(G)$ has:

two or more derivation trees

In other words:

A context-free grammar G is **ambiguous**

if some string $w \in L(G)$ has:

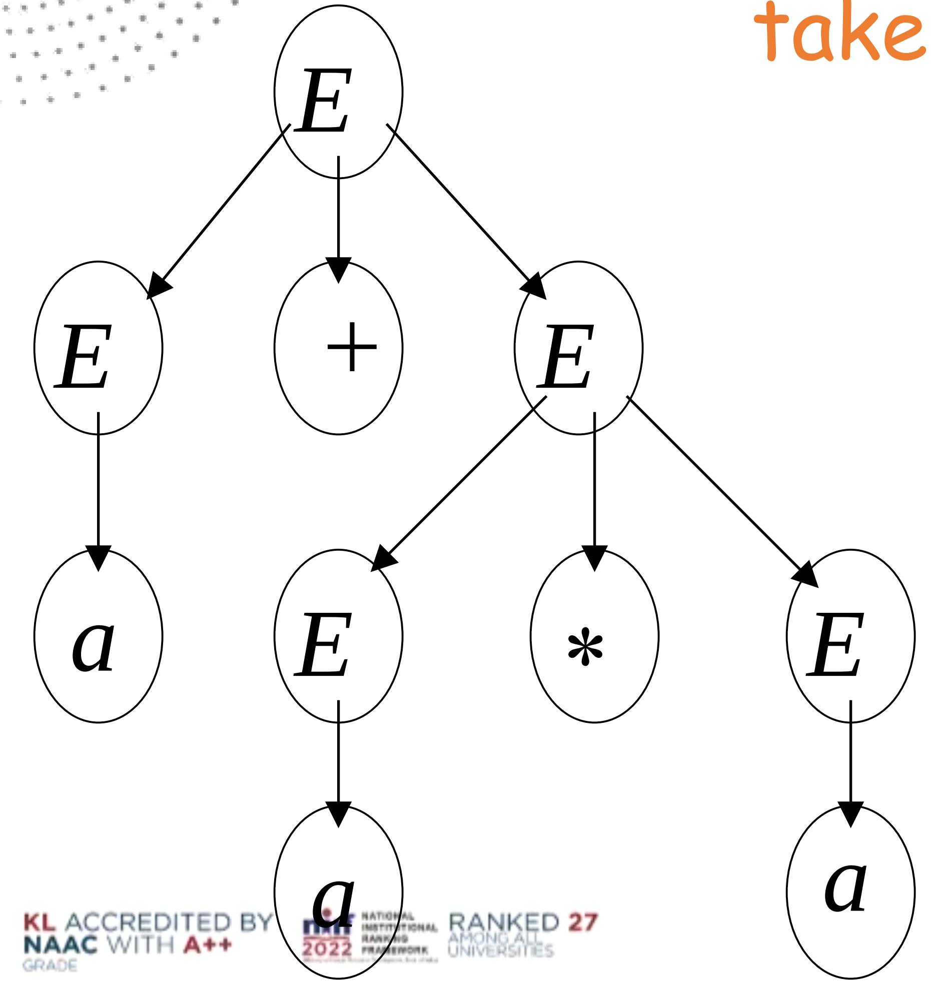
two or more leftmost derivations

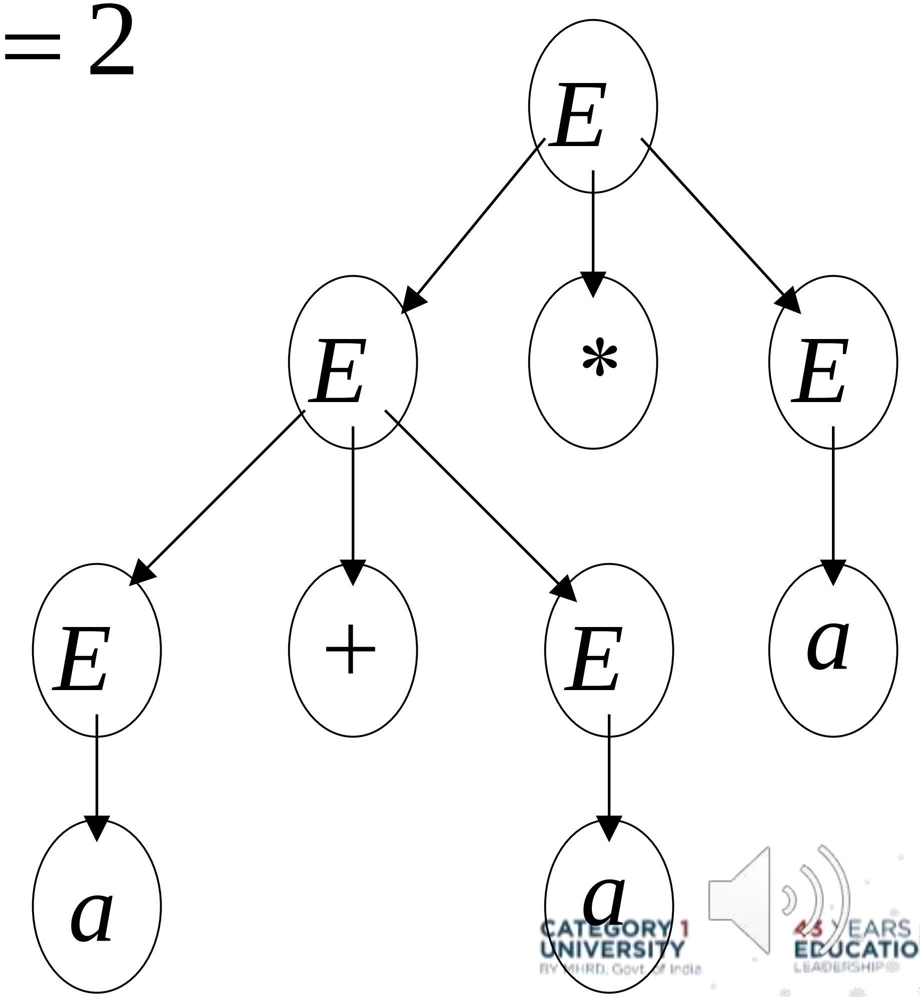
(or rightmost)

Why do we care about ambiguity?

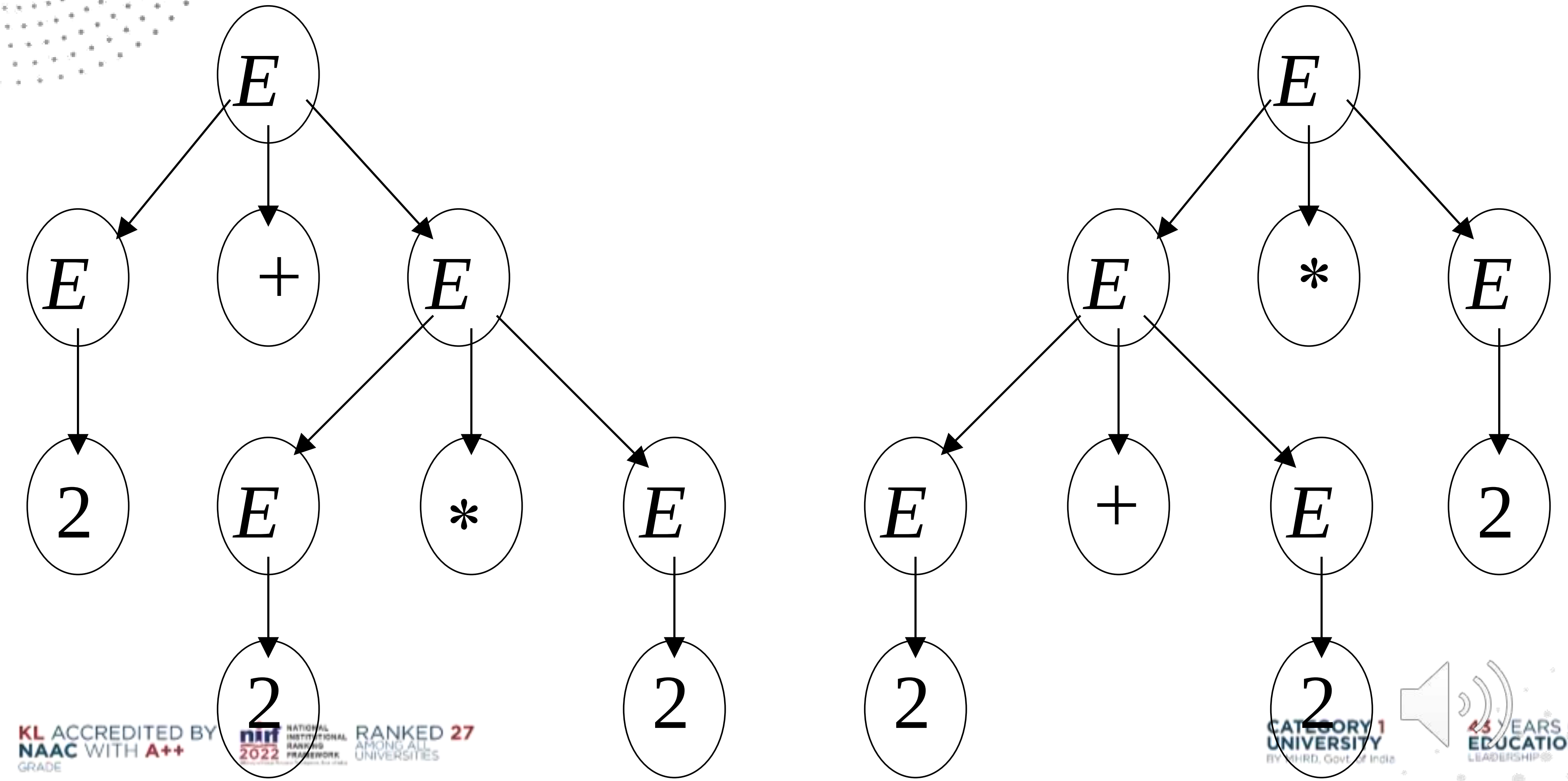
$$a + a * a$$

take $a = 2$



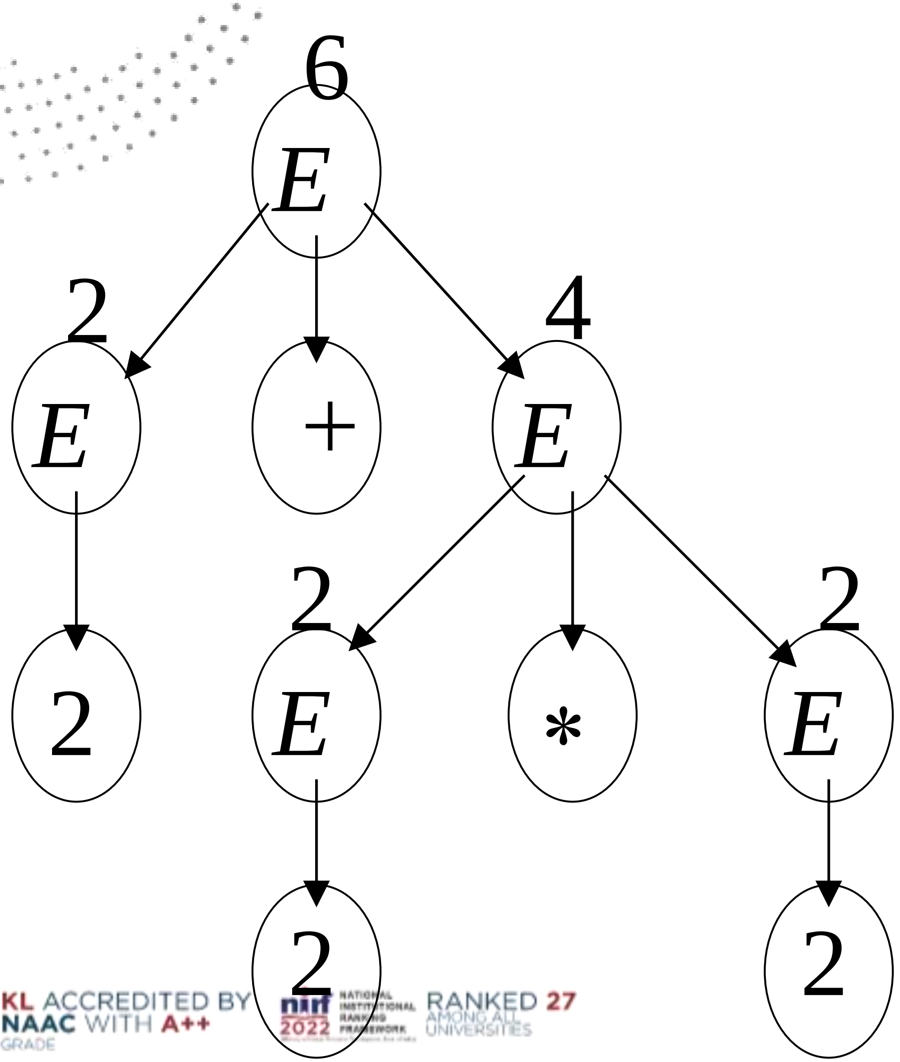


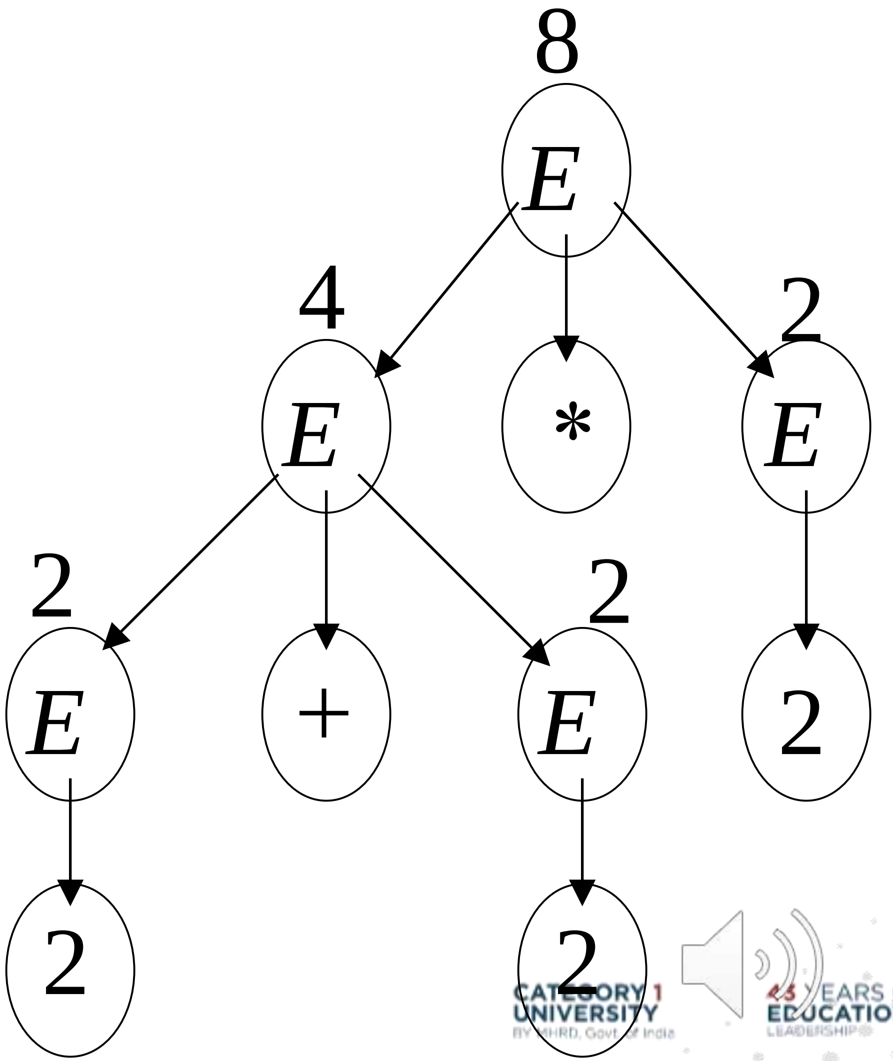
$$2+2*2$$



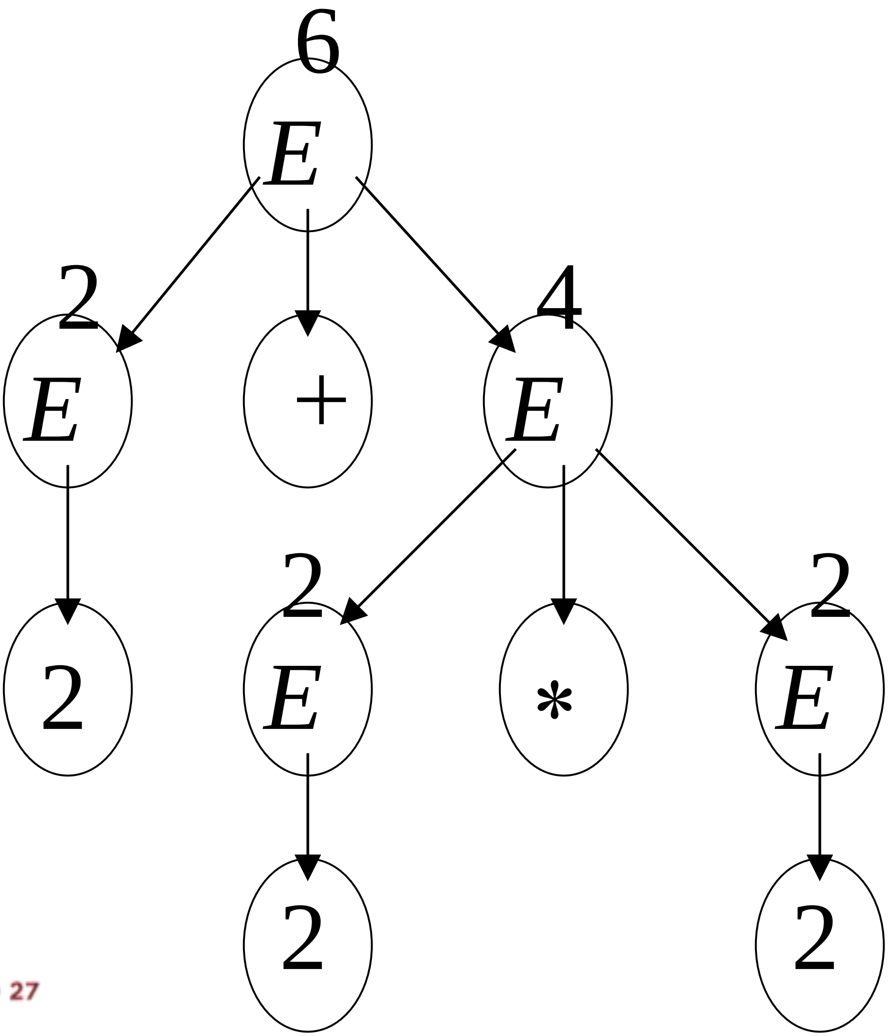
$2 + 2 * 2 = 6$

$2 + 2 * 2 = 8$





Correct result: $2+2*2=6$



- Ambiguity is **bad** for programming languages

- We want to remove ambiguity

We fix the ambiguous grammar:

$$E \rightarrow E + E \ \mid E * E \mid (E) \mid a$$

New non-ambiguous grammar:

$$E \rightarrow E + T$$

$$E \rightarrow T$$

$$T \rightarrow T * F$$

$$T \rightarrow F$$

$$F \rightarrow (E)$$

$$F \rightarrow a$$

$$E \Rightarrow E+T \Rightarrow T+T \Rightarrow F+T \Rightarrow a+T \Rightarrow a+T*F$$

$$\Rightarrow a+F*F \Rightarrow a+a*F \Rightarrow a+a*a$$

$$E \to E+T$$

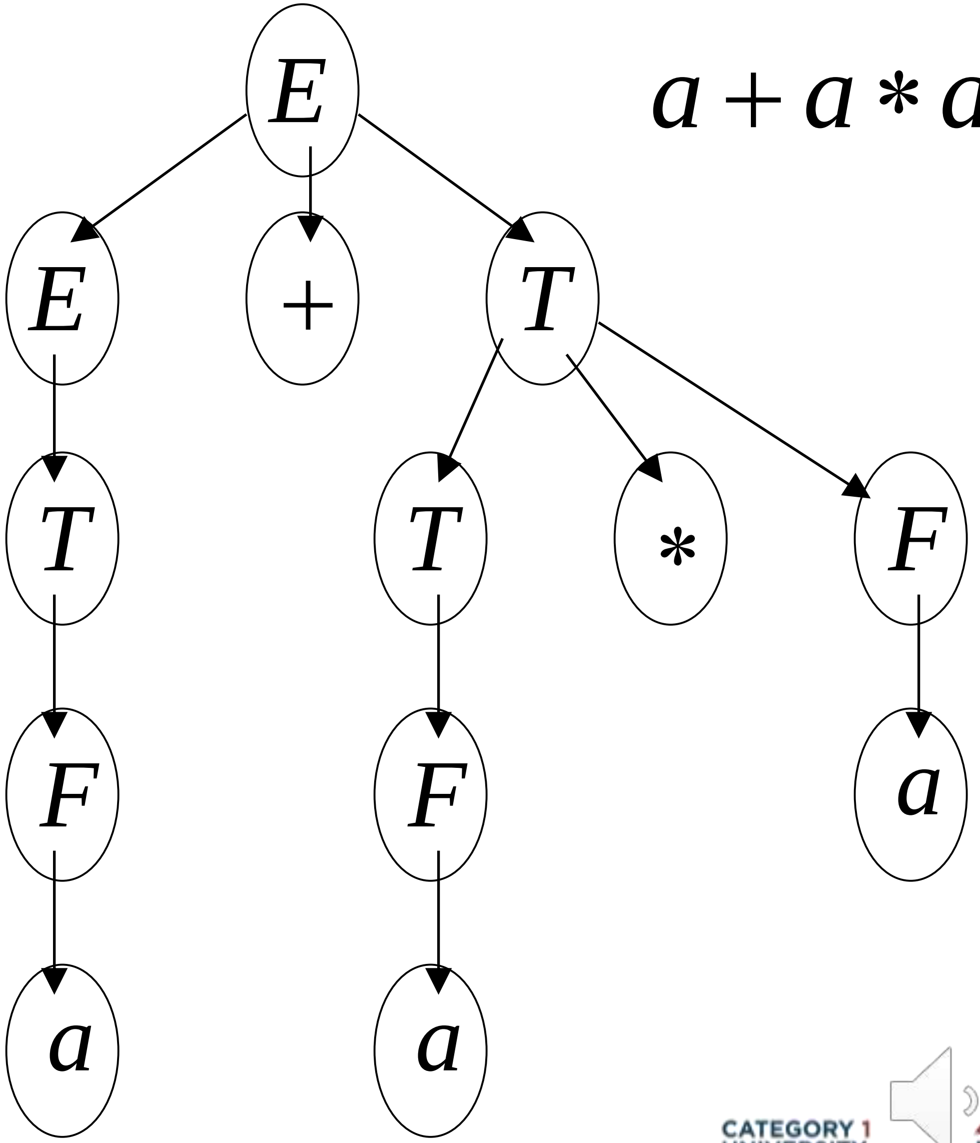
$$E \to T$$

$$T \to T*F$$

$$T \to F$$

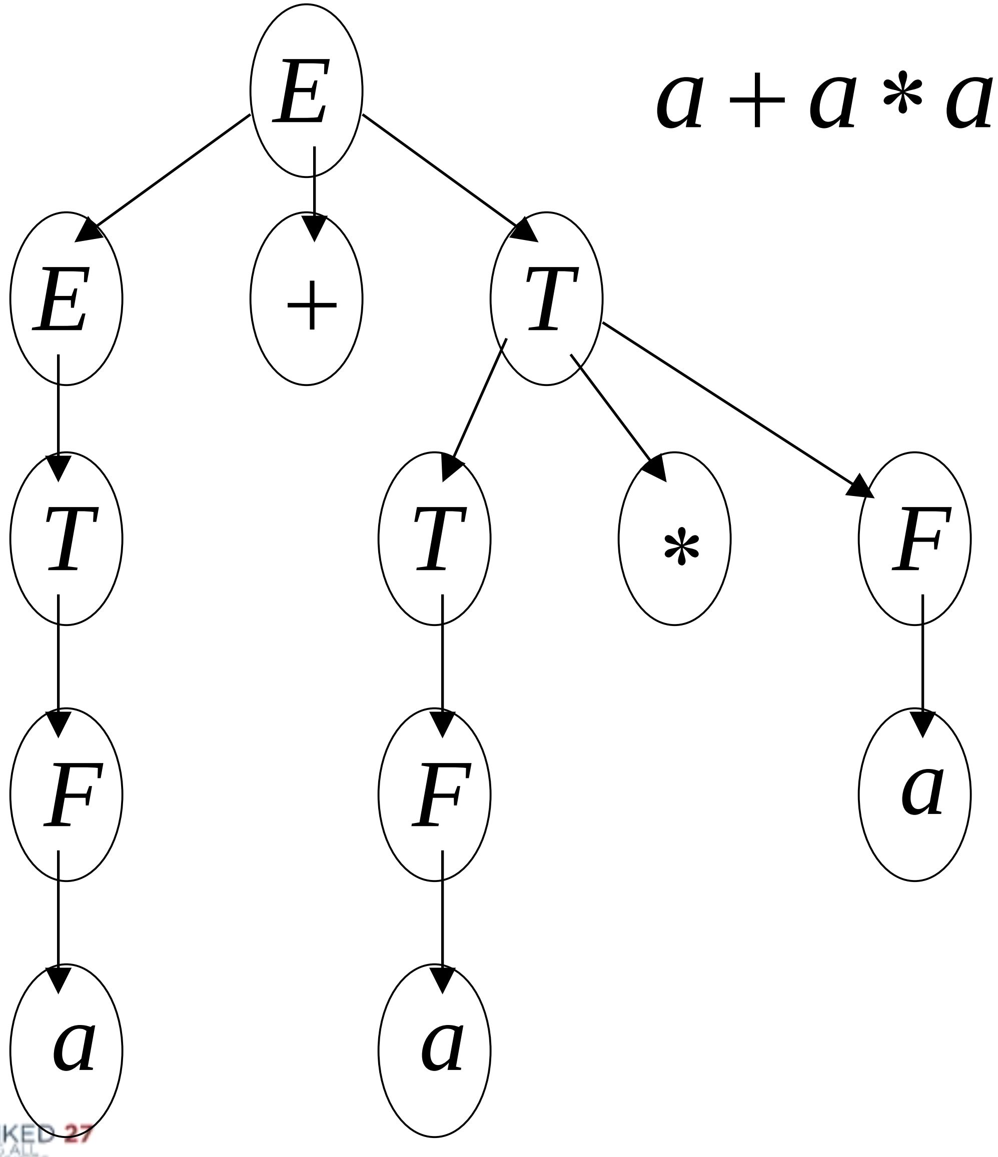
$$F \to (E)$$

$$F \to a$$



$$a+a*a$$

Unique derivation tree



$a + a * a$

The grammar G:

$$E \to E + T$$

$$E \to T$$

$$T \to T * F$$

$$T \to F$$

$$F \to (E)$$

$$F \to a$$

is non-ambiguous:

Every string $w \in L(G)$ has a unique derivation tree

MCQ

Question 1:

What does it mean for a grammar to be ambiguous?

A) The grammar has multiple production rules.

B) The grammar generates an infinite number of strings.

C) The grammar can generate multiple parse trees for a single string.

D) The grammar cannot generate any strings.

Answer:

C) The grammar can generate multiple parse trees for a single string.

Question 2:

Which of the following is a consequence of ambiguity in a context-free language?

A) The language becomes non-context-free.

B) The language becomes regular.

C) The language cannot be recognized by a finite automaton.

D) The language becomes empty.

Answer: A) The language becomes non-context-free.

MCQ

Question 3:

What is the impact of ambiguity on parsing algorithms?

A) Ambiguous grammars cannot be parsed.

B) Ambiguous grammars require exponential time to parse.

C) Ambiguous grammars can be parsed with any parsing algorithm.

D) Ambiguous grammars may lead to multiple valid parse trees.

Answer:

D) Ambiguous grammars may lead to multiple valid parse trees.

Question 4:

How can ambiguity in a context-free language be resolved?

A) By adding more production rules to the grammar.

B) By removing non-terminals from the grammar.

C) By using a different parsing algorithm.

D) By rewriting the ambiguous rules to make them unambiguous.

Answer:

D) By rewriting the ambiguous rules to make them unambiguous.

Terminal

Question 1: What does it mean for a CFG to be ambiguous?

Question 2: What is the impact of ambiguity in a CFG on language understanding?

Question 3: How can ambiguity in a CFG be resolved?

THANK YOU

(DEEMED TO BE UNIVERSITY)

Team – ATFL