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COMPLETE COMPILER DESIGN IN 1 VIDEO

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21ST MAY, 2022

By, Rashmi Ma'am

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What is a compiler?

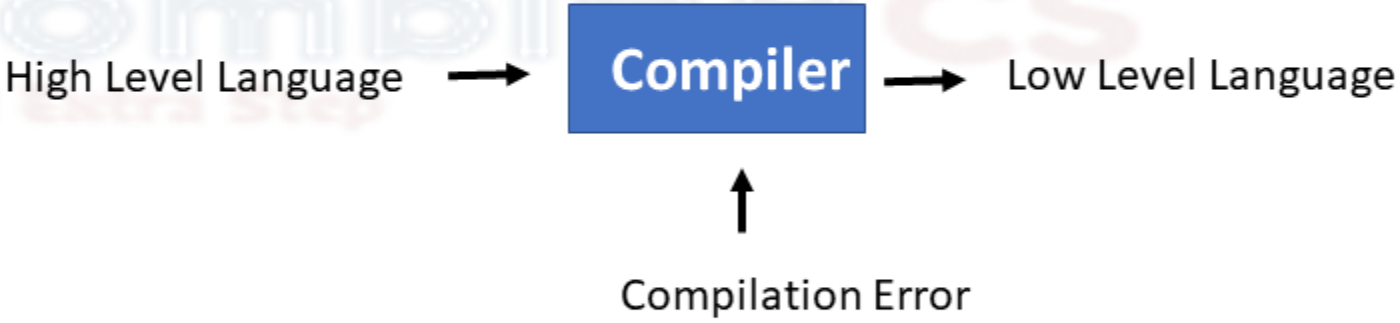
A compiler is a program that reads a program written in one language and translates it into an equivalent program in another language.

A compiler also reports errors present in the source program as a part of its translation process.

Types of the compiler.

1.Single-pass compiler

2.Multi-pass compiler



Difference between single-pass and multi-pass compiler.

	Single-pass compiler	Multi-pass compiler
Speed	fast	slow
Time	less	more
portability	No	YES
Efficient	More	Less
Memory	More	Less

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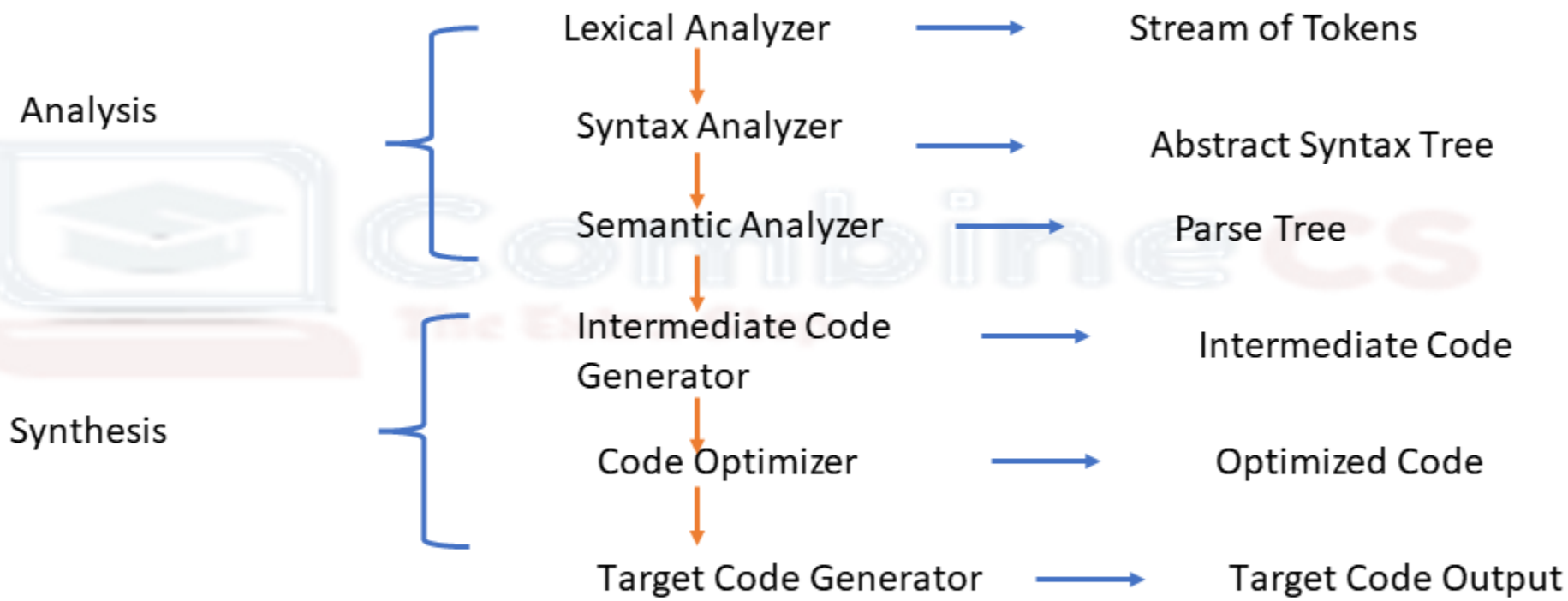
Phases of Compiler Design



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Phases of a Compiler

Lexical Analysis: It reads the input program character by character and produces a string of tokens.
It removes comments, white spaces, blanks, newline characters, tab.

Parser/Syntax Analysis: It takes a string of token as an input and generate a parse tree and verifies it that string of token is a valid sequence.

Semantic Analysis: It verifies the parse tree, whether it's meaning full or not. If not then generate a new parse tree.

Intermediate code generator: it generates intermediate code, which can be readily executed by a machine.

Code optimizer: It optimized the code so that it consumes fewer resources and increases the speed.

Target code generator: It generates a code that the machine can understand. Output is dependent on the type of assembler.

Parts of the compilation process

Analysis: It takes the input source program and creates an intermediate representation of the source program.

Synthesis: It takes the intermediate representation as input and creates the desired target program.

Run-Time Error : A run-time error is an error which takes place during the execution of a program, and usually happens because of adverse system parameters or invalid input data.

Compile Time Error handling in a compiler.

1.lexical: includes misspellings of identifiers, keywords, and operators.
2.syntactical: a missing semicolon or unbalanced parenthesis.
3.semantical: incompatible value assignment or type mismatches between operator and operand.
4.logical: code not reachable or infinite loop.

What are patterns, tokens, and lexemes?

A **token** is a sequence of characters like identifiers, keywords, operators, etc.
A **pattern** describes a rule that must be matched by the sequence of characters to form a token.
lexeme is a sequence of characters in the source program that is matched by the pattern for a token.

What is a symbol table?

The symbol table is a data structure that stores various identifiers and their attributes.

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	List - I		List - II
(a)	A part of a compiler that is responsible for recognizing syntax.	(i)	Optimizer
(b)	A part of a compiler that takes as input a stream of characters and produces as output a stream of words along with their associated syntactic categories.	(ii)	Semantic Analysis
(c)	A part of a compiler that understand the meanings of variable names and other symbols and checks that they are used in ways consistent with their definitions.	(iii)	Parser
(d)	An IR-to-IR transformer that tries to improve the IR program in some way (Intermediate Representation).	(iv)	Scanner

Code :

	(a)	(b)	(c)	(d)
(1)	(iii)	(iv)	(ii)	(i)
(2)	(iv)	(iii)	(ii)	(i)
(3)	(ii)	(iv)	(i)	(iii)

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Q) Consider the following statements: (GATE 2018)

(I) The output of a lexical analyzer is groups of characters.
(II) Total number of tokens in printf("i=%d, &i=%x", i, &i); are 11.
(III) Symbol table can be implementation by using array and hash table but not tree.

Which of the following statement(s) is/are correct?

a) Only 1
b) Only 2 & 3
c) All
d) None

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What is left recursion?

If a non-terminal(A) finds non-terminal(A) itself then it is called left recursive.

A- > Aa

top-down parsing technique can not handle left recursive grammar so we convert left recursive to right recursive.

A -> Aa | a

=> A -> aA'

A'-> aA' | a

What is left factoring?

left factoring is used when a non-terminal finds the same terminal symbol as a prefix in more than one production rule.

A -> ab | ac

A -> aA'

A' -> A -> b|c

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Grammar (Generator)

↓

Language

↓

Automata (M/c) (Acceptor)

start symbol $S \rightarrow id$ } $\rightarrow E$ – expression

identifier

$E \rightarrow E + T \mid T$ → Term

$T \rightarrow T * F \mid F$ – factor

$F \rightarrow id$

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Ambiguous Grammar

A grammar is said to be ambiguous if there exists more than

1. **one leftmost derivation or**
2. **more than one rightmost derivation or**
3. **more than one parse tree (derivation tree. Or syntax tree) for the given input string.**

If the grammar is not ambiguous, then it is called unambiguous.

Exam: Try to make tree & check for reconfirmation.

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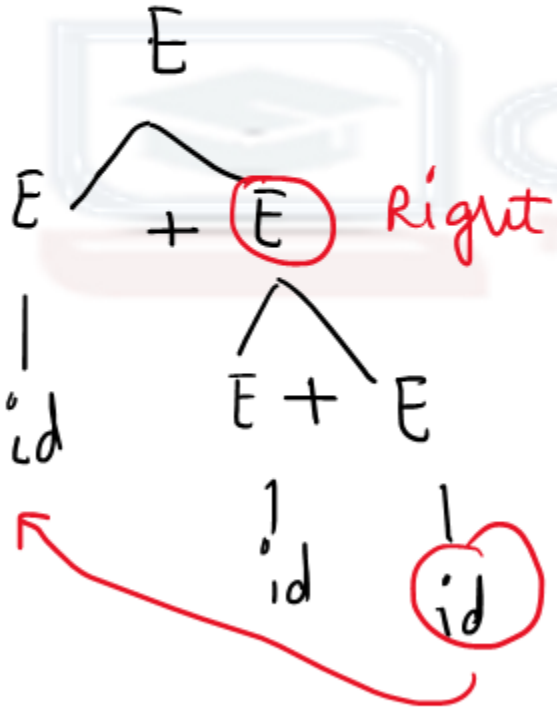
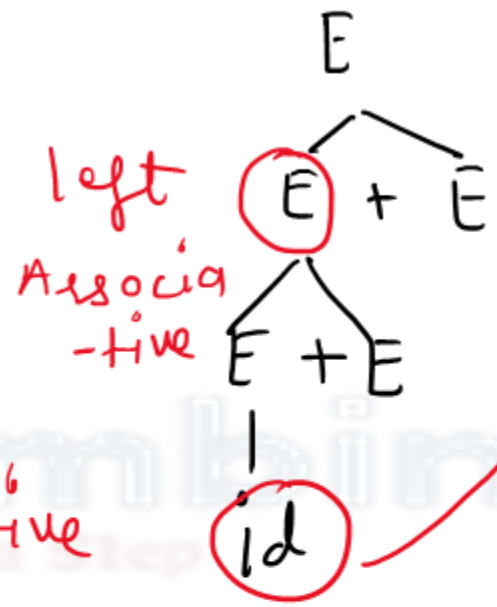
① Associativity Rule

$E \rightarrow E+E \mid E+E \mid id$



Right Associative



left Associa-tive

Note: Symbol is same in production & in '+' symbol associativity does not matter.

Hence, left Associative is Preferred.

Q) which is correct derivation tree?

$\boxed{\text{Left Associative}}$

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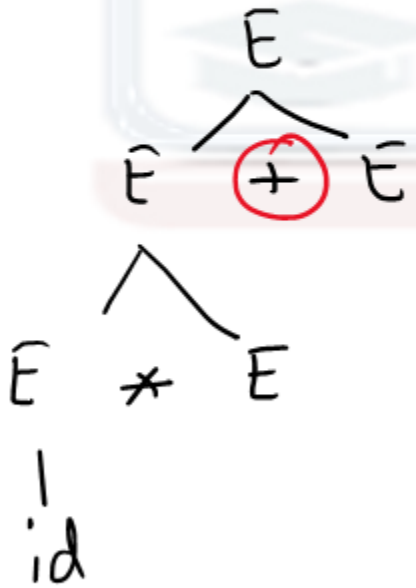
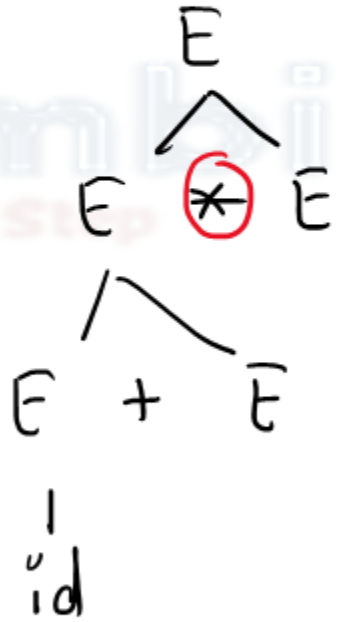
$E \rightarrow E + E \mid E * E \mid id$

+, * high precedence is '*'





(1) Both are left or Right associative?

(2) which is correct derivation tree?

(3) Hint: operator which is far possess high precedence

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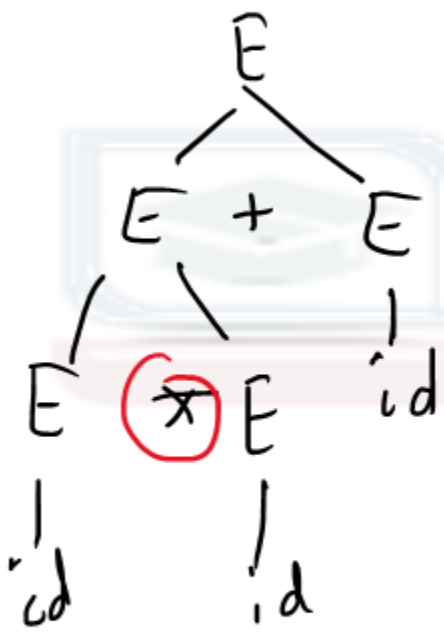
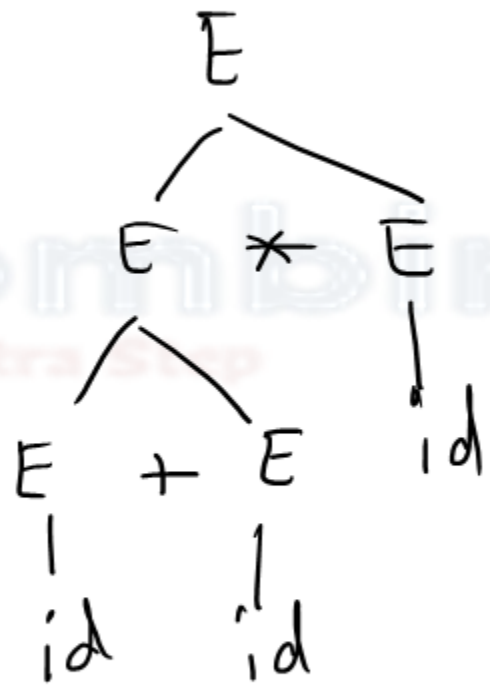
$E \rightarrow E+E \mid E*E \mid id$





Why?

'*' symbol has high precedence than '+' and in the parse tree it is far from Start Symbol.

✓ correct derivation tree

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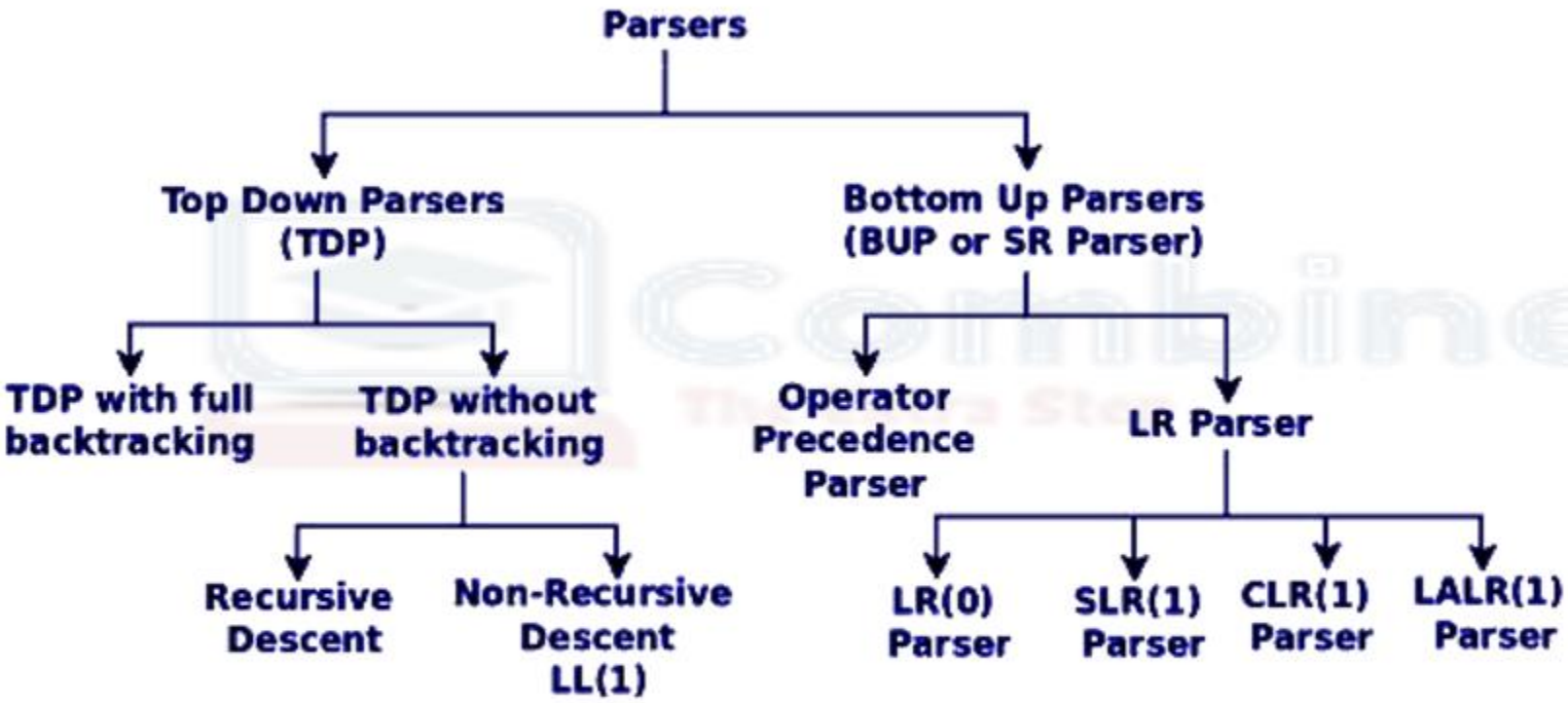

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Types of Parsing

1.Universal parser: It can parse any kind of grammar but not very efficient.
2.Top-down: Build the parse tree from the root to the leaves.
3.Bottom-up: Builds the parse tree by starting at the leaves and ending at root.

FIRST(A) is a set of the terminal symbols which occur as first symbols in string derived from A
FOLLOW(A) is the set of terminals which occur immediately after the nonterminal A in the strings derived from the starting symbol.

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LL(1) Parser : LL(1) grammar is unambiguous, left factored and non left recursive.

To check whether a grammar is LL(1) or not :

1. If A -> B1 | C2 ⇒ { FIRST(B1) ∩ FIRST(C2) = ϕ }
2. If A -> B | ∈ ⇒ { FIRST(B) ∩ FOLLOW(A) = ϕ }

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LL(1) Parser: LL(1) grammar is unambiguous, left factored, and non-left recursive. It is a top-down parser.

LR(0) Parser: It creates canonical form of LR(0) items.

SLR: It is more powerful than LR(0). Every LR(0) is SLR but every SLR is not LR(0).

CLR: CLR stands for canonical lookahead. CLR parsing uses the canonical collection of LR(1) items.

LALR: LALR stands for canonical lookahead LR. LALR parsing uses the canonical collection of LR(1) items.

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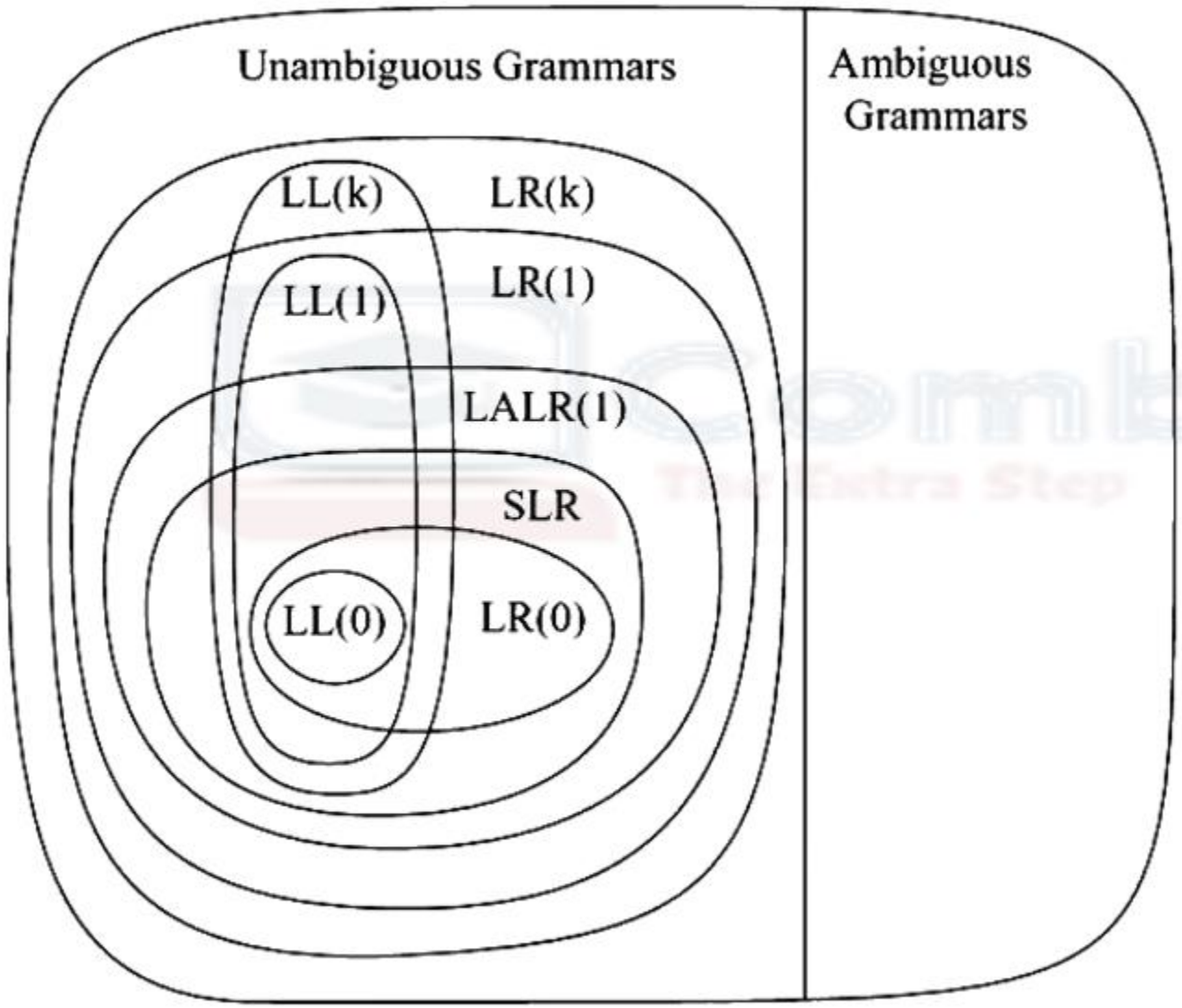

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Q) Consider the following two statements:

P: Every regular grammar is LL(1)
Q: Every regular set has LR(1) grammar

Which of the following is TRUE?

a) Both P and Q are true
b) P is true and Q is false
c) P is false and Q is true
d) Both P and Q are false

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LL(1) parsers can recognize the regular grammars also LL(1) is subset of LR(1) or CLR grammar so it also recognizes regular sets. So both accept regular grammar.

Q) Which of the following cannot be used as an intermediate code form? (NET 2020)

(A)Quadruples
(B)Syntax trees
(C)Three address codes
(D)Post fix notation

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Q) S -> (S)| a

Let the number of states in SLR(1), LR(1) and LALR(1) parsers for the grammar n1 n2 and n3 respectively.

a) n1 < n2 < n3

b) n1 = n3 < n2

c) n1 = n2 = n3

d) n1 $ n3 $ n2

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b) LALR powerful than Canonical LR parser
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(A)Reduction in strength
(B)Loop-invariant computation
(C)Code motion
(D)None of these

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