



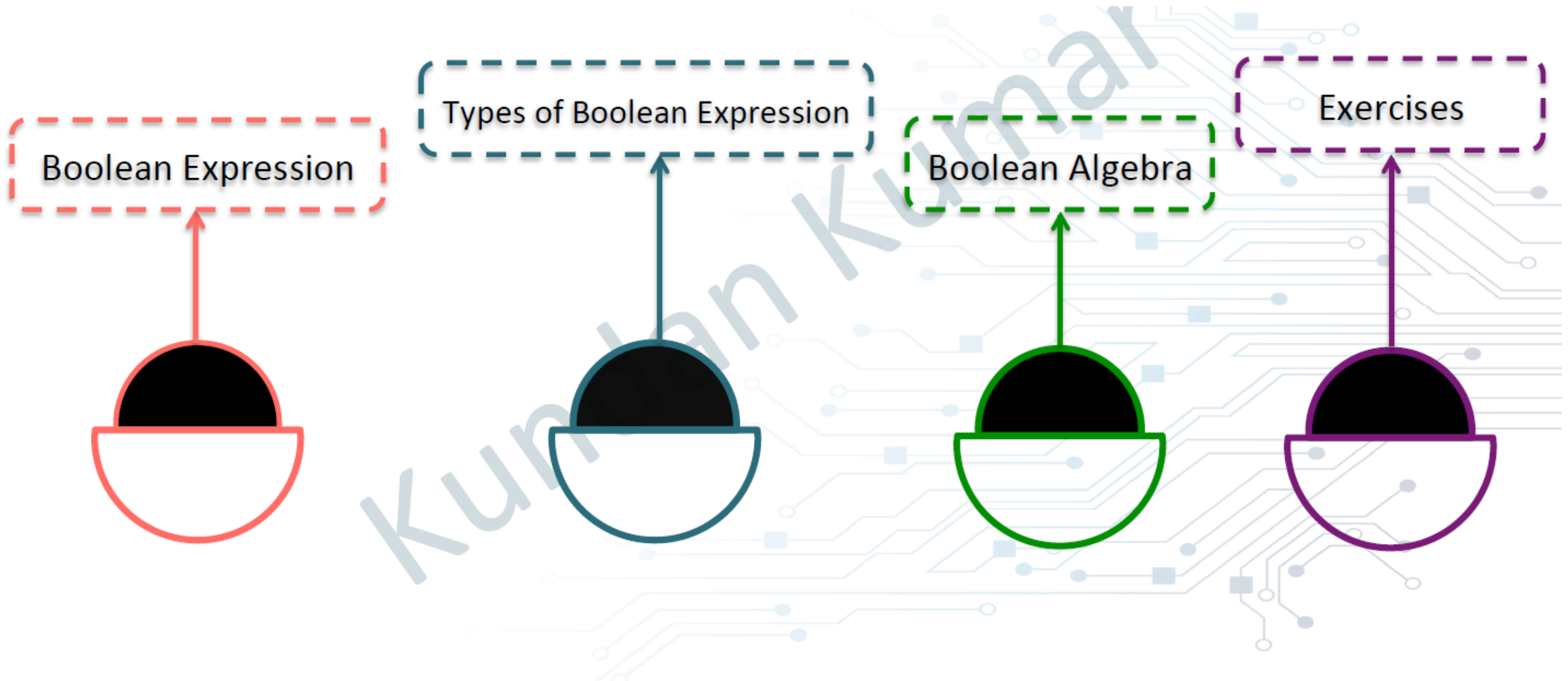
Dr. Kundan Kumar


Boolean Algebra

| A | A' | (A')'=A |
|---|----|---------|
| 0 | 1 | 0 |
| 1 | 0 | 1 |

Session Agenda

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What is Boolean Expression?

What is Boolean Expression?

A Boolean expression is composed of a combination of the Boolean constants true or false, Boolean-typed variables, Boolean-valued operators, and Boolean-valued functions

Example 1:
 $(A + B) . C$

Example 2:
 $A . (B + 1)$

A Boolean expression produces a Boolean value as an output when evaluated.

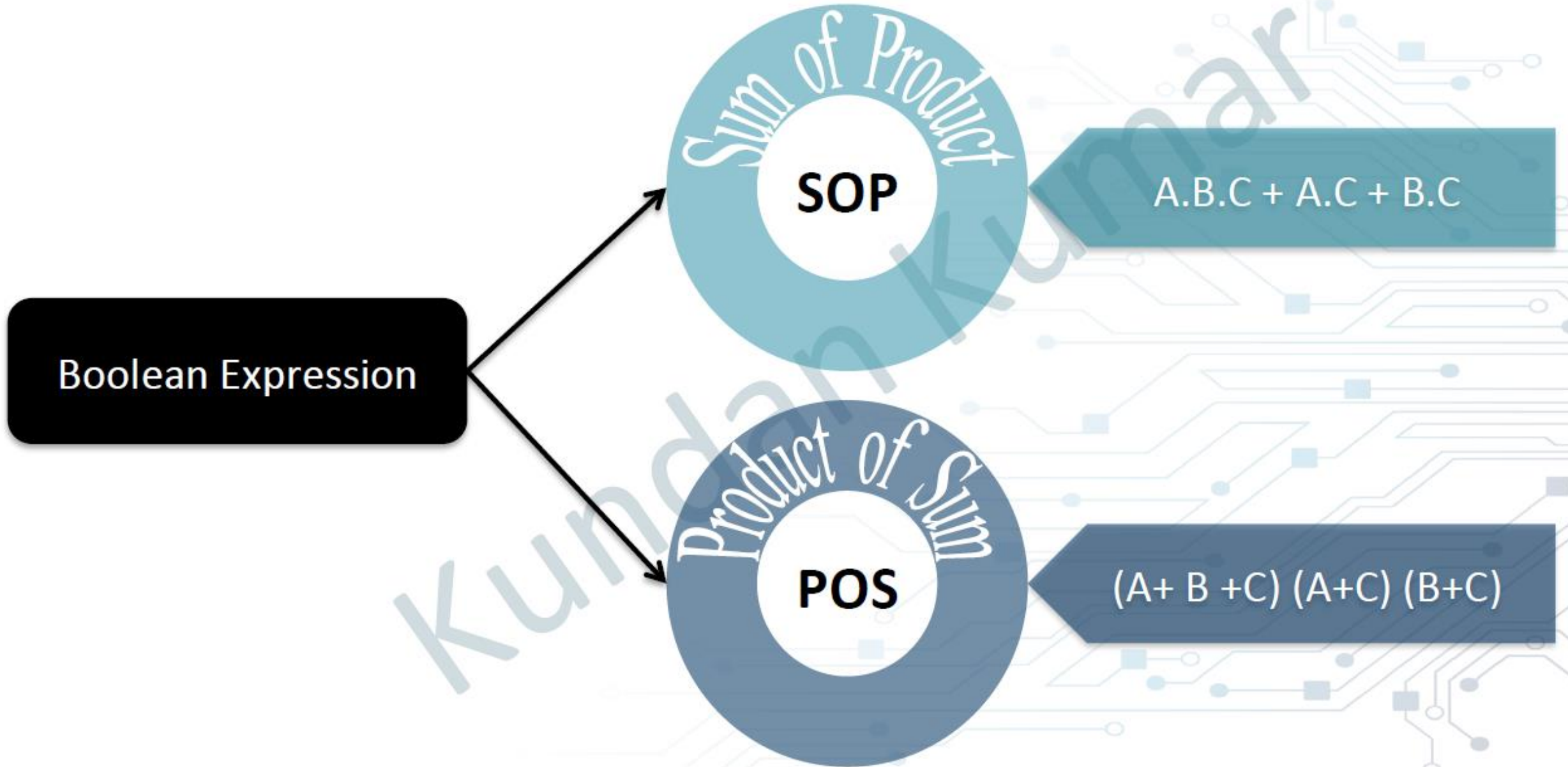
A Boolean value is either true or false



Types of Boolean Expression

Types of Boolean Expression

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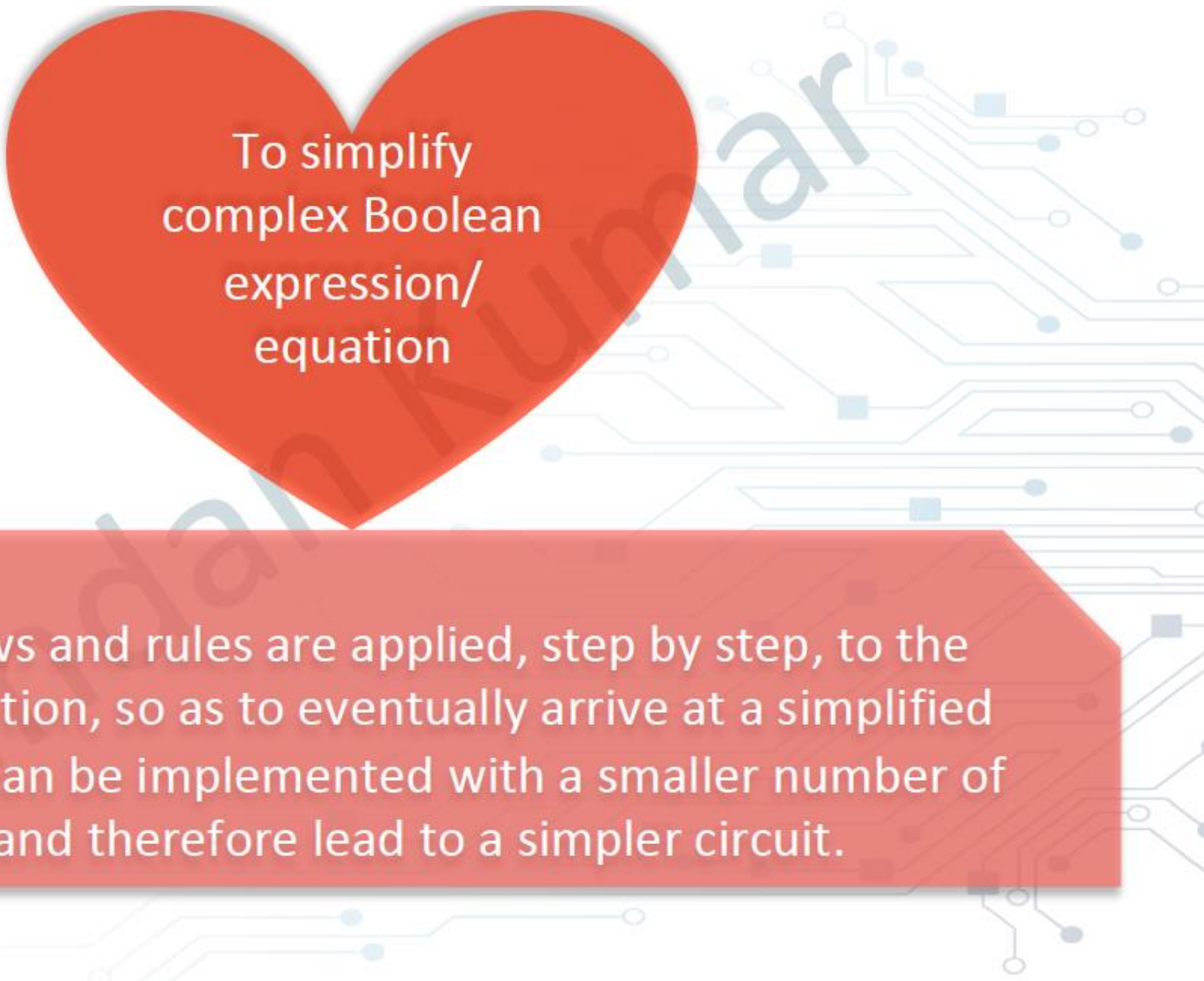


An abstract background pattern of light blue lines and dots on a dark blue field, resembling a circuit board or data flow. The lines are of varying lengths and directions, some ending in small circles or squares. The overall effect is a sense of digital connectivity and complexity.

Why Boolean Algebra?

Why Boolean Algebra?

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To simplify
complex Boolean
expression/
equation

Selected laws and rules are applied, step by step, to the original equation, so as to eventually arrive at a simplified version that can be implemented with a smaller number of gates and therefore lead to a simpler circuit.

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What is Boolean Algebra?

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Boolean Algebra is *used to analyze and simplify the digital (logic) circuits*.

It uses only the binary numbers i.e. 0 and 1.

Boolean algebra was *invented by George Boole* in 1854.

Rule in Boolean Algebra

Complement of a variable is represented by an overbar (-). Thus, complement of variable X is represented as X Bar. Thus if $X = 0$ then $X \text{ Bar} = 1$ and $X = 1$ then $X \text{ Bar} = 0$.

ORing of the variables is represented by a plus (+) sign between them. For example ORing of A, B, C is represented as $A + B + C$.

Logical ANDing of the two or more variable is represented by writing a dot between them such as A.B.C. Sometime the dot may be omitted like ABC.

The background is a solid dark blue. Overlaid on this are faint, light blue circuit-like patterns consisting of lines, dots, and squares, resembling a printed circuit board. In the top right corner, there is a light blue bookmark icon.

Boolean Algebra Laws

Boolean Algebra laws

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$$1) A + 1 = 1$$

| OR | | |
|----|---|---|
| A | | X |
| 0 | 1 | 1 |
| 1 | 1 | 1 |

$$2) A + 0 = A$$

| OR | | |
|----|---|---|
| A | | X |
| 0 | 0 | 0 |
| 1 | 0 | 1 |

$$3) A \cdot 1 = A$$

| AND | | |
|-----|---|---|
| A | | X |
| 0 | 1 | 0 |
| 1 | 1 | 1 |

$$4) A \cdot 0 = 0$$

| AND | | |
|-----|---|---|
| A | | X |
| 0 | 0 | 0 |
| 1 | 0 | 0 |

Cont...

$$5) A + A = A$$

OR

| A | A | X |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 1 | 1 |

$$6) A \cdot A = A$$

AND

| A | A | X |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 1 | 1 |

$$7) A + \overline{A} = 1$$

OR

| A | A' | X |
|---|----|---|
| 0 | 1 | 1 |
| 1 | 0 | 1 |

$$8) A \cdot \overline{A} = 0$$

AND

| A | A' | X |
|---|----|---|
| 0 | 1 | 0 |
| 1 | 0 | 0 |

Cont...

$$9) \overline{\overline{A}} = A$$

| A | A' | (A')'=A |
|---|----|---------|
| 0 | 1 | 0 |
| 1 | 0 | 1 |

This is known as Complement law

Cont...

Commutative Laws

The **order** of variables does not affect the result.

$$10) A + B = B + A$$

$$11) A \cdot B = B \cdot A$$

Associative Laws

Grouping (parentheses) of variables does not affect the result.

$$12) (A + B) + C = A + B + C$$

$$13) (A \cdot B) \cdot C = A \cdot (B \cdot C)$$

Distributive Laws

You can **distribute** one operation over another.

$$14) A \cdot (B + C) = A \cdot B + A \cdot C$$

$$15) A + (B \cdot C) = (A + B) \cdot (A + C)$$

| Law | Practical Use |
|--------------|---|
| Commutative | Input order doesn't matter-simplifies circuit layout. |
| Associative | Can regroup logic expressions-helpful in gate reduction. |
| Distributive | Used for factoring expressions and optimizing gate usage. |

De-Morgan's Laws

$$\overline{A \cdot B} = \overline{A} + \overline{B}$$

The complement of the product of two variables is equal to the sum of the complements of the variables

$$\overline{A + B} = \overline{A} \cdot \overline{B}$$

The complement of the sum of two variables is equal to the product of the complements of the variables.

Exercises



Exercise Solved

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#1:

$$A.(A+B+C)+A$$

$$A . (A + B + C) + A$$

$$(A.A + A.B + A.C) + A$$

$$(A + A.B + A.C) + A$$

$$A.(1 + B + C) + A$$

$$A . 1 + A$$

$$A + A$$

$$A$$

Distributive Laws

Since, $A.A=A$

Common Factor out

Since, $1+A=1$

Since, $A+A=A$

#1:

Simplified Expression

$$A.(A+B+C)+A = A$$

Class Activities Exercises

An abstract graphic of a circuit board pattern in a lighter blue shade, featuring various lines, dots, and squares, extending from the top right towards the bottom left across the dark blue background.

Thank You