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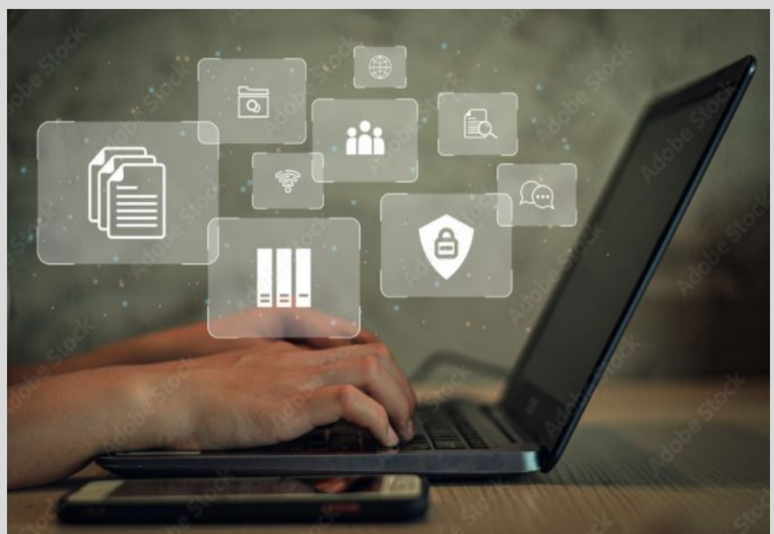
Fundamentals of Computer Science (MCAC-0017)

Topic: Boolean Algebra



INTRODUCTION

- Developed by English Mathematician George Boole in between 1815 - 1864.
- It is described as an algebra of logic or an algebra of two values i.e True or False.
- The term logic means a statement having binary decisions i.e True/Yes or False/No.

APPLICATION OF BOOLEAN ALGEBRA

- It is used to perform the logical operations in digital computer.
- In digital computer True represent by ‘1’ (high volt) and False represent by ‘0’ (low volt)
- Logical operations are performed by logical operators. The fundamental logical operators are:
  1. AND (conjunction)
  2. OR (disjunction)
  3. NOT (negation/complement)

AND operator

It performs logical multiplication and denoted by (.) dot.

X	Y	X.Y
0	0	0
0	1	0
1	0	0
1	1	1

OR operator

It performs logical addition and denoted by (+) plus.

X	Y	X+Y
0	0	0
0	1	1
1	0	1
1	1	1

NOT operator

It performs logical negation and denoted by (-) bar. It operates on single variable.

X	X	(means complement of x)
0	1	
1	0	

Truth Table

- **Truth table is a table that contains all possible values of logical variables/statements in a Boolean expression.**

No. of possible combination =

2^n, where n=number of variables used in a Boolean expression.

Truth Table

The truth table for XY + Z is as follows:

Dec	X	Y	Z	XY	XY+Z
0	0	0	0	0	0
1	0	0	1	0	1
2	0	1	0	0	0
3	0	1	1	0	1
4	1	0	0	0	0
5	1	0	1	0	1
6	1	1	0	1	1
7	1	1	1	1	1

Tautology & Fallacy

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If the output of Boolean expression is always True or 1 is called Tautology.

If the output of Boolean expression is always False or 0 is called Fallacy.

Exercise

1. Evaluate the following Boolean expression using Truth Table.

(a) X'Y'+X'Y (b) X'YZ'+XY'

(c) XY'(Z+YZ')+Z'

2. Verify that P+(PQ)' is a Tautology.

3. Verify that (X+Y)'=X'Y'

Implementation

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Boolean Algebra applied in computers electronic circuits. These circuits perform Boolean operations and these are called logic circuits or logic gates.

Basic Theorem of Boolean Algebra

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T1 : Properties of 0

(a) $0 + A = A$

(b) $0\,A = 0$

T2 : Properties of 1

(a) $1 + A = 1$

(b) $1\,A = A$

Basic Theorem of Boolean Algebra

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T3 : Commutative Law

(a) $A + B = B + A$

(b) $A\,B = B\,A$

T4 : Associate Law

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

(b) $(A\,B)\,C = A\,(B\,C)$

T5 : Distributive Law

(a) $A\,(B + C) = A\,B + A\,C$

(b) $A + (B\,C) = (A + B)\,(A + C)$

(c) A+A’B = A+B

Basic Theorem of Boolean Algebra

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T6 : Indempotence (Identity) Law

(a) $A + A = A$

(b) $A\,A = A$

T7 : Absorption (Redundance) Law

(a) $A + A\,B = A$

(b) $A\,(A + B) = A$

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Basic Theorem of Boolean Algebra

T8 : Complementary Law

(a) X+X'=1

(b) X.X'=0

T9 : Involution

(a) x'' = x

T10 : De Morgan's Theorem

(a) (X+Y)'=X'.Y'

(b) (X.Y)'=X'+Y'

De Morgan's Theorem 1

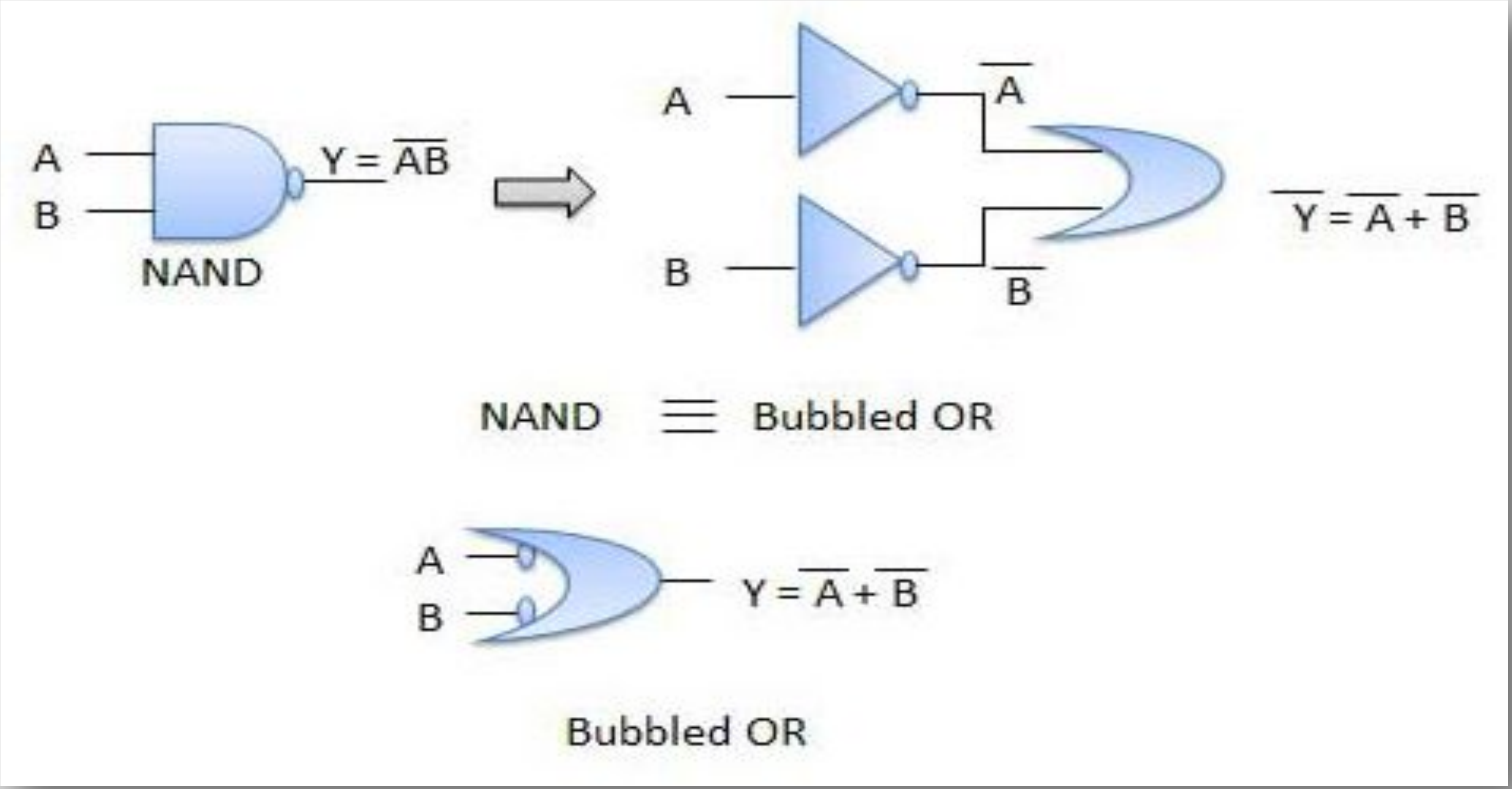
Theorem 1 $\overline{A \cdot B} = \overline{A} + \overline{B}$

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

NAND = Bubbled OR

De Morgan's Theorem 1

Theorem 1 $\overline{A \, . \, B} = \overline{A} + \overline{B}$



De Morgan's Theorem 1

Theorem 1 $\overline{A \, . \, B} = \overline{A} + \overline{B}$

A	B	$\overline{AB}$	$\overline{A}$	$\overline{B}$	$\overline{A} + \overline{B}$
0	0	1	1	1	1
0	1	1	1	0	1
1	0	1	0	1	1
1	1	0	0	0	0

De Morgan's Theorem 2

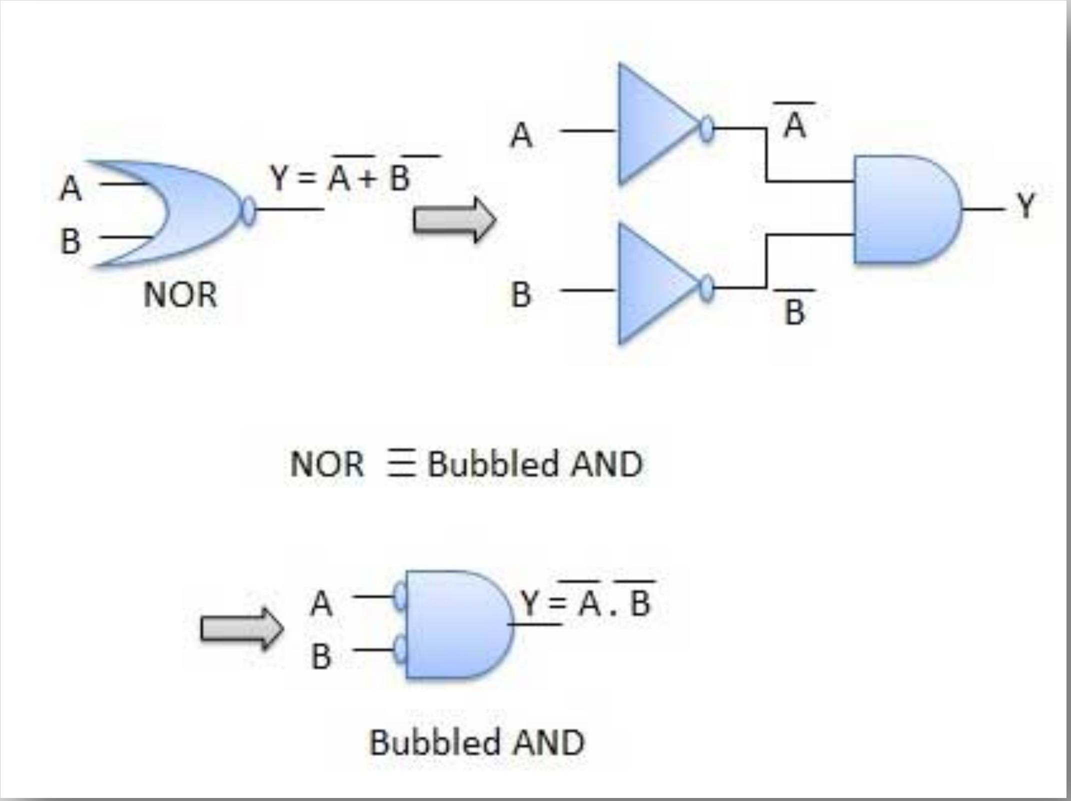
Theorem 2 $\overline{A + B} = \overline{A} \cdot \overline{B}$

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

NOR = Bubbled AND

De Morgan's Theorem 2

Theorem 2 $\overline{A + B} = \overline{A} \cdot \overline{B}$



De Morgan's Theorem 2

Theorem 2 $\overline{A + B} = \overline{A} \cdot \overline{B}$

A	B	$\overline{A+B}$	$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$
0	0	1	1	1	1
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	0

Thank You