

Boolean Logic

Key Words

Boolean A type of logic that deals with two states: true and false

Operator An operator is a symbol that represents a mathematical operation.

Truth Table A truth table is a table that shows the truth value of a logical statement for all possible combinations of truth values of its variables.

Equation An equation is a mathematical statement that two expressions are equal.

Decipher To decipher is to translate a coded message into plain text or the correct output

1: Logic Operators and Logic Gates

The term **Boolean** refers to anything with only two values, such as **Binary** which only has 1 or 0, also referred to as True or False, ON or OFF.

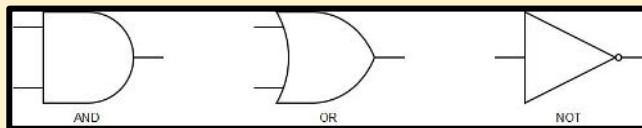
There are three main terms used in Boolean Logic:

AND - Both **inputs** need to be TRUE to **output** a TRUE.

OR - At least one of the inputs needs to be TRUE in order to output a TRUE.

NOT - If the input is TRUE the output is false, outputs the opposite of the input.

In a **logic circuit** they are represented by the following gates:



2: Truth Tables

A Truth Table is used to determine the output of a single gate or a circuit. You should always start with all the possible **combinations** of 1 and 0 for the inputs first.

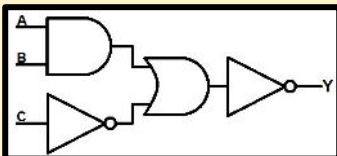
The Truth Tables for the AND gate, OR gate and NOT gate are below:

AND			OR			NOT	
Inputs	Output		Inputs	Output		Input	Output
A	B	C	A	B	C	A	C
0	0	0	0	0	0	0	1
0	1	0	0	1	1	1	0
1	0	0	1	0	1		
1	1	1	1	1	1		

3: Complex Logic Circuits

A **complex** logic circuit is made up of two or more gates, it is more complex as there may be more inputs/outputs and more gates to **decipher**.

An example of a complex logic circuit is below along with the correct Truth Table: (Zoom in!)

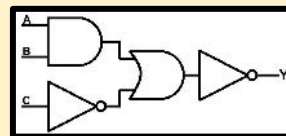


A	B	C	A AND B	NOT C	(A AND B) OR (NOT C)	Y
0	0	0	0	1	1	0
0	0	1	0	0	0	1
0	1	0	0	1	1	0
0	1	1	0	0	0	1
1	0	0	0	1	1	0
1	0	1	0	0	0	1
1	1	0	1	1	1	0
1	1	1	1	0	1	0
1	0	1	0	0	0	1

Looking at the first line we look at A AND B with 0 and 0 as the input, it produces 0 in the A AND B column. Then we look at C as 0 which goes through a NOT gate to produce 1. Then we compare both of those results (0,1) in an OR gate to get result of 1 as at least one is a 1. Finally we put the result through a NOT gate to reverse the answer and output a 0.

4: Writing/Solving Logic Equations

When we look at logic circuits we can write them as an **equation** which tells us what gates are used and how to solve it. An example is below:



$$Y = \text{NOT}((A \text{ AND } B) \text{ OR } (\text{NOT } C))$$

The easiest way to write this **equation** is to start with the output, in this case Y=. Then work backwards and write down the names of each gate, in this example there are 2 NOT gates, an OR gate and an AND gate, all of these should be in the equation.

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