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Logical Operations with Abstract Values

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Abstract: *This article presents the basic concepts of logical operations with abstract values which is different with false and true values. Moreover, it is given explanations how to make main logical operations.*

Keywords: *abstract, true, false, conjunction, disjunction, logical negation, doubt.*

We understand that logical operations are typically based on two truth values: *true* and *false.* However, let's consider the introduction of a third "abstract" value into these operations, even though grasping the concept of a logical abstract value might be challenging.

We can comprehend this notion through examples and assume the existence of such a value. For instance, consider the statement *"The child is inside the drawn circle."* If the child is entirely within the circle, we assign a true value; if the child is outside the circle, we assign a false value. But if part of the child is inside the circle while the other part is outside, the validity of this statement becomes uncertain, falling into an "abstract" category. Thus, we label this kind of value as "doubt."

Now, let's take two statements: A = "Ali is at home" and B = "Ali is at the museum." In real scenarios, these statements can be definitively true or false. However, if we remove the constraints of space and time, as in works of fiction, Ali's presence at home and the museum could coincide. Consequently, we cannot confidently attribute a "true" or "false" value to A and B; their value remains abstract.

Hence, we can interpret abstract values as "ambiguous" or "hypothetical," distinct from the usual true and false values.

We'll consider logical values as true (logical 1), false (logical 0), and abstract (logical -1), and provide definitions for the three fundamental logical operations.

Definition 1: When two propositions A and B are both true, the result is true. If at least one of them is false, the result is false. In all other cases, **the conjunction operation (logical multiplication)** produces a new proposition that the result is abstract.

A	B	A ∧ B
0	0	0
0	1	0
0	-1	0
1	0	0
1	1	1
1	-1	-1
-1	0	0
-1	1	-1
-1	-1	-1

Definition 2: The disjunction operation (logical addition) generates a new proposition. It results false when both A and B are false, abstract when one is abstract, and true in all other cases.

A	B	A ∨ B
0	0	0
0	1	1
0	-1	-1
1	0	1
1	1	1
1	-1	1
-1	0	-1
-1	1	1
-1	-1	-1

Definition 3: Logical negation, known as inversion, changes the value of proposition A to false when it is true, and changes it to true when it is abstract.

A	⌉A
0	1
1	0
-1	1

For instance: A = "true," B = "abstract," and C = "abstract." Find the value of the expression **A∧∨⌉B∨C**.

The solution: The solution involves performing the operations step by step. Initially ⌉B, then A∨⌉B and A∨⌉B∨C are done.

1. ⌉B ⇒ "true"

2. A∨⌉B ⇒ "true" ∨ "true" ⇒ "true"

3. A∨⌉B∨C ⇒ "true" ∨ "abstract" ⇒ "true"

Answer: true

When there are n considerations, the number of cases can be calculated using the formula 3^n

For example, let's construct the truth table for the expression A∧⌉B∨C. With 3 variables, the total number of cases is 3^3= 27. That is

A	B	C	⌉B	A∧⌉B	A∧⌉B∨C
0	0	0	1	0	0
0	0	1	1	0	1
0	0	-1	1	0	-1
0	1	0	0	0	0
0	1	1	0	0	1
0	1	-1	0	0	-1
0	-1	0	1	0	0
0	-1	1	1	0	1
0	-1	-1	1	0	-1
1	0	0	1	1	1
1	0	1	1	1	1
1	0	-1	1	1	1
1	1	0	0	0	0
1	1	1	0	0	1
1	1	-1	0	0	-1

1	-1	0	1	1	1
1	-1	1	1	1	1
1	-1	-1	1	1	1
-1	0	0	1	-1	-1
-1	0	1	1	-1	1
-1	0	-1	1	-1	-1
-1	1	0	0	0	0
-1	1	1	0	0	1
-1	1	-1	0	0	-1
-1	-1	0	1	-1	-1
-1	-1	1	1	-1	1
-1	-1	-1	1	-1	-1

Summary

By introducing an "abstract" value into these logical considerations, it will become possible to develop logical elements that function within the ternary number system in electrical engineering and to employ them extensively in the future. Furthermore, actions carried out using the logical "abstract" value can be applied to address the challenges that arise in the development of artificial intelligence.

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