# Boolean Algebra: Explained

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## Introduction

This paper is an introduction to the concept of boolean algebra, which is a branch of mathematics that utilizes True and False statements, using simple analogies fit for teaching kids and university students alike. The first analogy uses building a playground, and the second uses getting ready for class as a comparison.

## Analogy For Kids

Boolean algebra is like building a playground, where the playground standards are the boolean terms, the playground parts and placement are inputs to the boolean expression, and the final playground is the output.

### Playground Parts and Placement

As seen from the electronics trade journal All About Circuits (Bahn, 2022), an input in boolean algebra is called an operand which is essentially a variable that determines the output to a boolean equation (para. 5). Similarly, different playground components are inputs into creating a playground. For example, a playground component could be a slide, swing set, jungle gym, mulch, sand, etc. These different parts will determine if the playground is completed or not based on what the set standard is for a playground, which is another way of saying these inputs will determine whether a boolean expression returns True or False.

### Playground Standards

Boolean terms can be compared to the standard for what makes a playground. Based on inputs described above, if the playground standard contains a slide and a swing set, then a completed playground must have both of those things. In this example an AND term was used. Another example could be an OR term, where a playground standard states that a playground can have mulch or sand, so either is accepted. As cited from GeeksForGeeks (2024), a Computer

Science trade journal, a NOT gate has a similar function which negates an input (para. 8). In terms of the playground analogy, a playground standard may state that there cannot be a jungle gym when building a playground. Terms can be combined into an expression along with different rules for simplifying boolean expressions. Similarly, this is like a playground standard that has many different rules for what makes a playground.

**Final Playground**

Finally, the output to a boolean expression can be compared to whether the final playground fits the standard described above. As seen from another trade journal Investopedia (Kenton, 2023), an output to a boolean expression is True or False (para. 2). A boolean expression, in this case, would check if all conditions are met (in other words, if the inputs agree with boolean terms) and output accordingly. To continue the earlier examples, a standard could be that there must be a slide and swing set. The inputs in this case are the slide and swingset. However, the finished playground has a slide and jungle gym, no swing set. The output would be False in this case because the standard is not met. Simply, a finished playground would output True if it fits the standard and False if it doesn't.

**Conclusion**

All in all, boolean algebra can be described as building a playground where the components are inputs, playground standards are boolean terms, and the final playground is like the output. The final playground is dependent on the standards and inputs just as an output in a boolean expression.

## Analogy For University Students

In an analogy for university students, boolean algebra can be compared to getting ready for class in the sense that school supplies are inputs, deciding what needs to be brought to class are boolean terms, and checking if all needs are met is the output.

### School Supplies and Necessities

School supplies and other needs for the day are similar to boolean inputs in that they are variables which decide if a university student is ready for class. As described in a lesson from a researcher at the University of Utah (De St Germain, n.d.), variables are essentially "stand ins" for any possible values (para. 2). This is another way of saying that variables are interchangeable inputs in a boolean expression. School supplies, in the same way, may change from day to day depending on the specific class. An example may be a laptop for math class, goggles for lab, presentation slides for communications, etc. These inputs are subject to boolean terms described in the next points.

### Specific Class Needs

Continuing on to the previous point, deciding what is needed for the day can be described as a boolean term. Boolean terms are used to organize inputs, described as a “set of instructions” for said inputs (Blake, 1937, p. 7). In other words, some days a university student may need a journal and a pencil, or a laptop or tablet, but not both. The boolean terms described are AND and XOR, the latter meaning exclusive OR that means one or the other but not both. This is an example of building on existing base terms, such as an OR term. These different boolean terms, or deciding specific class needs, perform operations on the inputs.

**Checking That Needs Are Met**

Once all the inputs have been gathered and conditionals have been applied, there is an output. According to a researcher at the Swiss Federal Institute of Technology Lausanne, an output is described as a "selection of classes" in the sense that the output is subject to the ranging inputs (Moreira, 2000, p.1). These inputs are equivalent to the school supplies mentioned in the point above, the boolean terms are deciding what is needed for the day, and finally checking if the student can leave for class is the output. If the output, or checking if needs are met, is False, the university student may go back and get new inputs or change conditionals until it is True that he/she can leave for class.

**Conclusion**

In conclusion, boolean algebra can be compared to getting ready for class where school supplies and necessities are like inputs, deciding what is needed for specific classes are like boolean terms, and checking if needs are met is the output. A university student may first decide what is needed for the day (boolean terms), gather school supplies (inputs), and check if all needs are met (output).

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