

LW: Boolean Logic

Avoid working on this labwork in advance. Wait and do it collaboratively with other students during your lab session.

Objectives

- Become familiar with truth tables
- Use logical operators
- Overcome a common problem working with “Boolean like” functions
- Perform logic minimization

Completion

- **You attended lab or have an excused absence.**
- **A grade of "complete" on this lab work requires a score of at least 60 in the autograder.**

Submission

Submit the following files to the autograder:

- boolean.cpp
- boolean_functions.cpp
- boolean_functions.h

Instructions

Run the following compile and run statements.

```
$ g++ -std=c++17 -Wall -Werror -g -pedantic -Weffc++ boolean_functions.cpp boolean.cpp
$ ./a.out
program output
```

Note:

- Do not type the \$ symbol.

Required Tasks

[Download the starter code.](#)

Update code in boolean_functions.cpp to complete each task.

You should always review the code starting at main to understand the flow of the program for doing the assigned tasks.

Truth Tables

In computer science and digital logic, false is frequently represented as a 0 and true with a 1.

1. printNOT(): [4 points] Print the truth table for NOT
2. printOR(): [5 points] Print the truth table for OR
3. printAND(): [5 points] Print the truth table for AND
4. printXOR(): [5 points] Print the truth table for XOR

Calculate Boolean Formulas / Expressions

5. booleanLogic1(): [15 points] Compute $x \text{ OR } y \text{ OR } z$, given assigned truth values
6. booleanLogic2(): [15 points] Compute $x \text{ AND } y \text{ AND } z$, given assigned truth values
7. booleanLogic3(): [15 points] Compute $x \text{ XOR } y \text{ XOR } z$, given assigned truth values

Debug Function

Many functions inherited from C are “Boolean Like”. The function names sound like they should return a boolean value, but actually return another data type such as int.

8. countLetters(): [5 points] Fix error dealing with “boolean like” function
 - a. Run the function locally putting in test strings and see if you get the correct result.
 - i. E.g. “hi! 123 is a num” should have 8 letters
 - b. Look carefully at the return type for the function.
 - i. Does it return what is expected?
 - ii. What is the comparison actually doing?

Challenge Tasks

9. [15 points] Compute $f(x, y, z)$ given an assignment of truth values and the truth table and implement the mystery function.

x	y	z	f
0	0	0	0

0		0		1		1
0		1		0		1
0		1		1		1
1		0		0		1
1		0		1		0
1		1		0		0
1		1		1		1

One way to do this is to identify the rows of the table where $f(x,y,z)$ is true. Then express the assignment of truth values as a boolean formula (e.g. $(x,y,z) = (1,0,1)$ is expressed “ x AND NOT y AND z ”). The disjunction (OR) of all of those formulas will be a formula for f .

Another way to do it is to do the same thing for all the rows where f is false, combine them into one big disjunction, then take the negation (NOT) of the whole formula to obtain a formula for f .

A third way is to stare really hard at the table and crush the problem in your mind-vice to produce a succinct and elegant formula. This method is not recommended for novice logicians.

10. [15 points] Find an assignment to the boolean variables w,x,y,z that satisfies the boolean formula. Set these values by assigning the appropriate values in the `setAssignments()` function. Note: There are two possible solutions, either will work.

x AND (w OR y) AND (NOT w OR NOT z) AND (NOT y or z)

Crush it in your mind-vice: assign a truth value to one variable at a time and reduce the set of possible values of the rest until only 1 or 2 possibilities remain.