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boolean logic circuit simulator

AQA Computer Science NEA

[Date]

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# Analysis

## The Problem

GCSE Computer science is where a student’s introduction to logic gates may happen, this is a part of the curriculum but also helps to further a student’s logical thinking which can help in other areas of the subject, such as programming. A way to help me better understand logic gates were logic gate simulators, these simulators allowed me to create simple circuits using basic AND, OR, XOR, and NOT gates virtually. A simulator would allow the students to create circuits that give automatically give outputs without needing to be traced. However, the current simulators are too complex for what is needed for GCSE computer science and lack the teaching tools that my proposed system will include.

## Overview of Logic Gates

Logic gates are a model of computation that take one or two inputs and returns a single output based on the gate's logical operation / Boolean function, they are the fundamentals of logical circuits and physical logic gates made of diodes and transistors are what allow computers to work. Logic gates can be combined to produce a certain output based on the inputs of the circuit. An AND gate (Figure 1) for example will take two inputs and return a True output if both inputs are True, and a False output otherwise. Inputs and outputs can be True or False as they are Boolean, this is usually represented as a 1 and 0 for True and False, respectively. Certain gates such as the Not gate will only need one input. There are other parts to the logic circuits besides the gates; switches, constant inputs, and clocks can provide initial inputs. Output can be handled by a simple ‘bulb’ that is on/lit for True and off for False. A more complex output such as a 4-bit digit would produce an integer output based on a binary sequence from 4 Boolean inputs.



Figure 1: AND Logic Gate

## Features Needed for GCSE Students

The truth table below (Figure 2) displays all the possible inputs and outputs in tabular form for the Logic operations AND, OR, XOR, and NOT. These are the only gates that are needed for the AQA course as per the specification (Figure 3).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input** |  | **Output** |  |  |  |
| A | B | AND | OR | XOR | NOT (Input only A) |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 | 0 |

Figure 2: Truth Table

Table

Description automatically generated

Figure 3: AQA GCSE Specification for Boolean Algebra 3.4.2

As these are the only gates needed for the AQA course, they will be the only gates included, simplifying the program for the students. My solution would be more focused on teaching, specifically what is needed for the AQA GCSE specification. I had a short conversation with Mr Flynn about what features would make my program relevant to GCSE students. These included:

* Abstracting logic gates that are not needed.
* Including a checklist to determine if the user has used each of the gates at least once.
* A truth table generator to display the results of a circuit as a truth table.
* Converting a written Boolean expression into a truth table.
* Displaying the Boolean expression for the created circuit.
* Allowing individuals to save and load circuits to and from their computer’s local storage.

These are all the features I believe are needed for the student to understand and solve GCSE level questions (Example shown in Figure 4).

A picture containing diagram

Description automatically generatedTable

Description automatically generated

Figure 4: Logic Gate question from AQA GCSE Computer Science June 2019 (8020/1)

## Acceptable Limitations

Hardware and software constraints – The program must run on school computers, therefore must not be resource intensive. The school uses Windows 10 as their operating system

## Platform, Programming Language, and Modules

The program would run as either a web application or a windows desktop application. These choices are suitable as Highdown uses windows as the operating system on its computers, and all its computers have a browser and constant access to the internet.

A desktop application is a type of software that is directly installed onto the hard drive of the computer. It can be launched whenever, independent of other applications, i.e., it does not need a web browser to run within, like a web app. They also work regardless of internet connection (unless the program itself requires it).

A Web application is a type of software application that is used through the internet via a web browser. The files are stored on a remote server, and all of the backend processing is done remotely

Web Application vs Desktop Application for the Logic Gate Simulator:

Web application a

The programming language used will somewhat depend on the platform that the program will be run on. For a web app, the programming languages I would use would be Python, JavaScript, and HTML; I would also need to be familiar with CSS. For a windows application, there are many more languages that would be suitable, including python. As python is a language that I am already familiar with, it is my top choice for programming language.

## Objectives

Diagram

Description automatically generated

Figure 5: Object diagram for possible Logic Gate solution

## Guideline

1 Introduction

1.1 Background to the problem

1.2 Describe the problem

1.3 Justify the features of the problem

1.4 Why is this problem solvable by Computational Thinking?

2 Research

2.1 Description of the current system

2.2 Problems with the current system

2.3 Algorithms used with the current system

3 Stake Holders

3.1 Introduction

3.2 Identification of Prospective Users

3.3 Record of Client Interviews

3.4 Identification of User Need and Acceptable Limitations

4 Background

4.1 Description of Proposed Solution

4.2 Software development platform

4.3 Specify Hardware Requirements

4.4 Justify Hardware Requirements

4.5 Specify Software requirements

4.6 Justify Software requirements

4.7 Development language

5 Objectives

5.1 Introduction

5.2 General Objectives

5.3 Specific Objectives

5.4 Essential Features of the Computational Solution

5.5 Acceptable Limitations of the proposed solution

6 Modelling of the Problem

6.1 Introduction

6.2 Data Sources

6.3 Data Destinations

6.4 Data Volumes

6.5 Data Dictionary

6.6 Database Information

6.7 Database Design of the Current System

6.8 Database Design of the New System

6.9 Object Orientation Plan

# Design

## Input,

Diagram

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