2020

Boolean Logic Practice WebApp

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A Project Submitted to

GRAND VALLEY STATE UNIVERSITY

In

Partial Fulfillment of the Requirements

For the Degree of

Master of Science in Applied Computer Science

School of Computing and Information Systems

December 2020

GRAND VALLEY
STATE UNIVERSITY

The signatures of the individuals below indicate that they have read and approved the project of Spencer Firlik in partial fulfillment of the requirements for the degree of Master of Science in Applied Computer Science.

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Dr. Zachary Kurmas, Project Advisor Date

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Dr. Robert Adams, Graduate Program Director Date

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<name of unit head>, Unit head Date

Abstract

Currently, the GVSU School of Computing offers a course during undergraduate studies that teaches Boolean logic and its corresponding basic circuit design. The textbook used in that course, while being very informative, lacks the quantity of practice problems that a student might need. Therefore, students will have the availability to experience a greater variety of practice problems. This will allow students to increase their knowledge in the world of Boolean logic which will help them along in their pursuit of their undergraduate degree.

The students will be provided scenarios such as, translating a truth table to an expression, expression to truth table, circuit to truth table, and circuit to expression. In future developments, truth table and expression to circuits may be available. This web application is deployed through Heroku and was developed with a Ruby on Rails backend server with a JavaScript, HTML, and CSS frontend as well as a Wolfram Alpha API call used to generate the circuits.

Introduction

The purpose of the web application delivered in this project was designed for the GVSU School of Computing so its undergraduate students can gain the appropriate amount of knowledge they need to be fluent in Boolean logic. Using JavaScript, Ruby on Rails, and the traditional HTML and CSS I have created an such an application that will fulfill these knowledge requirements for CIS 351.

I have personally used the knowledge gained during my tenure in the GVSU Master of Applied Computer Science program. Throughout my professional career I have always challenged myself within my company and enrolling in this program was no different. I am an Infrastructure Engineer by trade so with enrolling into this program I was excited to learn to transition to a more DevOps way of thinking.

I have used the skills acquired from this program to create the web application provided in this project. The courses that I took into account while developing this application were CIS 641, CIS 642, CIS 643, CIS 656, and CIS 658. These five courses were instrumental in helping me plan and execute this project. CIS 658 with Dr. Kurmas was the course that resonated me the most. This is why I decided to ask Dr. Kurmas to be my advisor for this project.

Throughout this project I came across many setbacks. With the skills gained in CIS 641 and CIS 642 I was able to diagnose the issues and deploy them in time to not fall behind my proposed project timeline. Also, with the assistance of CIS 643 I was able to demonstrate and present my project clearly and efficiently. In the next section you will see the project timeline that was projected.

Project Management

Below is my project timeline. I was able to deliver the product within the estimated timeline successfully. While I did have some setbacks, I was able to stay on schedule and produce a complete product with potential for future development.

Timeline Outlook:

9/1 – Begin Rails design (models, views, controllers)

9/1 – Begin Rails environment creation

9/1 - Begin development of feature(s) 1 and 2

9/16 - Progress report to advisor

9/30 - Finish/Test feature(s) 1 and 2

10/1 - Progress report to advisor

10/1 - Begin development for feature(s) 3 and 4

10/14 - Progress report to advisor

10/30 - Finish/Test feature(s) 3 and 4

11/1 - Begin development for feature(s) 5 and 6

11/8 - Progress report to advisor

11/15 - Finish/Test feature(s) 5 and 6

11/16 - Begin user testing

11/30 - End user testing/Bug fixes

12/10 - Begin generating final report

Organization

The features of this project that are essential to the overall scope and functionality of the project are as follows:

Auto Generated Problems

1. Generate a Boolean expression given a truth table
2. Generate circuit given a truth table (future development)
3. Generate a truth table given a Boolean expression
4. Generate a circuit given a Boolean expression (future development)
5. Generate a truth table given a circuit
6. Generate a Boolean expression given a circuit.

This project as stated in the introduction was developed using a Ruby on Rails and JavaScript backend as well as an HTML, CSS, and JavaScript frontend. This app was successfully deployed as a Heroku web server application and no internal or external database was necessary.

Reflection

Like I have stated I believe that I have successfully completed this project that was originally proposed. I did come across some difficulties which did force me to modify my current scope of the project. Originally the feature of the students to create their own circuit given a truth table or expression was in scope. I quickly realized that there was not a current framework or API call that I could use easily which is why I had to add these features in the future deployment category.

The expression generation was one of the critical aspects of my project. I had to make sure that the number of inputs were more complex than simple (A && B) and also was able to be understood by WolframAlpha for the circuit generation. A significant issue I came across was where my Boolean expression algorithm would generate very trivial expression. For example, at times it would generate (B && ~B) which of course would generate a truth table of all zeroes. To combat this issue, I had to add multiple checks to make sure an input generate was not the same as the previous input within the input expression.

Another issue was the evaluation of my expression when the truth table was generated. At first, I would generate simple expressions to make sure the truth table was populating correctly. Once I introduced more complex expressions, I noticed that if a NOT gate was generated before the inputs the evaluator would assign it to the first input rather than the entire input expression. For example, ~(A && B) would be evaluated as (~A && B). To alleviate this issue, I first evaluated the expression inside the parenthesis then re-evaluated the results with the NOT gate. I do believe that my debug and fix methods could have been improved. I would typically try to fix multiple issues during one push which at times caused more issues. Instead, I should have completed an issue fix before starting on the next.

Conclusions

In conclusion I believe I have created a successful product that will be able to help the School of Computing in their undergraduate course. This project provides current undergraduate students to advance their skills with Boolean logic and also allows professors to challenge the students without having to create multiple problems by hand which can become time consuming. I have also given the opportunity for future deployment by implementing a way to have students create their own circuits given a truth table or expression. It is also possible for future students to develop a way to generate a circuit that would not involve an API call to WolframAlpha thus eliminating the licensing cost currently required to generate the circuits.

I also believe that this project has been successful due to my willingness to push the boundaries of my knowledge which allows me to gain additional skills that can be used in future work. With the completion and successful deployment of this project I am certain that I have fulfilled the program requirements and have shown how I have used the skills gained throughout to provide value to other students and their future careers within the information technology industry.

Appendices

GitHub Repository:

https://github.com/safirlik51/MastersCapstone

Heroku WebApp:

https://booleanpractice.herokuapp.com/