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Project Report

Logic Circuits Simulator

Digital Design 1

The American University in Cairo

Presented to: Dr. Mohamed Shalan

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23 March 2024

Used Data Structures and Algorithms:

Data structures:

Vectors: Vectors were used to store all the information in .lib file, .cir file and .stim file.
Maps: They were used to store the intermediate values of outputs in the compute_circuit function
Unordered_map: used to map the string variables to their boolean values.
Structs: They were used to define gates, intermediate_values and Data.
Unordered_sets: Handling the cases where one of the inputs of gates is invalid.
Sets: Deleting duplicates

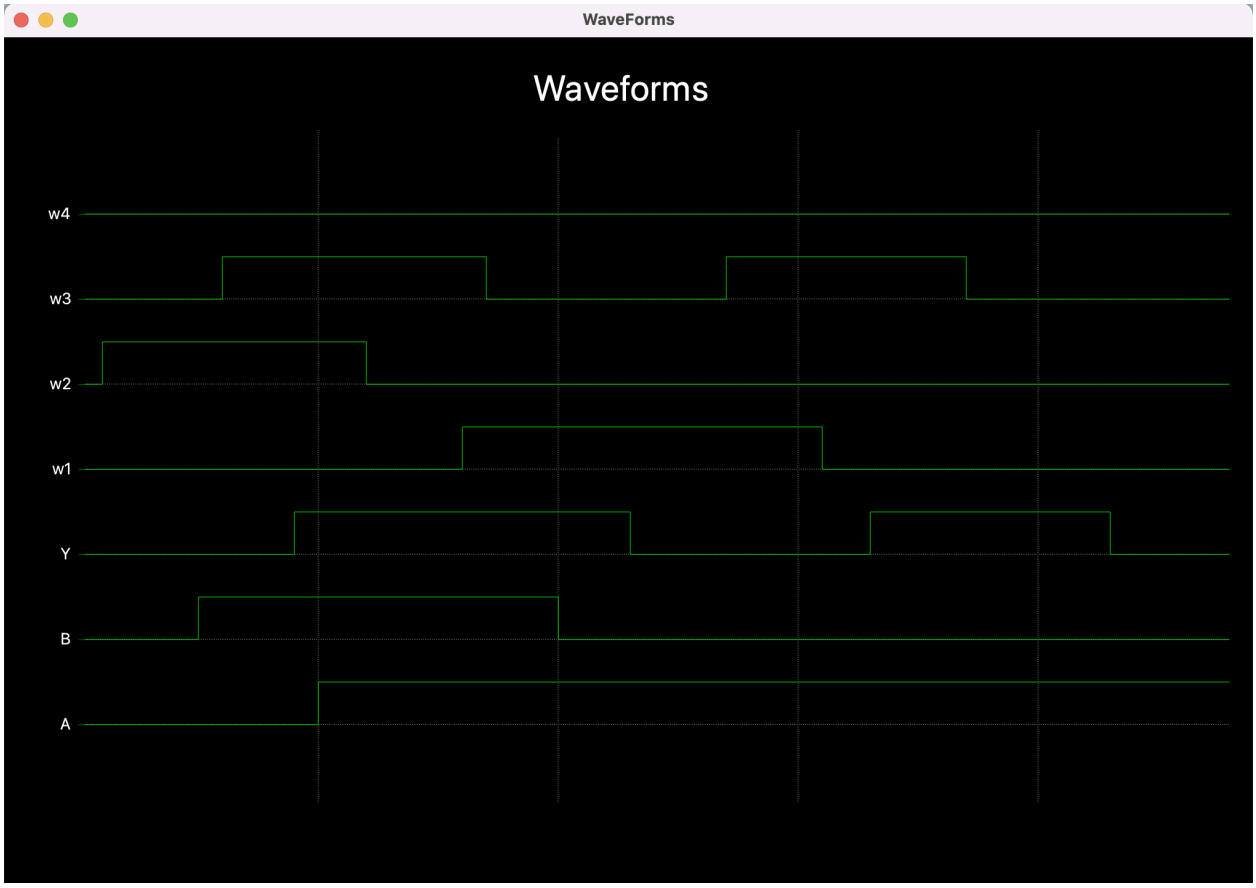
Algorithms:

Sorting: to sort the events based on their timestamps
Search: searched in the gates dictionary to compute the functionality
File Manipulation: all of our inputs were read from files and the output is extracted to an output file.
String Manipulation: extracted substrings from the read files to be able to simulate the circuit.

Testing:

- Tested circuits with different numbers of variables.
- Tested circuits with different types of gates.
- Tested the simulation on different circuits.
- Compared the waveform written by hand to the waveform generated by qt.
- Compared the written .sim file to the generated .sim file.

For Example, circuit 5 waveforms look like this:



0,A,0
0,B,0
100,w2,1
300,w1,0
400,w4,0
500,B,1
600,w3,1
900,Y,1
1000,A,1
1100,w2,0
1100,w3,0
1300,w1,1
1400,Y,0
1500,B,0
1600,w3,1
1800,w1,0
1900,Y,1
2100,w3,0
2400,Y,0

The previous information was read to sketch the above waveform.

Challenges:

- Lib, Cir, and Stim files were readable by some programs and others not so we had to convert some to Txt files, but we then used compilers that are compatible with reading different file types to overcome the challenge.
- Finding the suitable software for plotting the waveforms
- Making the code more generic
- Handling most of the run time errors and logic errors.
- Coordinating between the group members
- Some of the syntax information of the QT waveform generator was taken from the chatgpt prompt: How to have variable names on the yaxis in qcustomplot?
- Switching bool values with the string in expression using find and replace functions were taken from chatgpt prompt: How to replace indexes from a string with a bool value
- Knowing isalpha() and erase() functions. Prompt: Are there functions to remove space and check if it is an alphabet?

Contributions of each member:

Ismail's contributions:

- Reading and Storing info into a Vector Named Gates Dictionary Info from Lib File using Struct.
- Function to Read Gates Dictionary
- Did Output Function that returns the output of any n-input gate stored in Lib File and stored as gate data in the struct.
- Corrected the output in the Sim file to add the extra delay of any gates dependent on other Gates, this was done in accesscirfile function to adapt to the way the function compute circuit was written.
- Allow to compute Predefined Expressions of any size
- Helped in Compute Circuit Errors
- Done 2 circuits with its waveform and sim files
- Done infinite I/O gates to output correctly in the sim file.

Aly's contribution:

- Did the QT waveforms
- Reading and storing info from the stimFile and storing them in a vector, to simulate the event-based simulator
- Handled cases where no events are happening
- Compute circuit function that takes the boolean values and simulates the logic circuit
- SimulateProgram function that computes the .sim file based on the stim events

- Wrote all stim files
- Done 1 circuit with its waveform and sim files.
- Did the LogicGates class

Islam's contribution:

- Implemented the .cir file reader function. Reading the Information in .cir file and storing them in a vector of gates.
- Comparing the gates of the .cir to the gates in .lib to check if .cir gates exist in the .lib file and assigning the cir_gates their properties based on the .lib gates .
- Organized the output of the SimulateProgram and managed the delay in compute_circuit.
- Handled cases where one of the inputs of the gates is not valid.
- Fixed the errors of extra spaces.
- Sorted the output and printed the output in .sim file.
- Wrote the waveforms and .sim files of 2 circuits.
- Wrote the .lib file.