Lab session Gates and Wires

Group A: october 5, 2009
Group B: october 6, 2009

Work in the given groups of two. Submit your solutions to the respective assignment on Blackboard. The file name is:
`a01_s0XXXXX_s0XXXXX.tar.gz`
One of the group members commits your solution. The other(s) submit a txt-file with a confirmation. Keep an eye on the deadline (see Blackboard)!

1 Exercises

1. Prove DeMorgan's theorems by composing a truth table. The theorems are
   (a) $\overline{A+B} = \overline{A} \cdot \overline{B}$
   (b) $\overline{A \cdot B} = \overline{A} + \overline{B}$

2. Prove by using Boolean algebra that

$$E = ((A \cdot B) + (A \cdot C) + (B \cdot C)) \cdot (\overline{A \cdot B \cdot C})$$
$$\Longleftrightarrow$$
$$E = (A \cdot B \cdot \overline{C}) + (A \cdot \overline{B} \cdot C) + (\overline{A} \cdot B \cdot C)$$

   In each step, write *each* used algebraic law.

   Remark: the last equation is a normalized *product of sums* representation, and will prove to be useful in implementing the behaviour of such algebraic equations.

3. Use Logisim to build a NAND port as a new component out of AND, OR an NOT gates.

   Like the set of AND, OR, NOT gates, the singleton NAND gate set is functionally complete. This means that any algebraic expression or truth table can be implemented by using only NAND gates. Show that NAND is functionally complete by building an AND, OR and NOT gate using only your own NAND component in Logisim.

4. Implement the following truth table in Logisim using AND, OR and NOT gates. To do this, first write the truth table as a Boolean algebraic expression.

A	B	C	X	Y
0	0	0	1	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

5. In Logisim, show the two-digit hexadecimal ASCII representation of the characters you type. For example, the character "n"'s ASCII representation is "6E". Use the *Keyboard* and *Hex Digit Display* components of the *Input/Output* library. You will also need to use *Splitter* components of the *Base* library. Check the documentation pages on how to use these components: `http://ozark.hendrix.edu/~burch/logisim/docs/2.3.0/libs/`

2 Project

Build a circuit that translates the binary representation of numbers 0 to 7 to a LED display.

- compose a truth table with binary outputs.
- find the Boolean algebraic expressions for this truth table. Discuss why these expressions are useful in the context of building a circuit.
- implement the circuit in Logisim. Use the *7-Segment Display* of the *Input/Output* library.

The LED display should display numbers as follows:

Decimal number	binary representation	LED
0	000	
1	001	
2	010	
3	011	
4	100	
5	101	
6	110	
7	111