Week 12 – Computer Systems

Caroline Cahill

Some of what we've Covered:

- Calculate operations using various number bases
- Apply the basics of Boolean Logic
- Be able to describe how the computer components operate together: understanding of a simulator
- discuss the relative merits of various operating systems
- compare and contrast CPU scheduling algorithms
- explain the following: process, address space, file.
- distinguish between the various memory computers use

Linux distro – Ubuntu

- user-friendly
- Free
- Safe
- High customisation
- Lots of Ubuntu flavours
- Supportive Ubuntu community
- Low system requirements
- Lots of free software
- Improved compatibility, included drivers
- It’s open source

Computing Basics

- Decimal_{10}
- Binary_{2}
- Octal_{8}
- Hexadecimal_{16}
- Signed Number Representations

TIPS:

dec→oct groups of 3 (recall $111_2 = 2^2+2^1+2^0=7$; Decimal 0-7)

dec→hex groups of 4 (recall $1111_2 = 2^3+2^2+2^1+2^0=15$; Decimal 0-15)

- Signed numbers usually 2's Complement:
  - 1's Complement + 1
  - Take note of how many bits is n? n=4? n=8?

1’s Complement:

- If x is positive, simply convert x to binary.
- If x is negative, write the positive value of x in binary
- Reverse each bit.

2’s Complement:

- Last, we add 1 to the 1’s Complement number

Binary Arithmetic

Tutorial Video

http://courses.cs.vt.edu/~csonline/NumberSystems/Lessons/AddingTwoBinaryNumbers/index.html

Logic

What would be a suitable gate to represent the following situation:

1. *“Allow more people enter if the lights are on and there are empty seats”*
2. “*I buy shoes that are comfortable or cheap”*

Distributive law

X + (Y . Z) = (X + Y) . (X + Z)

X	Y	Z	Y.Z	X + (Y.Z)	X + Y	X + Z	(X + Y) . (X + Z)
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0
0	1	0	0	0	1	0	0
0	1	1	1	1	1	1	1
1	0	0	0	1	1	1	1
1	0	1	0	1	1	1	1
1	1	0	0	1	1	1	1
1	1	1	1	1	1	1	1

Proof by perfect induction

Exclusive OR

A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

- When B is 1

  output is complement of A

Boolean Algebra

1) $X \cdot 0 = 0$

2) $X \cdot 1 = X$

3) $X \cdot X = X$

4) $X \cdot \overline{X} = 0$

5) $X + 0 = X$

6) $X + 1 = 1$

7) $X + X = X$

8) $X + \overline{X} = 1$

9) $\overline{\overline{X}} = X$

10A) $X \cdot Y = Y \cdot X$

10B) $X + Y = Y + X$

Commutative Law

11A) $X(YZ) = (XY)Z$

11B) $X + (Y + Z) = (X + Y) + Z$

Associative Law

12A) $X(Y + Z) = XY + XZ$

12B) $(X + Y)(W + Z) = XW + XZ + YW + YZ$

Distributive Law

13A) $X + \overline{X}Y = X + Y$

13B) $\overline{X} + XY = \overline{X} + Y$

13C) $X + \overline{X}\,\overline{Y} = X + \overline{Y}$

13D) $\overline{X} + X\overline{Y} = \overline{X} + \overline{Y}$

Consensus Theorem

14A) $\overline{X\,Y} = \overline{X} + \overline{Y}$

14B) $\overline{X + Y} = \overline{X}\;\overline{Y}$

DeMorgan's

$(A + B)(A + C)$

↓ Distributing terms

$AA + AC + AB + BC$

↓ Applying identity $AA = A$

$A + AC + AB + BC$

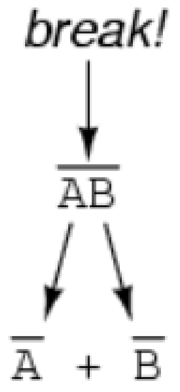
↓ Applying rule $A + AB = A$ to the $A + AC$ term

$A + AB + BC$

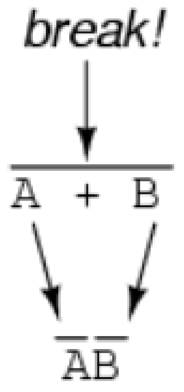
↓ Applying rule $A + AB = A$ to the $A + AB$ term

$A + BC$

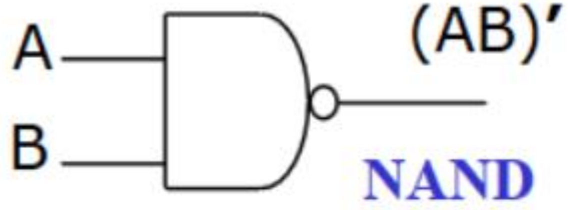
DeMorgans Theorem

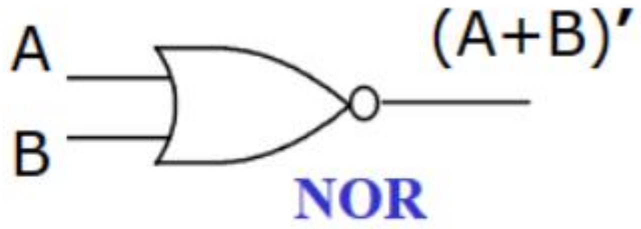


NAND to *Negative-OR*



NOR to *Negative-AND*





Law/Theorem	Law of Addition	Law of Multiplication
Identity Law	$x + 0 = x$	$x \cdot 1 = x$
Complement Law	$x + x' = 1$	$x \cdot x' = 0$
Idempotent Law	$x + x = x$	$x \cdot x = x$
Dominant Law	$x + 1 = 1$	$x \cdot 0 = 0$
Involution Law	$(x')' = x$	
Commutative Law	$x + y = y + x$	$x \cdot y = y \cdot x$
Associative Law	$x+(y+z) = (x+y)+z$	$x \cdot (y \cdot z) = (x \cdot y) \cdot z$
Distributive Law	$x \cdot (y+z) = x \cdot y+x \cdot z$	$x+y\cdot z = (x+y) \cdot (x+z)$
Demorgan's Law	$(x+y)' = x' \cdot y'$	$(x \cdot y)' = x' + y'$
Absorption Law	$x + (x \cdot y) = x$	$x \cdot (x + y) = x$

Simplification of Boolean Expressions

$$(X + Y)(X + \overline{Y})(\overline{X} + Z)$$

Multiply out the first two terms

$$= (XX + X\overline{Y} + XY + Y\overline{Y})(\overline{X} + Z)$$

$$= (X + X + F)(\overline{X} + Z)$$

$$= X(\overline{X} + Z)$$

$$= X\overline{X} + XZ$$

$$= XZ$$

Week 6: K-maps

A \ BC	00	01	11	10
0	A'B'C' (0)	A'B'C (1)	A'BC (3)	A'BC' (2)
1	AB'C' (4)	AB'C (5)	ABC (7)	ABC' (6)

RULES:

- No 0's
- Never diagonal
- Groups of 2^n
- Large group as possible
- Groups can overlap
- Groups can wrap around edges
- Few groups as possible

Real world application in error codes

Week 7: Flip-flop

- In RAM, each location stores a word
- In SRAM, the memory cell is a type of flip-flop circuit

Types:

- S-R
- D-Type Flip-Flop circuit that is usually built using NAND logic gates
- Edge-triggered