Friday – 9:10 am – BA3175 – meet TAs
– ask tutorial #4
– Quiz #4

CSC104 fall 2012

Why and how of computing

week 6

Danny Heap
heap@cs.toronto.edu
BA4270 (behind elevators)
http://www.cdf.toronto.edu/~heap/104/F12/
416-978-5899

Text: Picturing Programs

Outline

Representing information

Notes

Some convergence

digital, binary, small, fast, cheap...

Computers have converged on two general design ideas:

digital: Using discrete, sharply-changing, rather than analog, smoothly-changing states

binary: Two states is the smallest, most easily designed

early 50s

memory should be reliable
fast, and cheap
magnetic (left), transistor (right)

1970s

mag core.

use as electronic switches.

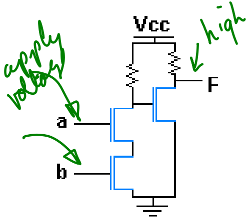
Boolean logic

simple operators

```
(and (< 3 5)
     (> 3 2))

(and (< 3 2)
     (< 2 3))
```

Two values, **true** and **false** can be combined:



NMOS
AND gate

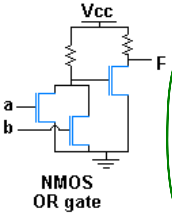
a	b	(and a b)
true	true	true
true	false	false
false	true	false
false	false	false

Boolean logic

more simple operators

(or (> 3 5)
(< 1 2))

Two values, **true** and **false** can be combined:



a	b	(or a b)
true	true	true
true	false	true
false	true	true
false	false	false

Boolean logic

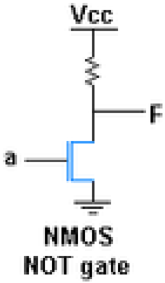
one more simple operator

(not true) → false

(not (> 3 5)) → true.

#

Single value, **true** or **false** can be transformed:

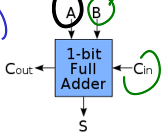


a	(not a)
true	false
false	true

Boolean arithmetic

bitwise operator

Two values, **0** or **1**, can be combined:



A	B	C_{in}	C_{out}	S
0	0	0	0	0
1	0	0	0	1
0	1	0	0	1
1	1	0	1	0
0	0	1	0	1
1	0	1	1	0
0	1	1	1	0
1	1	1	1	1

binary, decimal. . .

5897 — multiply each digit by the appropriate power of 10

$$5 \times 1000 + 8 \times 100 + 9 \times 10 + 7 \times 1$$

shift → (divide by 10, round ↓)

← shift multiply by 10

- What happens when you add zeros on the right —- 58970 589700?

- What happens when you drop digits from the right — 589, 58?

  ≠ 589.7

- Can you guess at a general rule?

  add 0 at right? ≡ multiply by 10

  drop right-most digit?

binary, decimal...

1011 multiply each digit by the appropriate power of 2

$$1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1$$

- What happens when you add zeros on the right — 10110, 101100?
- What happens when you drop digits from the right — 101, 10?
- Can you guess at a general rule?

number to binary

How do you write 37 in binary?

- Suppose you knew it had six binary digits (bits), ??????. Does the fact that 37 is odd help you know whether the bit on the right is a 0 or 1?

- Suppose you know what the digit on the right is. What connection is there between the remaining bits, ?????, and 37/2 (rounded down)?

Notes