CS 130 : Computer Systems - I

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Digital versus Analog Systems

- In a *digital* system information is represented and processed in *discrete* rather than continuous forms.

- Systems based on *continuous* forms of information are called *analog* systems

- For example, information on traditional audio cassette tapes is recorded as a continuous analog signal. Same signal can be sampled at uniform time intervals and converted to a set of discrete values to be recorded in a digital form.

Continuous and Discrete
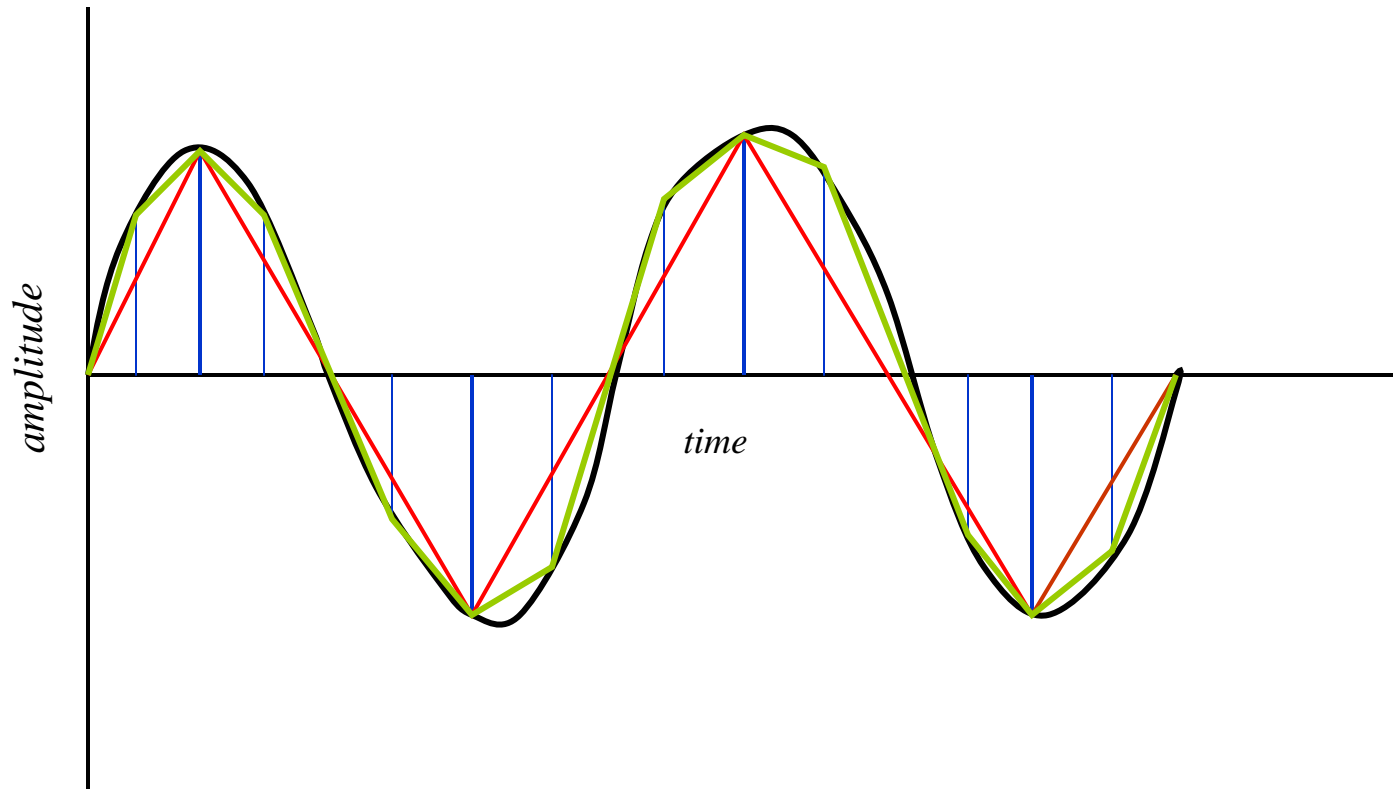
Language of Mathematics

- Decimal
  - Digits 0-9
- Binary
  - Bits 0,1
- Anything that you can represent in decimal can be done in binary also
  - Reverse is also true
- The prefix "bi" is not new to you
  - Bi-cycle
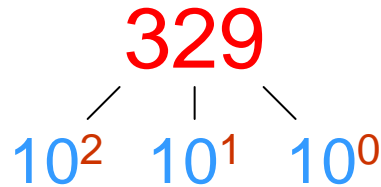 - Bi-annual
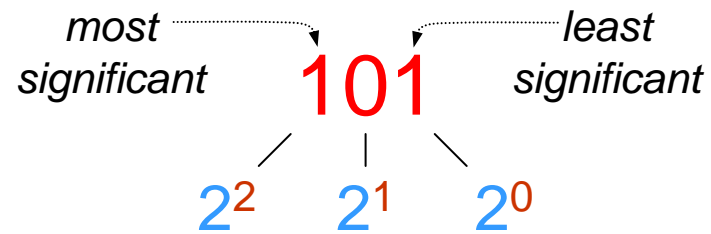 - Bi-centennial

Two Choices Not New Either

- True or False

- Correct or Wrong

- Hot or Cold

- Tall or short

- Alien or not ☺

- Information must be represented using bits
  - You should attach meaning to the bits

Representing Numbers

■ Weighted Position

$$329$$

$$10^2 \quad 10^1 \quad 10^0$$

3x100 + 2x10 + 9x1 = 329

most significant → $$101$$ ← *least significant*

$$2^2 \quad 2^1 \quad 2^0$$

1x4 + 0x2 + 1x1 = 5

■ You saw more representations in an earlier class
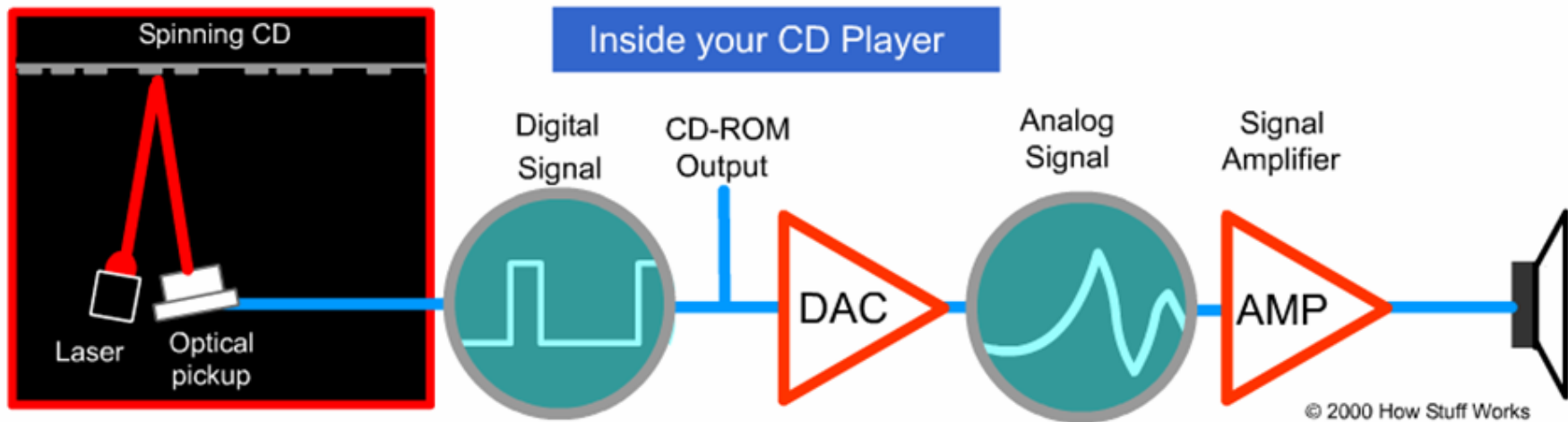
  □ 1's complement

  □ 2's complement

  □ Signed and Unsigned etc.

Two Choices in Binary

- 0 and 1

- 0 is typically used to represent FALSE, NO

- 1 is typically used to represent TRUE, YES

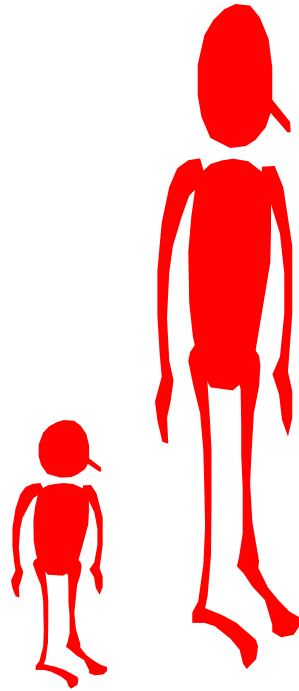- How are zero's and one's differentiated?
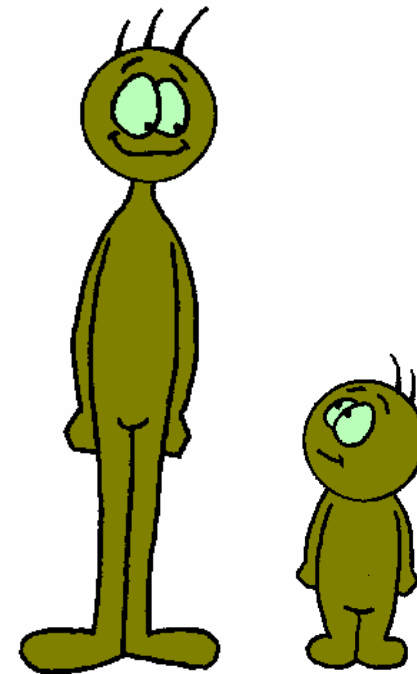
Differentiate Between 0 and 1

5V

1's

2.5V

0's

0V

Example : In a CD-ROM

Inside your CD Player

Spinning CD — Laser — Optical pickup

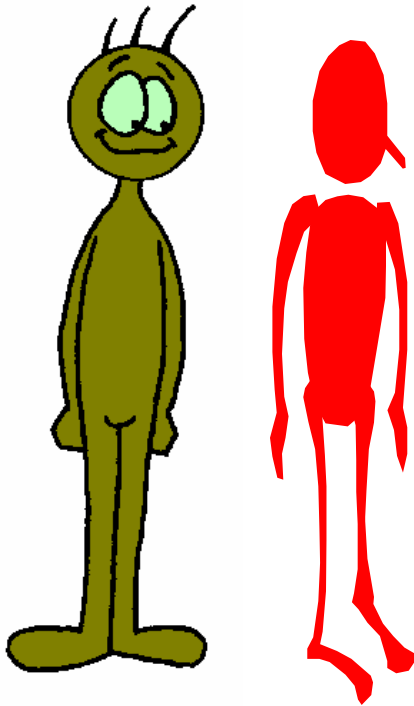Digital Signal — CD-ROM Output — DAC — Analog Signal — Signal Amplifier — AMP

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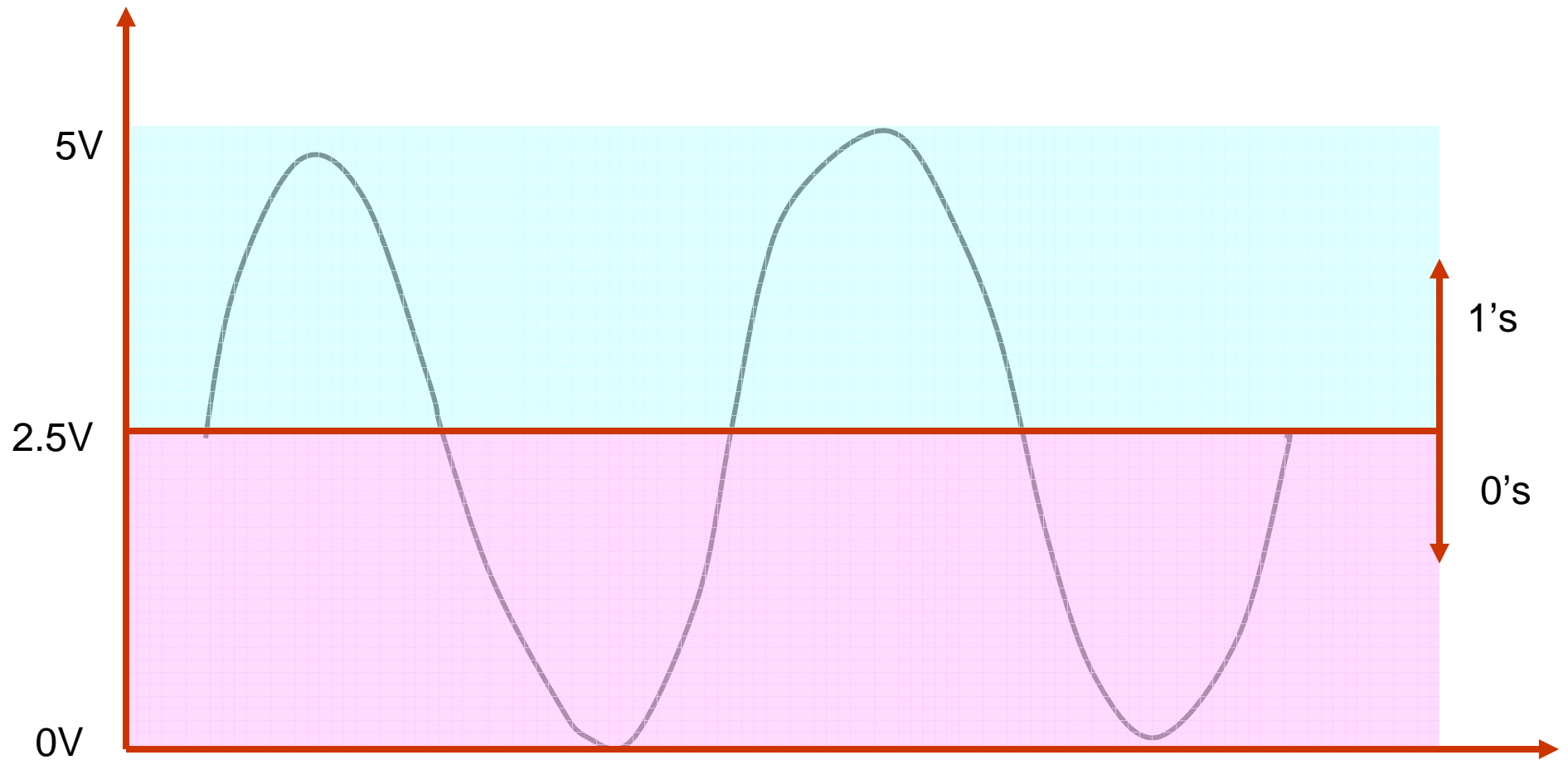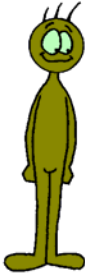
Aliens and Humans

Aliens

Humans

Tall and Short

Tall
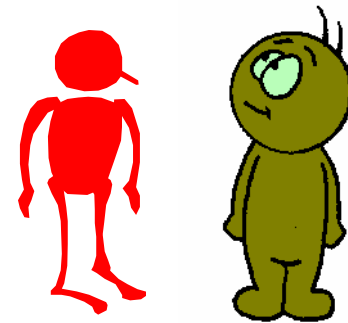
Short
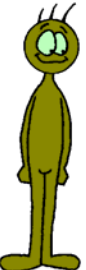
Two Questions

	Alien?	Tall?
	No	No
	No	Yes
	Yes	No
	Yes	Yes

Computers Understand Only Zeros
and Ones

We have used the convention that

True   =   1
False   =   0

	Alien?	Tall?
	0	0
	0	1
	1	0
	1	1

Let's Ask the Computer Now

Show me a tall alien :

Show me a short human :

Let's Make Some Assertions

- We will make assertions about   and let's decide on a grade
    - Both assertions correct : 1 point
    - Otherwise : 0 point
- Assertions can be verified

AND

				Grade
He is short	No	He is alien	No	0
He is short	No	He is human	Yes	0
He is tall	Yes	He is alien	No	0
He is tall	Yes	He is human	Yes	1

Let's Make New Assertions

- Again about
- Grading Policy
  - Both Wrong   : 0 Points
  - Otherwise   :1 Point
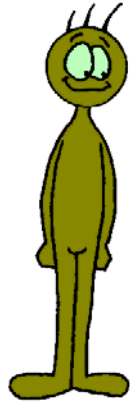
OR

		Grade
He is short	He is alien	0
He is short	He is human	1
He is tall	He is alien	1
He is tall	He is human	1

Teaser
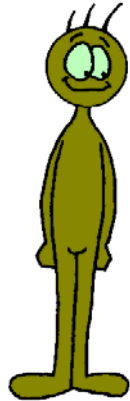
- Grading :
  - Correct answer : 0 Point
  - Wrong answer : 1 Point

	Grade
He is alien	1
He is alien	0

Now in 0's and 1's
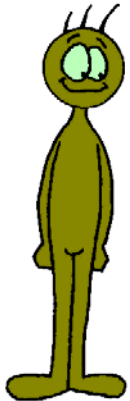
AND

				Grade
He is short	0	He is alien	0	0
He is short	0	He is human	1	0
He is tall	1	He is alien	0	0
He is tall	1	He is human	1	1

Truth Table - AND

		AND
0	0	0
0	1	0
1	0	0
1	1	1

Truth Table - OR

		OR
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table - NOT

	NOT
0	1
1	0

Logic

- **You just learned the basic algebra of logic**
    - Just like you learnt algebra in Class VI

- **It's called Boolean Algebra**
    - Named after Boole

- **Variables can take only two values in Boolean Algebra**
    - 0 and 1

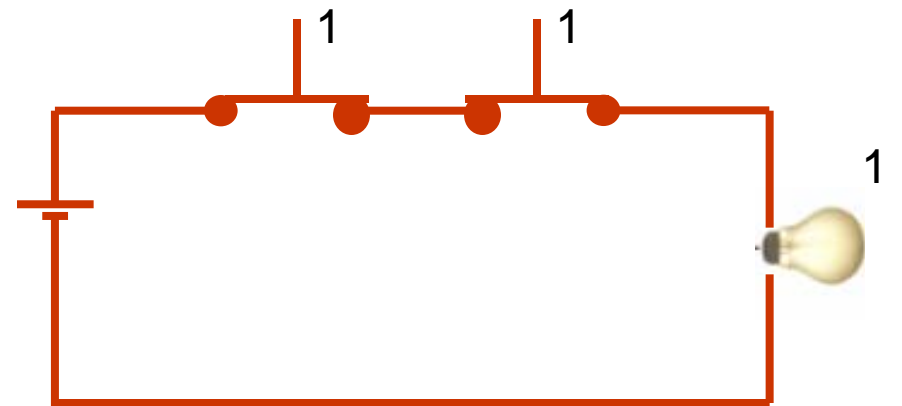- **What about the electrical values?**
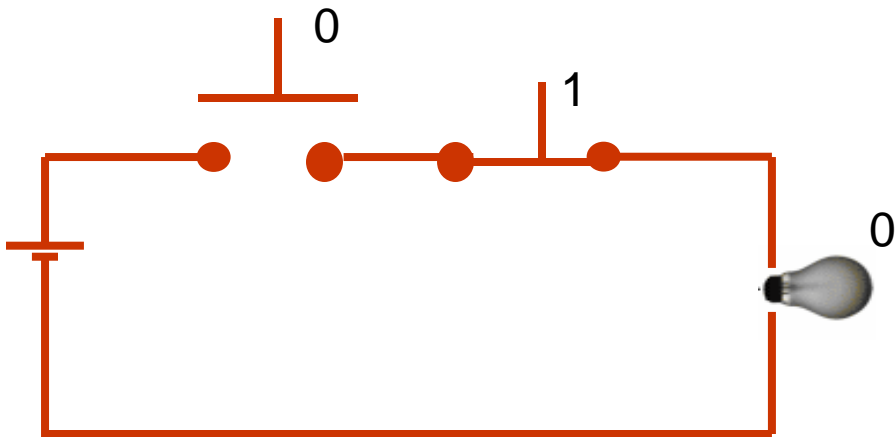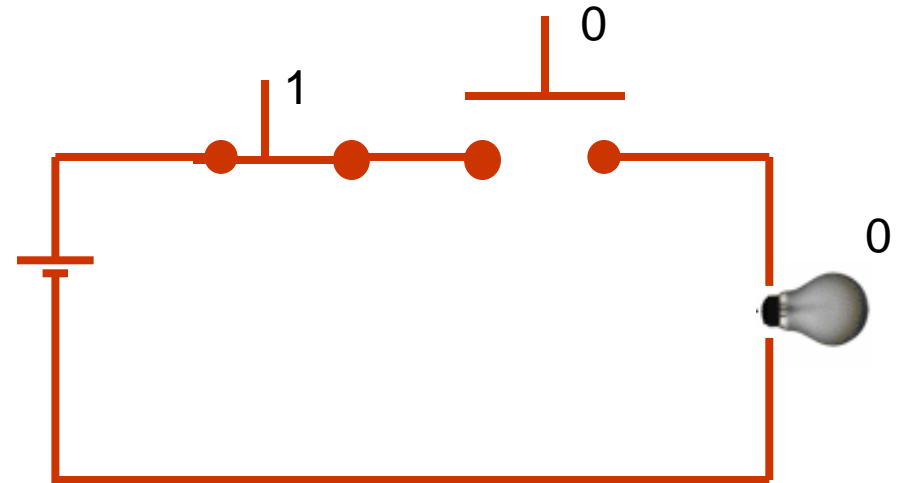   - Abstracted
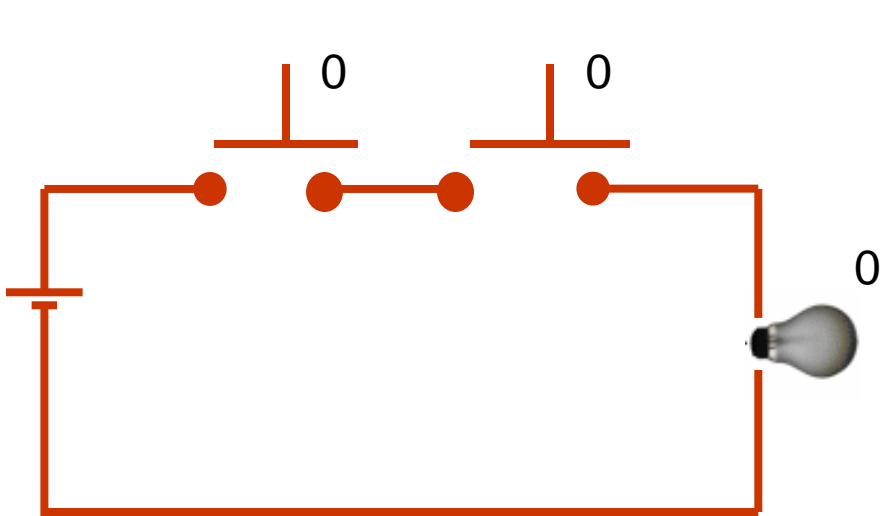   - 0 and 1, not voltage levels
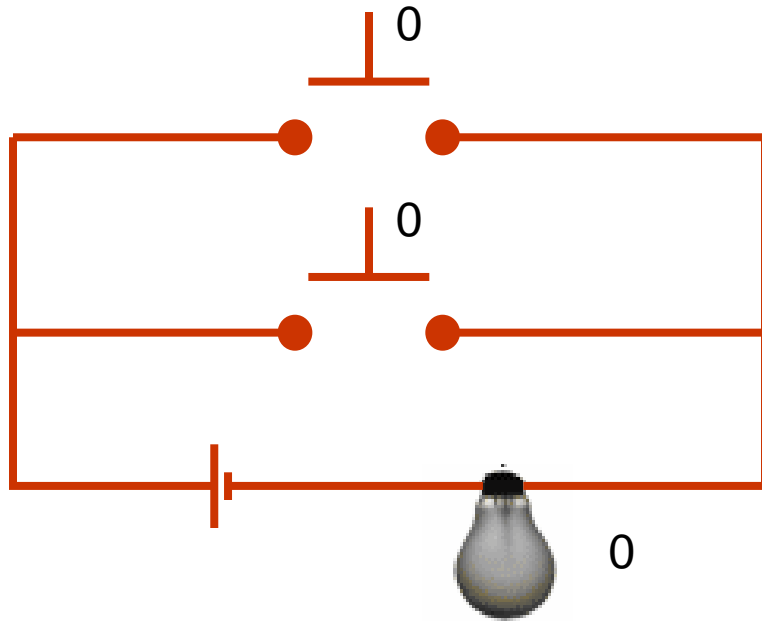
AND, OR and NOT

- Three powerful musketeers
- Forms the basis of all computer operations
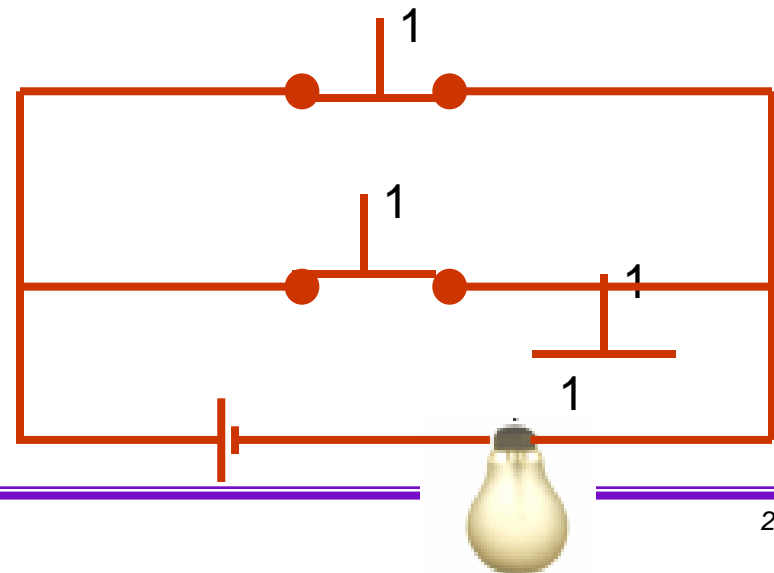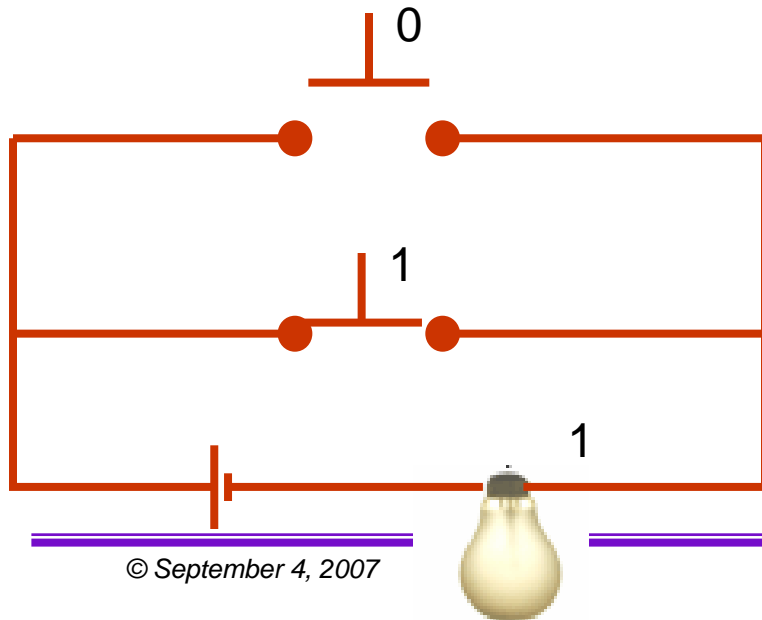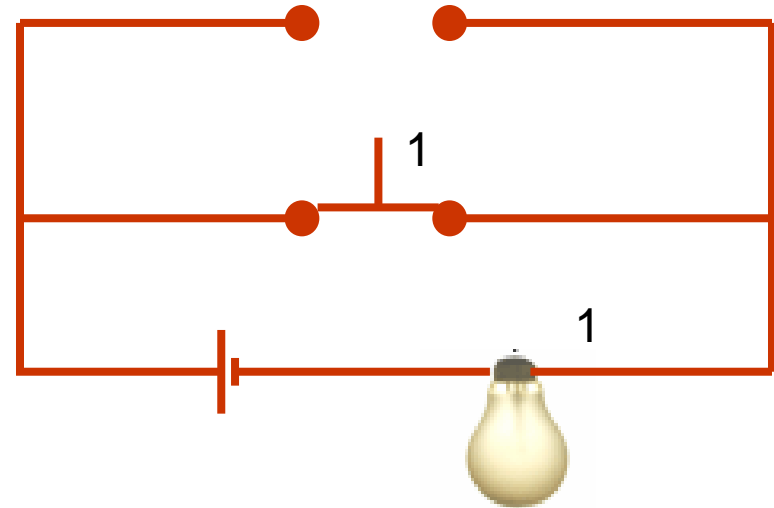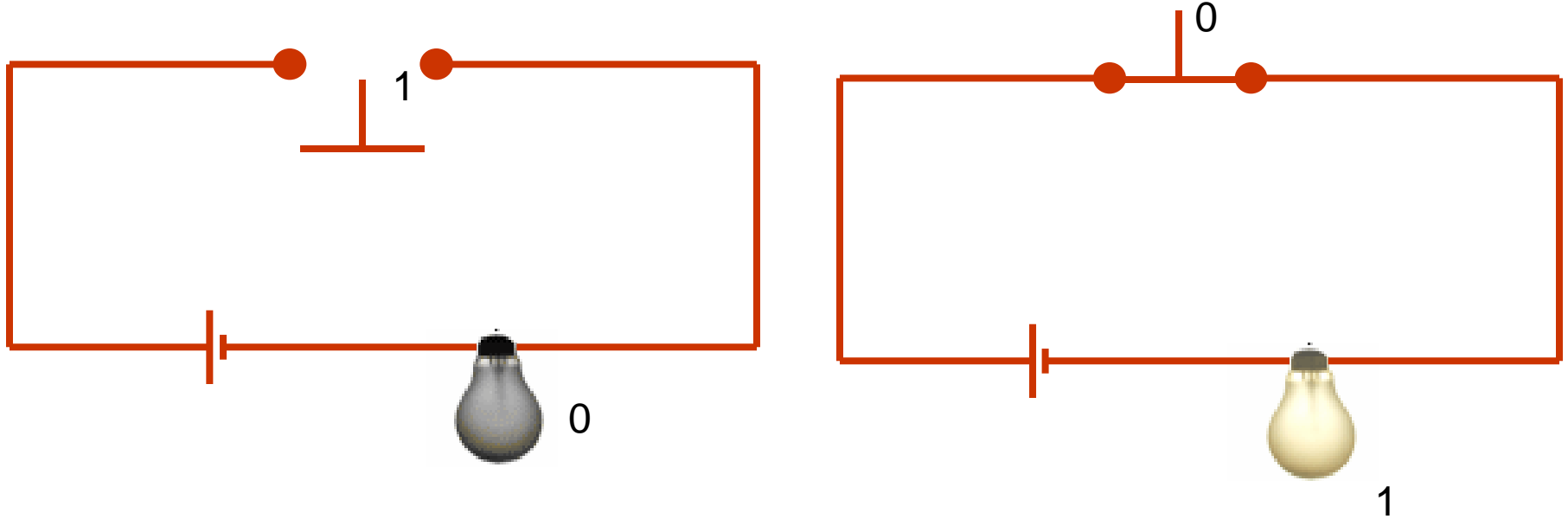- Let's look at more examples

Let there be light (1)

Logical AND

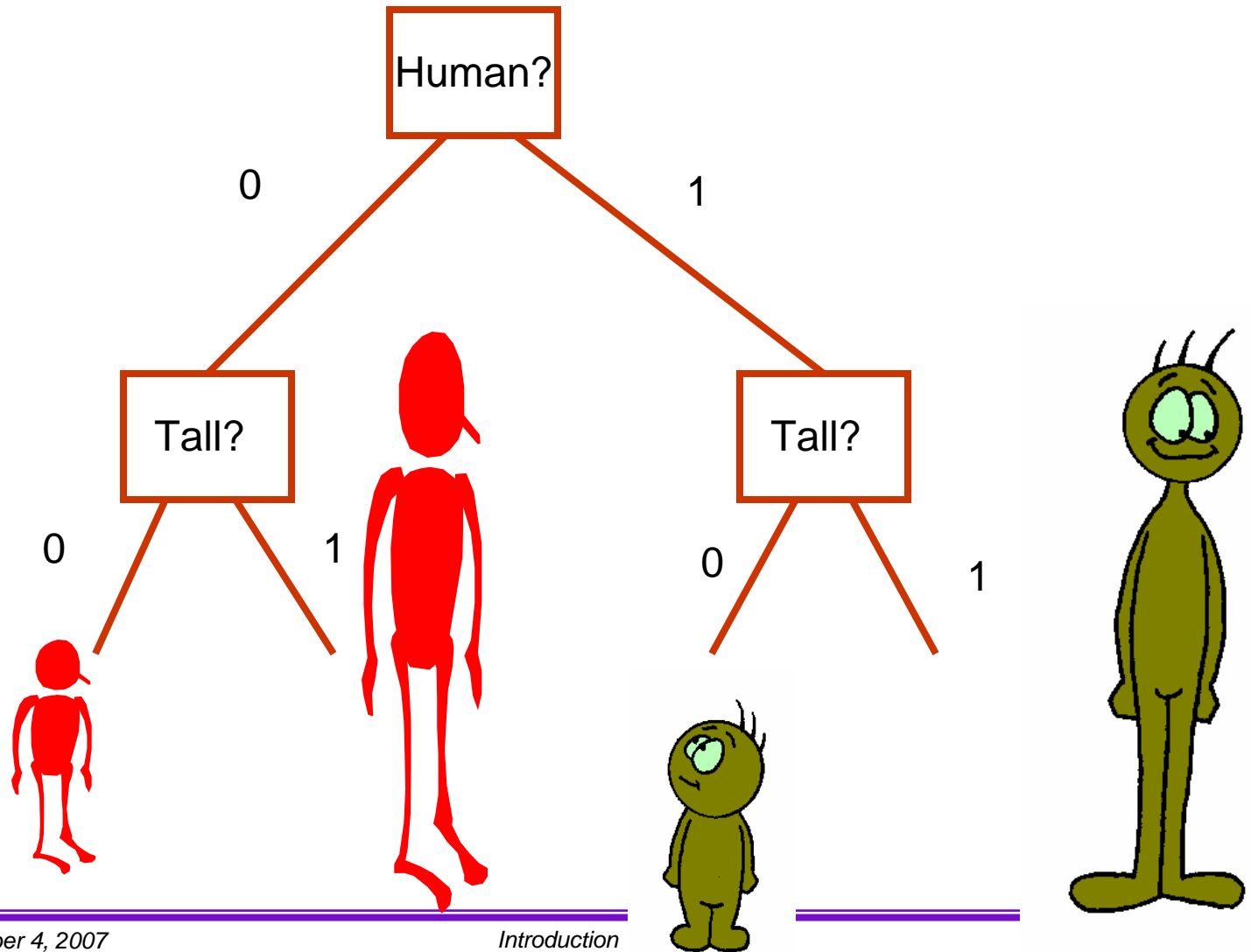# Let there be light (2)

Logical OR

Introduction

Let there be light (3)

Logical NOT

Let's See How Else 0 and 1 Can be Used

What Did We Just Do?

- Took two decisions
  - First one, alien or not
  - Second, tall or not
- Methodical steps
  - Check for aliens first
    - Cuts down choices to two
  - Check for height next
    - Finds exact answer
- Such a sequence of methodical steps is called an algorithm
- We used the same semantics
  - 0 means False
  - 1 means True