A Bit More Information

Background on Binary and Computers

Charlie Chiccarine

PaTTAN Computer Science Praxis Prep

Quick Overview

Almost nothing in this section is on the Praxis exam. However, almost all of this information will be helpful in understanding more about computers and how binary and bits work. This mostly goes over how this works on a fundamental hardware level. Also, this is all super cool.

On and Off

What is a bit?

- 1 and 0
- On and Off
- True and False
- High and Low

When we look at this from a hardware standpoint, on wires, we mostly care about On and Off.
We can toggle these On and Offs with electronic switches called **transistors**.

Transistors

- Transistors are little switches controlled by an electronic pulse
- These are fundamental in computer systems
- Moore's Law
  - The speed and capacity of computers doubles each year
  - The number of transistors in a microchip doubles each year

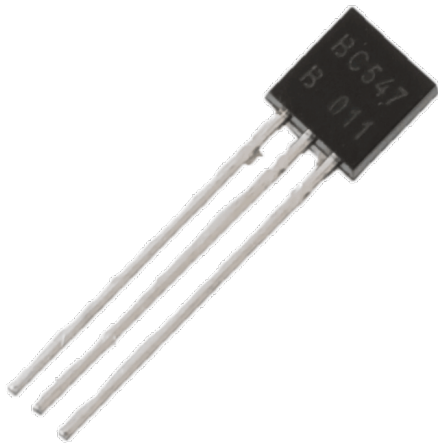


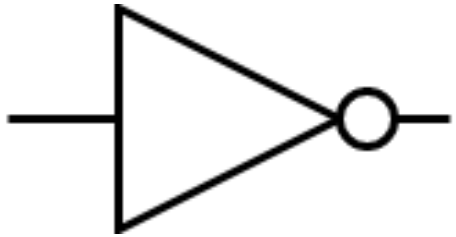
Image Source: https://potentiallabs.com/cart/bc547-transistor

Logic Gates

- Logic gates are made of transistors
- How we perform operations on bits
- Four main important gates
  - Not
  - Or
  - And
  - Xor
- Kinda like the + - * / of bit math

Not

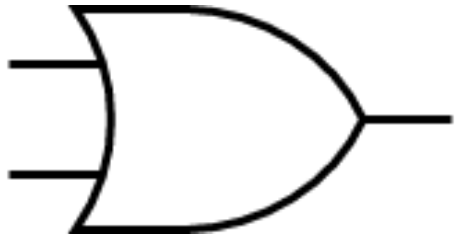
- Returns the opposite of what was entered
- Negates the input
- In goes 0, out comes 1
- In goes 1, out comes 0



x	NOT x
0	1
1	0

Or

- Returns true (1) as long as there is a 1 in the equation
- Think about it in terms of language
- True if this or this happens
- Only one thing has to happen for it to be true



x	y	x OR y
0	0	0
0	1	1
1	0	1
1	1	1

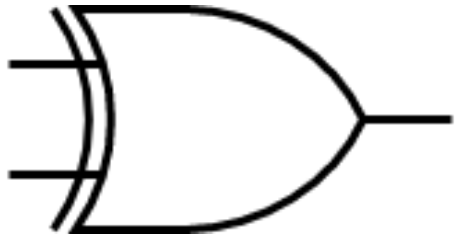
And

- Returns true (1) as long as all things are 1
- Think about it in terms of language
- True if this and this happens
- Both things must happen for it to be true

x	y	x AND y
0	0	0
0	1	0
1	0	0
1	1	1

Xor

- Exclusive Or
- Returns true (1) if only one thing is true
- Thing about it in terms of language
- True if this or this happens, but not both



x	y	x XOR y
0	0	0
0	1	1
1	0	1
1	1	0

Doing More Complex Operations

- Now that we have our basic operations, we can do more complex things
- We can use these operations to add bits in binary
- Once we can add, we can also subtract (addition in reverse), multiply (repeated addition), and divide (inverse of multiplication) in binary
- Once we have all these operations, we have a computer

Adding

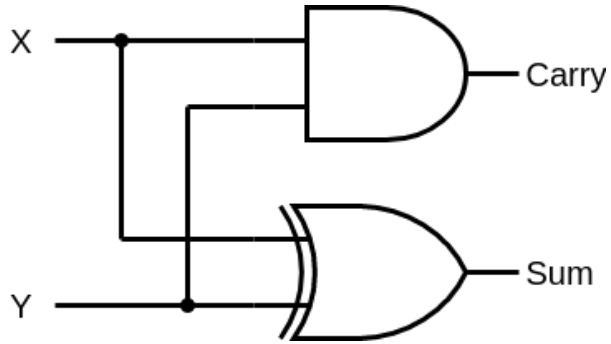
- Now, instead of performing an operation on a true false value, I'm gonna add the numerical 0 and 1 values of x and y in binary
- $0 + 0 = 00$, $0 + 1 = 01$, $1 + 0 = 01$, $1 + 1 = 10$
- What do we notice about the sum and carry column?
- Look familiar?

x	y	carry	sum
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

Adding

- They should look familiar!
- The carry column is the same output as x AND y
- The sum column is the same output as x XOR y
- Using our logic operators, we can perform binary math

x	y	carry	sum
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0



Recap

- Binary and bits are fundamental to how computers work
- Since a wide variety of operations can be performed on bits, and all information can be represented using bits, a wide variety of operations can be performed on all information