QCI

Day 1: The classical computing paradigm

Introductions!

About me

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Introduce yourselves!

Name

Where you're from

Interests

Classical Computing

Storing information

Transistors → circuits

Logic gates

Speaker notes

We store information digitally in classical computers using circuits

Circuits are made of lots of transistors (on/off switches)

We can use transistors to build logical gates, which will allow electrical current to flow through only in certain conditions

Bit

Smallest unit of information

Speaker notes

Bit = binary digit

Jamboard: Go over how to add in binary

8 bits = 1 byte

1000 bytes = 1kB

10^6 bytes = 1MB

Representing the Bit

booleans: on/off, 0/1, true/false

Coin, magnets

Switches

The Transistor

Computer circuits

Made of semiconductors

Function as electronic switches

Billions on modern chips

Logic gates

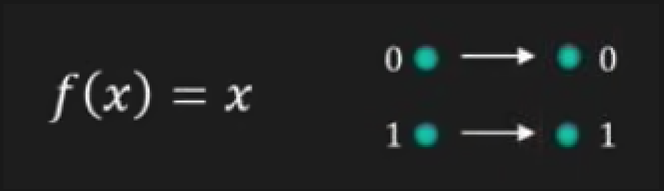
Computing with switches

Speaker notes

Computing with dominoes (2:50)

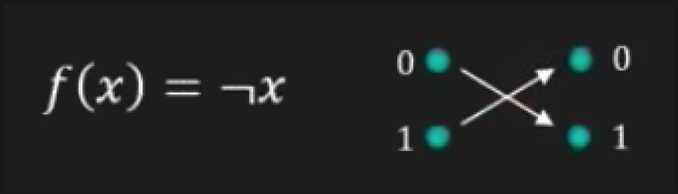
4 single-bit gates

Identity



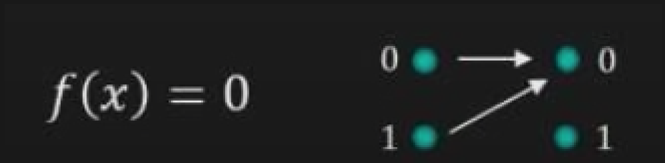
$f(x) = x$

Negation



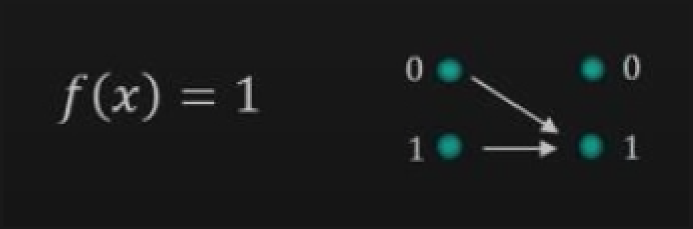
$f(x) = \neg x$

Constant-0



$f(x) = 0$

Constant-1

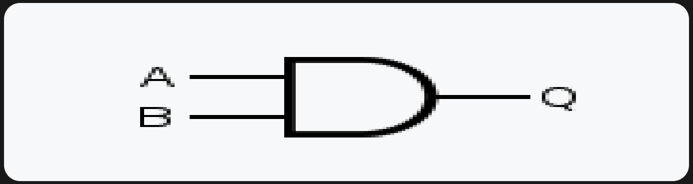


$f(x) = 1$

Multi-bit gates

Understand, don't memorize

AND gate



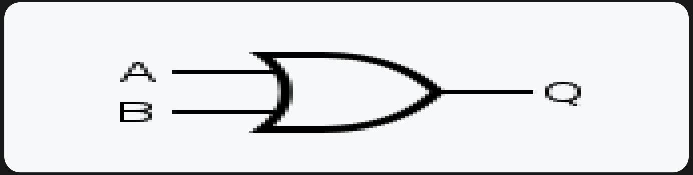
0 0 → 1

0 1 → 0

1 0 → 0

1 1 → 1

OR gate



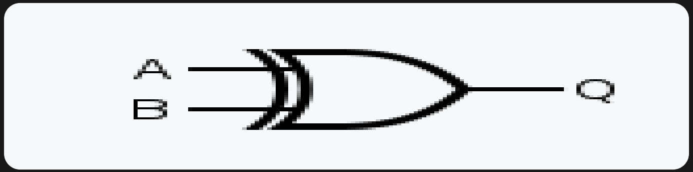
0 0 → 0

0 1 → 1

1 0 → 1

1 1 → 1

XOR gate



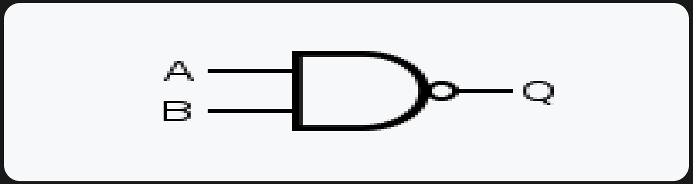
0 0 → 0

0 1 → 1

1 0 → 1

1 1 → 0

NAND gate



0 0 → 1

0 1 → 1

1 0 → 1

1 1 → 0

Exercises

(0 OR 1) AND 1

NOT((1 XOR 1) OR 0)

0 NAND 0

0 XOR (0 NAND 1)

1 OR (1 AND XOR(0 OR (0 NAND NOT(1))))

Programming Exercise

Write a function

```
myFunc(s: str) -> bool
```

that computes a running XOR

```
myFunc("0101")
myFunc("0101")
```

0 XOR 1 → 1

101

```
myFunc("101")
```

1 XOR 0 → 1

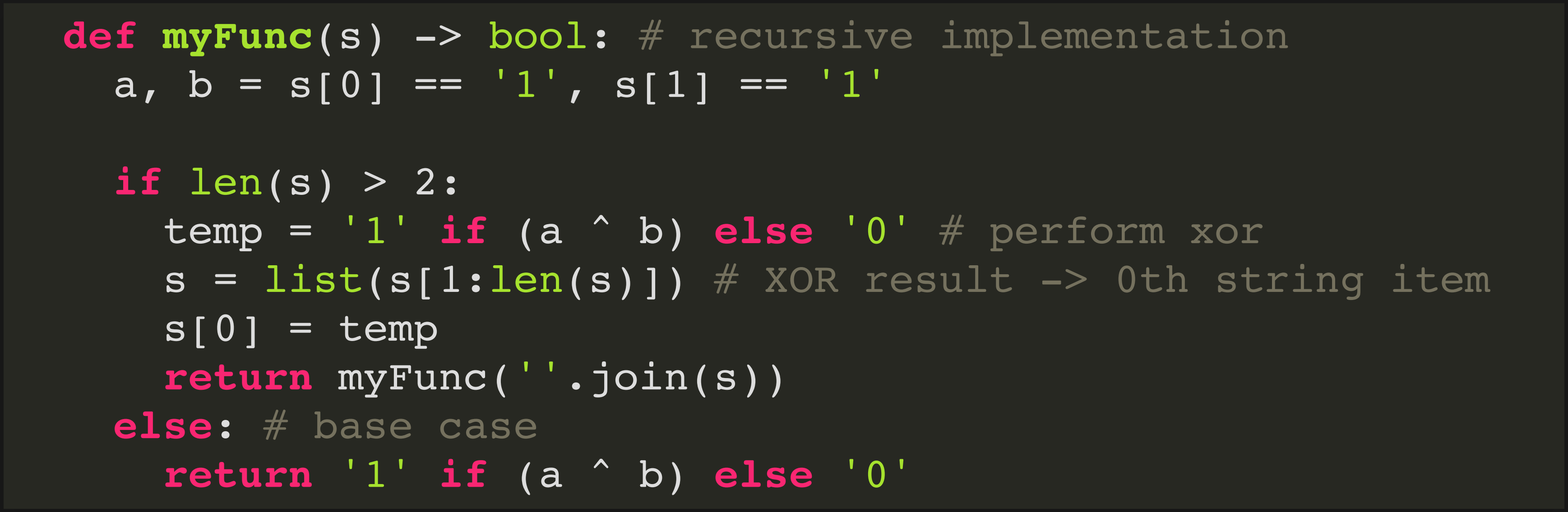
11

```
myFunc("11")
```

1 XOR 1 → 0

0

Sample Solution



```python
def myFunc(s) -> bool: # recursive implementation
  a, b = s[0] == '1', s[1] == '1'

  if len(s) > 2:
    temp = '1' if (a ^ b) else '0' # perform xor
    s = list(s[1:len(s)]) # XOR result -> 0th string item
    s[0] = temp
    return myFunc(''.join(s))
  else: # base case
    return '1' if (a ^ b) else '0'
```

Challenge: Solve XOR iteratively

Next time: Intro to Linear Algebra

Questions?

Thank you!

References

- https://en.wikipedia.org/wiki/Bit
- https://en.wikipedia.org/wiki/Transistor
- https://www.youtube.com/watch?v=F_Riqjdh2oM
- https://en.wikipedia.org/wiki/Logic_gate