Boolean Algebra

CS 2130: Computer Systems and Organization 1
January 14, 2026

Announcements

If you need to switch labs:

- Send me an email if you are unable to swap

Final exam update

- April 30, 2026 at 7-10pm

Questions?

Ask me *almost* anything

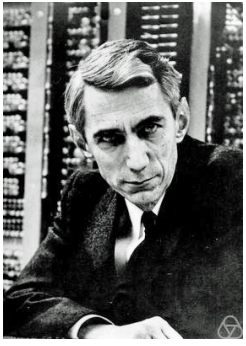
Where to start?

Where to start?

0 and 1

Why only 0 and 1?

Claude Shannon



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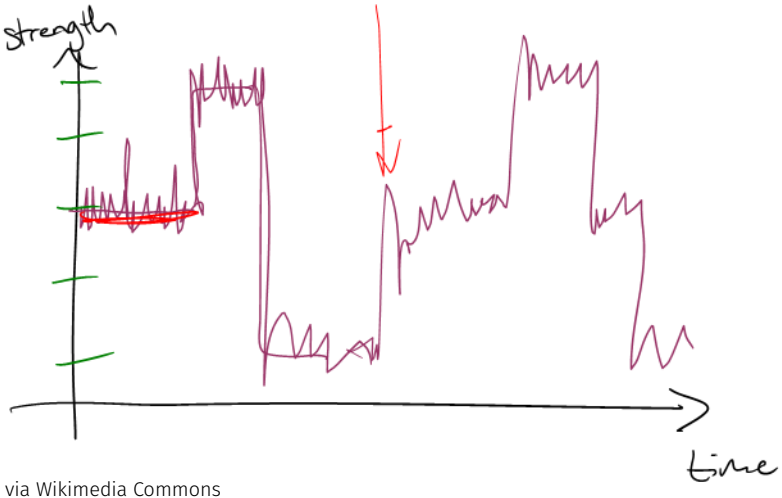
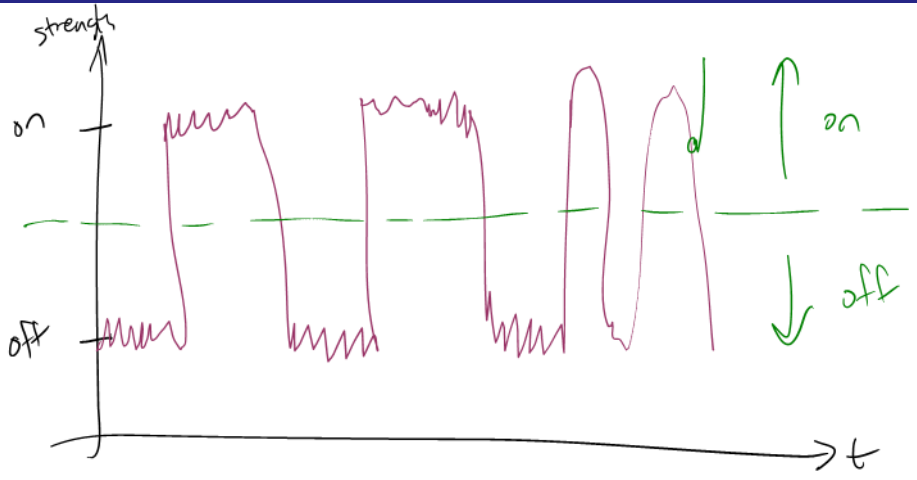


Why only 0 and 1?



Vocabulary

- **bit** - either a 0 or 1
- **binary** - a system that has only two positions
- **trinary** - a system that has only three positions
- **quadrinary** - a system that has only four positions
- ...

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- ...
- **decinary** - ...

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- **decimal** - system that has ten positions

Boolean Algebra

Python: and or not

Java: && || !

George Boole

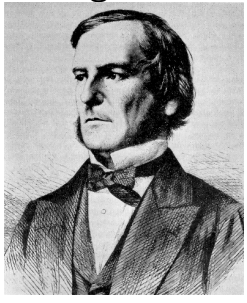

Photo Public Domain

Putting it together

Overall idea:

- Only need two things (Shannon)
- We can do math with two things (Boole)

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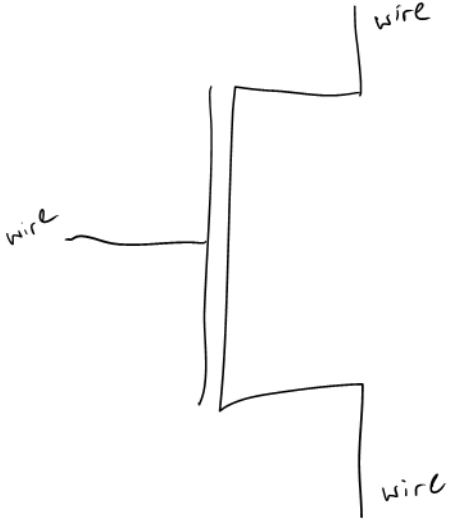
Now we need a physical device that deals in two levels

Transistors



More Vocabulary

Electricity (conceptually) - involves flow of electrons or other charged carriers through a conductive material

- **current** - rate of flow
- **voltage** - pressure of flow

Examples in water

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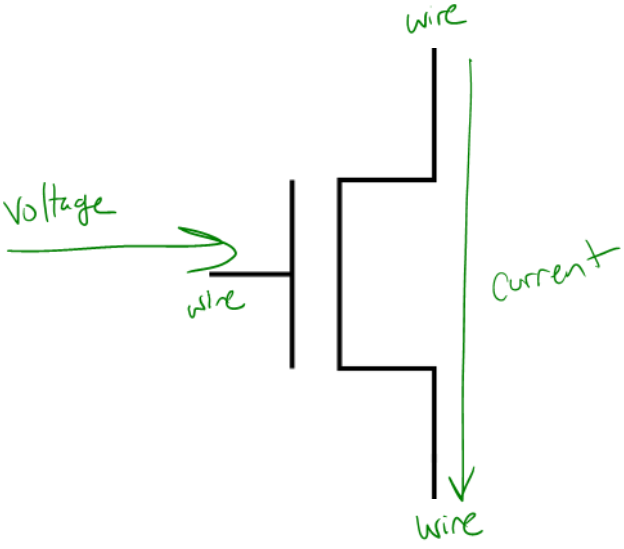
- High pressure, low flow - squirt gun
- Low pressure, high flow - bucket of water

Transistors



Transistors

Transistors act like an electrically-triggered switch

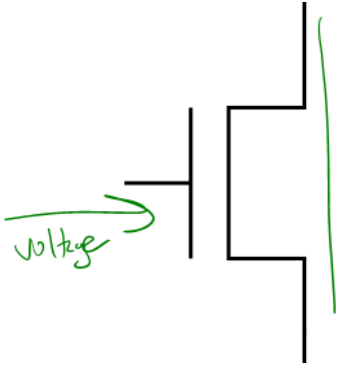
- No voltage, no current
- Apply voltage to allow current to flow

Transistors

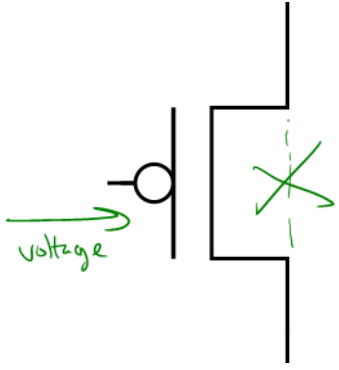
Transistors act like an electrically-triggered switch

- No voltage, no current
- Apply voltage to allow current to flow
- The amount of voltage needed to close the gate is boundary between 0 and 1
- Central technique for how we are going to build binary computers

Transistors



push to close



push to open

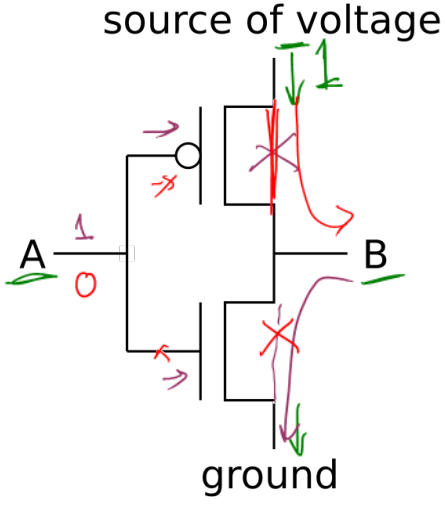
Circuit Diagram

A	B
1	0
0	1

NOT

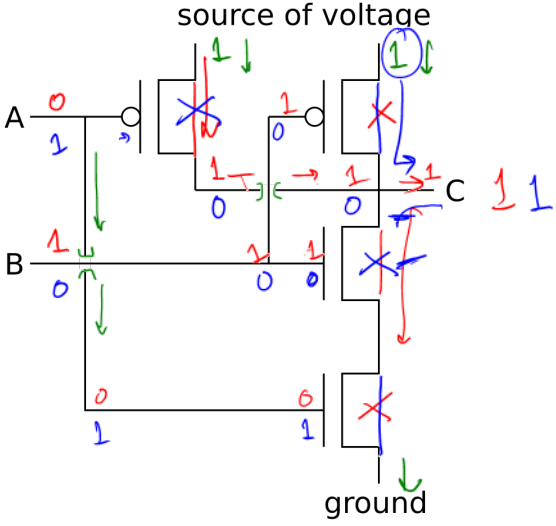
B = !A

B = not A



Circuit Diagram

A	B	C
0	0	1
0	1	1
1	0	1
1	1	0



Circuit Diagram

NAND