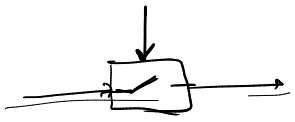
2 transistors ⟶ NAND.

(Transistors — electronic switch



NAND	T	F
T	F	T
F	T	T

Claim: NAND is universal, i.e. we can build anything out of NAND.

Lemma: AND + OR + NOT are universal.

Proof:

Suppose we have an arbitrary Boolean function. eg.

x	y	f(x,y) — XOR
T	T	F
T	F	T
F	T	T
F	F	F

① Write down the inputs for each row that is T using AND, NOT.

$x \wedge \neg y$.

$\neg x \wedge y$.

② Combine with OR:

$(x \wedge \neg y) \vee (\neg x \wedge y)$.

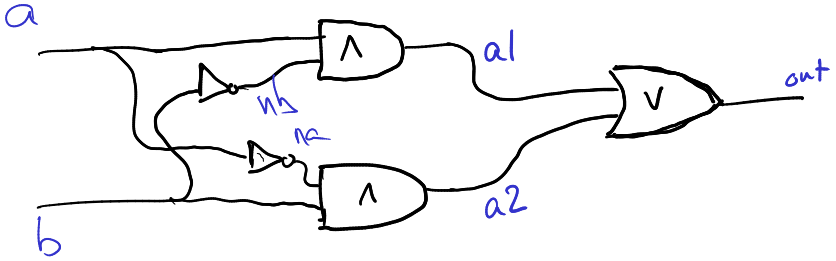
Lemma: we can build AND, OR, NOT out of NAND.

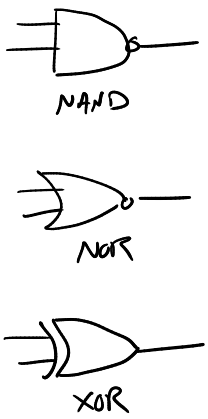
Proof: Project 1.

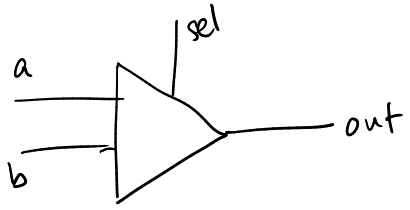
Let's build XOR gate!

① Come up w/ a boolean expression

② Draw it as a digital logic circuit diagram.

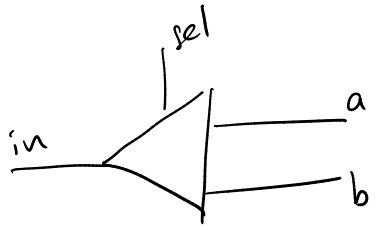






Mux

either a or b is copied to output depending on sel.



DMux