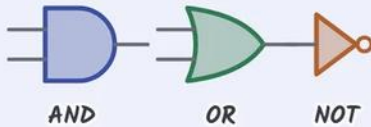


seven gates, two of them enough on their own, and the circuits built out of them

Seven gates, and what each one answers

- NOT inverts, AND is true only when all inputs are true, OR is true when at least one is
- NAND and NOR are those two followed by an inversion, and the bubble on the symbol is what marks it
- XOR is true when the inputs differ, and XNOR is true when they agree, so XNOR is the equality detector
- a gate is a physical circuit, so its truth table is a description of voltages, not of an abstract formula



the three basic shapes every other gate is drawn from: AND's flat back, OR's swept curve, NOT's triangle with the inverting bubble

A	B	XOR
0	0	0
0	1	1
1	0	1
1	1	0

XOR: 1 exactly when the inputs differ

XNOR: the XOR column inverted, so 1 exactly when the inputs agree

XOR and XNOR are complements of each other, and each is the other with a bubble added

Why NAND and NOR are called universal

- a set of gates is universal if AND, OR and NOT can all be built from it alone, because everything else is built from those three
- NAND alone: tie both its inputs together and it inverts, so NOT is free; a NAND then a NOT gives AND; NOT on each input then a NAND gives OR
- NOR alone does the same job by the dual route, and both facts follow directly from De Morgan
- chips are made largely of one gate type because one repeated cell is cheaper to fabricate than seven different ones