Let's Make A Circuit!

Grab Logisim, and get comfortable using it. You can build all sorts of simple circuits, and simulate them.

We'll build an adder. Some key ideas -- the notion of abstraction (hide details of how something operates, to reduce complexity). Modularity -- be able to reuse parts. Regularity -- try to keep things from getting messy, and have a structure that's easy to understand. Heirarchy -- build a complex system with multiple layers of smaller, simpler parts.
To start with. Truth tables

Suppose we're going to add 0101 and 0011. In the first, right-most column, we add 0 to 1... We have a "sum" bit of 0, and a "carry" bit of 1. But let's make a truth table for all the possible combinations....
Circuit Design Time....

We've got AND, OR, NOT gates, XOR, XNOR, NAND, NOR.... Can we wire them together to make a circuit that does addition. (Spoiler alert, the answer is "yes.")
Other Columns

In other columns, we have two bits from the numbers we're adding... plus a "carry" bit from the prior column. We build another truth table, with a sum bit, and a carry that could go into the next column.
The Circuits -- Half Adder
The Circuits -- Full Adder
An Adder