Half Adder

A half adder adds 2 single-digit binary numbers and produces a sum and a carry.

\[
\begin{array}{c|c|c}
A & B & \text{Carry} & \text{Sum} \\
\hline
0 & 0 & 0 & 0 \\
0 & 1 & 0 & 1 \\
1 & 0 & 0 & 1 \\
1 & 1 & 1 & 0 \\
\end{array}
\]

But if we want to add multiple digits, this only does "half" of the job (hence the name "half adder"). To add multi-digit binary numbers, we need to be able to handle a carry coming in from the previous column and then send our carry out to the next column.

This is exactly the same way we add multi-digit decimal numbers:

\[
\begin{array}{c|c|c}
\text{Carry out} & \text{Carry in} \\
\hline
0 & 0 & 1 & 0 \\
2 & 6 & 7 & 7 \\
+ & 2 & 8 & 0 \\
\hline
2 & 9 & 5 & 5 \\
\end{array}
\]

In the middle column, we're adding 6 + 2. But we have a carry coming in from the column on the right. So we need to add 6 + 2 + 1 (the carry) and produce 9 (the sum) and 0 (the carry for the next column).