




Computers talk using only 0s and 1s

Computers **only** use 0's and 1's. They do math with only 0's and 1's. They communicate to other computers using only 0's and 1's. Everything on a computer is done with combinations of 0's and 1's.

This is called Binary! So you might be wondering, "How can I add $8 + 7$ using only 0's and 1's?"

Good question!

Combinations of 0's and 1's represent normal numbers and letters.

computer number representations				Human number representations
0		=		0
1		=		1
10		=		2
11		=		3
100		=		4
101		=		5
110		=		6
111		=		7
1000		=		8
1001		=		9
1010		=		10

To do addition like a computer follow these steps:

1. Convert human representation of numbers to computer representation.
2. Add the 0's and 1's like normal (remember $1 + 1 = 10$ represented in a computer).
3. Convert the solution from computer representation back to human representation.

Example: Compute $3 + 4$ like a computer would.

1. Convert numbers from human representation into computer representation

$$3 \longrightarrow 11$$

$$4 \longrightarrow 100$$

2. Add like normal

$$\begin{array}{r} 011 \\ +100 \\ \hline 111 \end{array}$$

3. Convert back to human representation:

$$111 \longrightarrow 7$$

$$\text{Therefore, } \mathbf{3 + 4 = 7}$$

Problems: compute the following equations like a computer does

$$1 + 1 =$$

$$\begin{array}{r} 01 \\ + 01 \\ \hline 10 \end{array}$$

$$10 \rightarrow 2$$

**Notice how $1 + 1 = 10$, so you carry the 1

$$1 + 1 = 2$$

$$7 + 3 =$$

$$\begin{array}{r} 111 \\ + 011 \\ \hline 1010 \end{array}$$

$$1010 \rightarrow 10$$

$$7 + 3 = 10$$

$$1 + 2 =$$

$$6 + 3 =$$

$$0 + 0 =$$

$$5 + 0 =$$

$$7 + 1 =$$

$$4 + 1 =$$

$$2 + 3 =$$

$$9 + 1 =$$

$$2 + 8 =$$

$$10 + 0 =$$

Solutions

Example: Compute $3 + 4$ like a computer would.

1. Convert numbers from human representation into computer representation

$$3 \rightarrow 11$$

$$4 \rightarrow 100$$

2. Add like normal

$$\begin{array}{r} 011 \\ +100 \\ \hline 111 \end{array}$$

3. Convert back to human representation:

$$111 \rightarrow 7$$

$$\text{Therefore, } \mathbf{3 + 4 = 7}$$

Problems: compute the following equations like a computer does

$$1 + 1 =$$

$$\begin{array}{r} 1 \\ 01 \\ + 01 \\ \hline 10 \end{array}$$

**Notice how $1 + 1 = 10$, so you carry the 1

$$10 \rightarrow 2$$

$$1+1=2$$

$$7 + 3 =$$

$$\begin{array}{r} 11 \\ 111 \\ + 011 \\ \hline 1010 \end{array}$$

$$1010 \rightarrow 10$$

$$7+3=10$$

$$1 + 2 =$$

$$\begin{array}{r} 01 \\ + 10 \\ \hline 11 \end{array} \rightarrow 3$$

$$6 + 3 =$$

$$\begin{array}{r} 11 \\ 110 \\ + 11 \\ \hline 1001 \end{array} \rightarrow 9$$

$$0 + 0 =$$

$$\begin{array}{r} 00 \\ + 00 \\ \hline 00 \end{array} \rightarrow 0$$

$$5 + 0 =$$

$$\begin{array}{r} 101 \\ + 000 \\ \hline 101 \end{array} \rightarrow 5$$

$$7 + 1 =$$

$$\begin{array}{r} 111 \\ 111 \\ + 001 \\ \hline 1000 \end{array} \rightarrow 8$$

$$4 + 1 =$$

$$\begin{array}{r} 100 \\ + 001 \\ \hline 101 \end{array} \rightarrow 5$$

$$2 + 3 =$$

$$\begin{array}{r} 10 \\ + 11 \\ \hline 101 \end{array} \rightarrow 5$$

$$9 + 1 =$$

$$\begin{array}{r} 101 \\ + 1001 \\ \hline 1010 \end{array} \rightarrow 10$$

$$2 + 8 =$$

$$\begin{array}{r} 10 \\ + 1000 \\ \hline 1010 \end{array} \rightarrow 10$$

$$10 + 0 =$$

$$\begin{array}{r} 0000 \\ + 1010 \\ \hline 1010 \end{array} \rightarrow 10$$