2021Q30 CHANGE OF BASE

QUESTIONS

Computers do wonderful things! They delivered this Wind Study to you; they let us spread the word about Utility 2.0 (check out our new video!); and they allow us to always communicate with our projects. However, computers manage to do this with only the numbers zero and one. They can sense whether they see an incoming message or not; there's no in-between for computers. But how can computers do such complicated and amazing processes with only zeros and ones? They do what's called a change of base!

A change of base means that instead of counting by tens, they count by twos. Humans count with one digit for ten numbers: 0 through 9. Then, we add the second digit: 10, 11, 12, etc. Computers do this after two numbers: 0 and 1. Then, they add the second digit: 10, 11, etc. In the following sequences, the top row is how computers count, and the bottom row is how you have probably seen counting before.

Base-2	0	1	10	11	100	101	110	111	1000
Base-10	0	1	2	3	4	5	6	7	8

We can convert from base-2 to base-10 with the power of exponents! First, we count the digits, beginning with zero, starting from the right. Then, we raise 2 to the number of the position. The zeroth position from the right is 2^0; the first position is 2^1, etc. Then, we multiply that expression by the number at that position. Let's use 101_2 (that little 2 means base-2!) as a quick example. For 101_2, we start from the right, at position zero. Now, we have 2^0, and we multiply that by the value of the digit: 1. It looks like this:

$$The\ digit's\ value * 2^{Position\ of\ that\ Value} = Part\ of\ Answer$$

$$1 * 2^0 = 1 * 1 = 1$$

Then, we do this for all the digits and add them all up. The table below runs through the whole process for 101_2.

NUMBER: 101_2			
	1	0	1
POSITION	2	1	0
EXPONENT EXPRESSION	2^2	2^1	2^0
VALUE OF DIGIT	$1 * 2^2$	$0 * 2^1$	$1 * 2^0$
FINAL VALUE	4	0	1
SUMMED VALUE	4 + 0 + 1 = 5		

Therefore, $101_2 = 5_{10}$. It's possible to translate every whole number from base-2 into base-10.

Level 1: Let's try to translate a couple numbers from base-2 to base-10.

Follow the same process in the example for the following base-2 numbers:

101101101_2

1000001_2

11111111_2

Level 2: We can translate numbers from any base including systems greater than 10! Base-16 is quite common and equates some base-10 values with letters.

A	B	C	D	E	F
10	11	12	13	14	15

A number like $A0_{16}$ does not equal 100_{10}, which would be the case if we just replaced the "A" with "10." Instead, it's equivalent to 160_{10}. Try converting the following number to base-10:

$DADCABFAD_{16}$

Our LiDAR units collect data about the wind. They transmit this data as 0s and 1s which our computers convert so that we can perform our wind analysis!