

# Some unknown methods of converting numbers to Gray code

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## Abstract

I discovered the methods I present here as I was working on a different mathematical object. I checked the relevant sequence in OEIS and found that it is similar to the A003188 sequence. That's when I learned about the existence of the Gray code. Searching the Internet, I found no reference to these methods. I do not have strict proof that guarantees the accuracy of these methods. The burden of control and proof falls on you. Once all of this is proven, I think they will make the lives of the Gray code developers easier.

## Convert decimal to Gray code

Note first that the function  $\text{int}(r+1/2)$  rounds a positive number to the nearest integer. eg  $\text{int}(13.4+1/2)=13$ ,  $\text{int}(13.5+1/2)=14$ . In practice, you can easily round a number with your mind.

We will convert 147 to a gray code.

$$\text{int}(147/2 + 1/2) = 74 \text{ even} \rightarrow 0$$

$$\text{int}(147/4 + 1/2) = 37 \text{ odd} \rightarrow 1$$

$$\text{int}(147/8 + 1/2) = 18 \text{ even} \rightarrow 0$$

$$\text{int}(147/16 + 1/2) = 9 \text{ odd} \rightarrow 1$$

$$\text{int}(147/32 + 1/2) = 5 \text{ odd} \rightarrow 1$$

$$\text{int}(147/64 + 1/2) = 2 \text{ even} \rightarrow 0$$

$$\text{int}(147/128 + 1/2) = 1 \text{ odd} \rightarrow 1$$

$$\text{int}(147/256 + 1/2) = 1 \text{ odd} \rightarrow 1$$

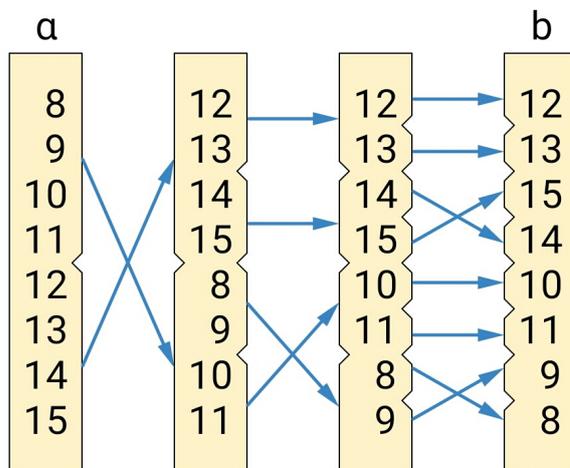
*Gray code* 11011010

We divided the 147 with successive powers of 2 and stopped at 256 because  $147/512 < 0.5$ . We rounded each fraction to the nearest integer. If this integer is even, then we put next to it the digit 0, otherwise we choose the digit 1. The formed Gray code is read from bottom to top.

## Mass conversion of numbers to Gray code

Note first that the gray code has the same number of binary digits as the number to be encoded. This means that the set of the coded numbers that in the binary system have  $n$  digits is a rearrangement of numbers from  $2^{n-1}$  to  $2^n - 1$ .

The following table shows the characteristic matching pattern in the area of the four-digit binary numbers (8-15). The numbers to be coded are written in order in the first column from top to bottom. There are two ways to transfer groups of numbers from column to column, crosswise ( $\times$ ) and parallel ( $=$ ). For example, if  $a=11$  then (Gray code)  $b=14$  (and vice versa).



As you can see, from the second column onwards the two types of number transfer always start at the top with "=" and alternate with each other\*.

You could place the numbers below the first column in their binary format to get the binary representation of their codes in the last column. You must now be able to encode any group of  $n$ -digit binary numbers.

(\*) By the way, if you start with " $\times$ " you will end up with another OEIS sequence.