

Let's get started !

Q: How do people and computers
represent numbers ?

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

Base 10

$$238 = 2 \cdot 10^2 + 3 \cdot 10^1 + 8 \cdot 10^0$$

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

$$m = \sum_{i=0}^{k-1} a_i 10^i$$

$$= (a_{k-1} \ a_{k-2} \ \dots \ a_2 \ a_1 \ a_0)_{ten}$$

Base 2

$$11010 \equiv 1 \cdot 2^4 + 1 \cdot 2^3 + 0 \cdot 2^2$$

$$+ 1 \cdot 2^1 + 0 \cdot 2^0$$

Assignment Project Exam Help

$$= 16 + 8 + 2 = 26$$

Add WeChat edu_assist_pro

$$m = \sum_{i=0}^{n-1} b_i 2^i$$

$$= (b_{n-1} b_{n-2} \dots b_2 b_1 b_0)_{\text{two}}$$

Counting in binary

decimal

0

1

2

3

4

5

6

7

8

⋮

binary

0

1

10

11

100

101

110

111

1000

⋮

binary

0000

0001

0010

0011

0100

0101

0110

0111

1000

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

To convert from binary to decimal, you need to know the powers of 2.

n	2^n
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256
9	512
10	1024
\vdots	\vdots

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

memorize

How can we convert m from decimal to binary?

Idea 1:

Find the biggest power of 2 less than or equal to m , <https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

Repeat until done.

(Requires memorizing powers of 2.)

How can we convert **m** from decimal to binary?

Idea 2: Consider familiar idea from base 10:

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

$$238 = 230 + 8$$

$$m = (m / 10) \times 10 + m \% 10$$

↑
integer division

Same idea works in base 2.

$$m = (m / 2) \times 2 + m \% 2$$

Assignment Project Exam Help

Example:

<https://eduassistpro.github.io/>

$$m = (10011)_{\text{two}}$$

Add WeChat edu_assist_pro

$$m / 2 = 1001$$

$$m \% 2 = 1$$

$$m = \sum_{i=0}^{n-1} b_i 2^i$$

$$= (b_{n-1} b_{n-2} \dots b_2 b_1 b_0)_{\text{two}}$$

Assignment Project Exam Help

$$m/2 = \sum_{i=1}^{n-1} b_i 2^{i-1}$$

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

$$= (b_{n-1} b_{n-2} \dots b_2 b_1)_{\text{two}}$$

$$m \% 2 = b_0$$

Algorithm:

given m in decimal, convert it to binary.

$i \leftarrow 0$

while $m > 0$ {

$b_i \leftarrow m \% 2$

$m \leftarrow m / 2$

$i \leftarrow i + 1$

}

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

Example

$$m = 241 = (1111\ 0001)_{\text{two}}$$

b_i

m

241

$\equiv 120 \times 2 +$

60

30

15

7

3

1

0

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

0

0

0

1

1

1

1

3

(1111 0001)_{two}

1111 000

1111 00

1111 0

1111

111

11

1

bi

1

0

0

0

1

1

1

1

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

Q: How to add two numbers in binary ?

Addition (base 10)

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

$$\begin{array}{r} 2343 \\ + 5819 \\ \hline 8162 \end{array}$$

You need to memorize single digit sums to do this.

Addition (base 2)

0 0 | 1 0 | 0

0 0 0 | 1 0 1 0 ←

0 0 0 | 1 0 1 0 ←

Add WeChat edu_assist_pro

0 0 | 1 0 | 0 1 ←

26

27

53

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Subtraction (base 10)

2 3 4 3

Assignment Project Exam Help

<https://eduassistpro.github.io/>

Add WeChat edu_assist_pro

ASIDE: the grade school algorithm doesn't work when the bigger number is on the bottom. To take the difference using the grade school algorithm, you put the bigger number on top and take the negative of the result.

$$a - b$$

$$= a + (-b)$$

Assignment Project Exam Help

Next class we will learn how to represent negative numbers in binary which allows us to perform sum.

Add WeChat edu_assist_pro