

Section 1.1: Decimal and Octal

Tuesday, January 7, 2020 11:24 AM

decimal = base 10

(why? 10 fingers)

historical note: (digression - will not be tested)

Sumerians / Babylonians	used base	60
Mayans		20
Aksumites		27

decimal:

0

1

2

3

4

5

6

7

8

9

10

← one ten, no ones

11

← one ten, one ones

12

← one ten, two ones

note: in base ten,
we use two symbols
(10) to represent
the base
- we don't have a
single digit for "ten"

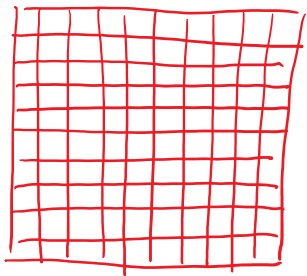
the number 23 means:

2 tens 3 ones
2 of the base 3 leftover



what about 123?

1 hundred



$$123 = 1 \times 100 + 2 \times 10 + 3 \times 1$$

$$= 1 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$$

so for bases other than ten, it's the same idea!

let's look at base four:

0_4
 1_4
 2_4
 3_4
 10_4
 11_4
 12_4
 13_4
 20_4
 21_4
 22_4
 23_4
 30_4
 31_4
 32_4
 33_4
 100_4

\leftarrow 3 fours, 3 ones
 \leftarrow 1 sixteen, no fours, no ones
 \uparrow
 group of 4 fours
 $4^2 = 16$

notation:

123_4

\uparrow
 the subscript is the base (in base ten)
 if no subscript, default is ten

$$\begin{aligned}
 123_4 &= 1 \times 4^2 + 2 \times 4^1 + 3 \times 4^0 \\
 &= 1 \times 16 + 2 \times 4 + 3 \times 1 \\
 &= 27 \quad (\text{or } 27_{10})
 \end{aligned}$$

example: convert the following numbers to decimal:

$$a) 213_4 = 2 \times 4^2 + 1 \times 4^1 + 3 \times 4^0 = 39$$

$$b) 3012_4 = 3 \times 4^3 + 0 \times 4^2 + 1 \times 4^1 + 2 \times 4^0 = 198$$

2020/01/08

what bases are commonly used in computing?

binary - base two
hexadecimal - base 16
octal - base 8

} next section

octal: base 8:

decimal	octal
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	10 ₈
9	11 ₈
10	12 ₈

9	11_8
10	12_8
11	13_8
12	14_8
13	15_8
14	16_8
15	17_8
16	20_8

example: convert to decimal

$$a) 72_8 = 7 \times 8^1 + 2 \times 8^0 = 58$$

$$b) 5604_8 = 5 \times 8^3 + 6 \times 8^2 + 0 \times 8^1 + 4 \times 8^0 = 2948$$

example: convert to decimal

$$a) 212_3 = 2 \times 3^2 + 1 \times 3^1 + 2 \times 3^0 = 23$$

example: what's wrong with writing 215_3 ?

working in base, only digits allowed are 0, 1, 2

5 is not permitted

note: in base 10, there are 10 digits (0, 1, 2, 3, ... 9)
 4 (0, 1, 2, 3)
 8 (0, 1, 2, 3, ... 7)