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
Oksapmin 27

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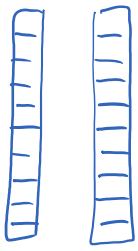
decimal:

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 — 2 of the base
3 ones — 3 leftover



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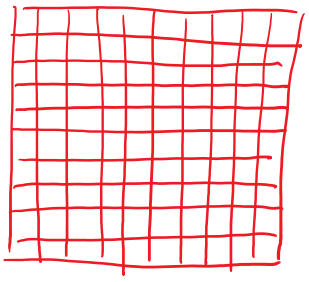
what about 123?

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

let's look at base four:

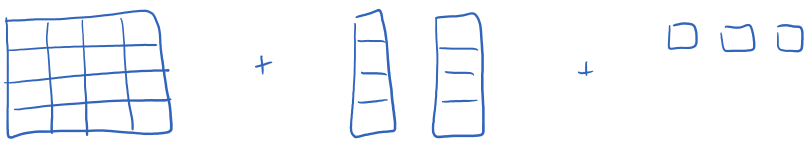
0_4
1_4
2_4
3_4
10_4
11_4
12_4
13_4
20_4
21_4
22_4
23_4
30_4
31_4
32_4
33_4 ← 3 fours, 3 ones
100_4 ← 1 sixteen, no fours, no ones

↑
group of 4 fours
$4^2 = 16$

notation: 123_4

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

$123_4 = 1 \times 4^2 + 2 \times 4^1 + 3 \times 4^0$



$= 1 \times 16 + 2 \times 4 + 3 \times 1$

$= 27$ (or 27_{10})

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 : $3 \times 4^3 + 0 \times 4^2 + 1 \times 4^1 + 2 \times 4^0 = 198$

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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

6	6
7	7
8	10_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 4 (0, 1, 2, 3)

Note: In base 10, there are 10 digits (0, 1, 2, 3, ... 9)

4	4	(0, 1, 2, 3)
8	8	(0, 1, 2, 3, ... 7)