HOW COMPUTERS WORK? MEMORY MANAGEMENT
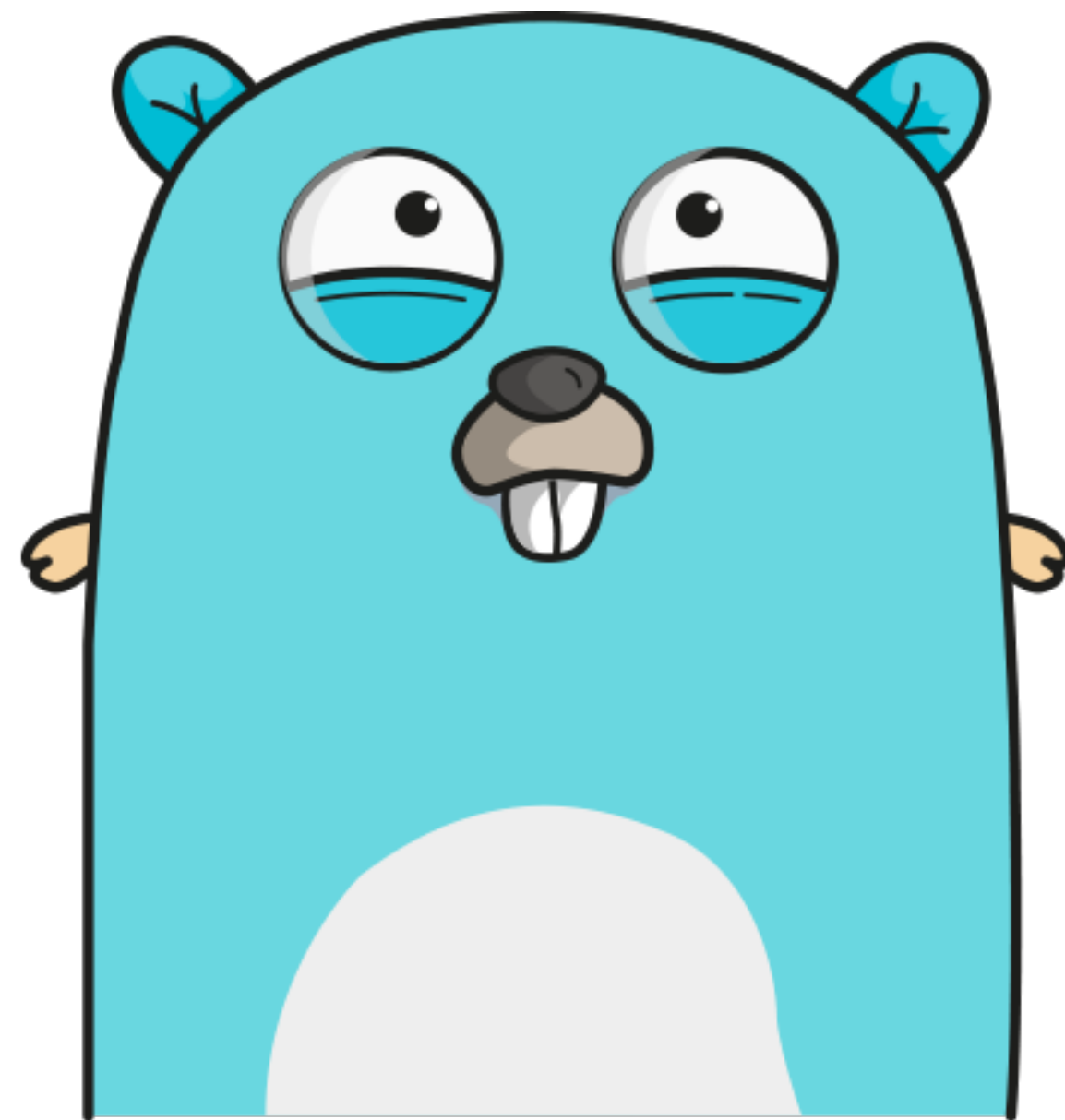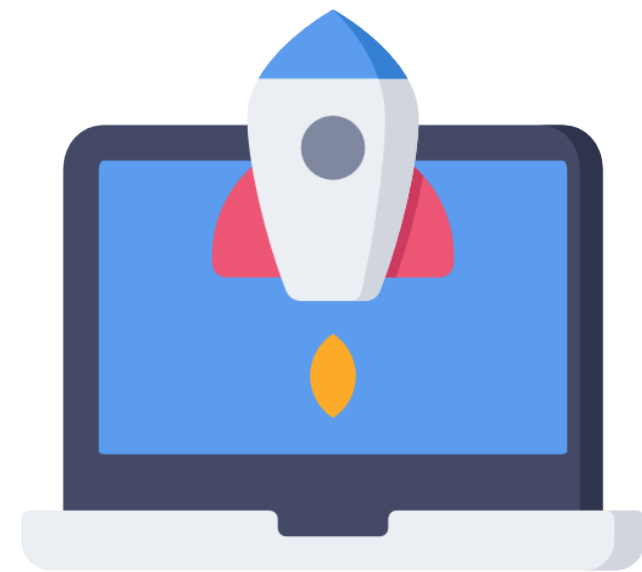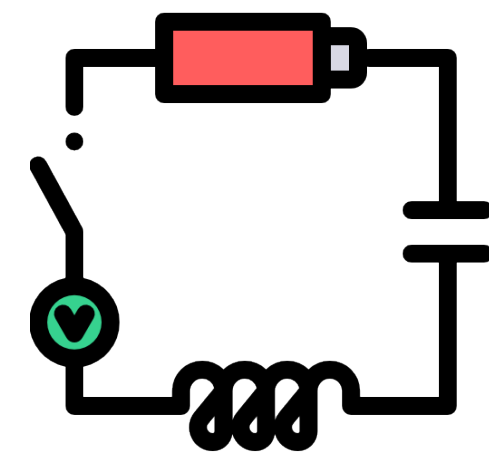

GOPHERTUTS

HOW COMPUTERS WORK?
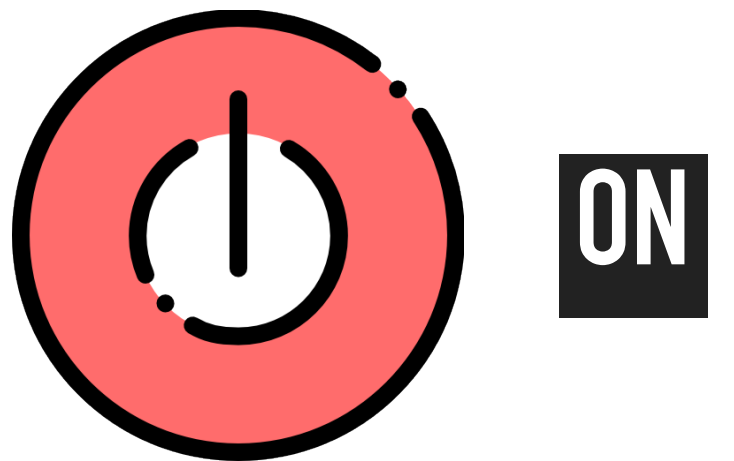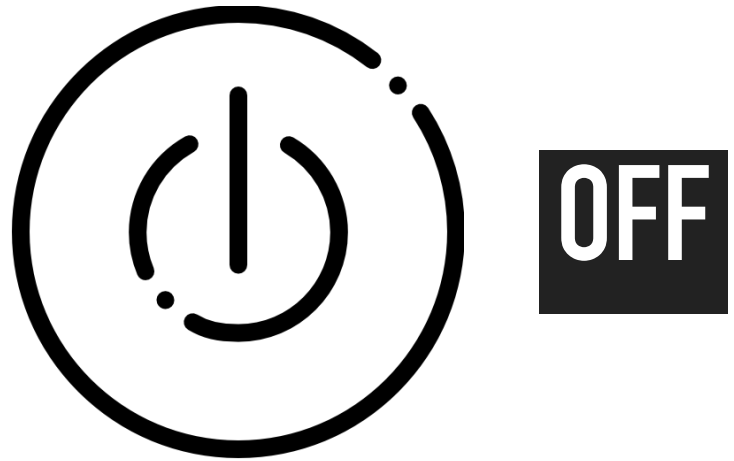
RUN ON ELECTRICITY

MADE OF CIRCUITS/SWITCHES

STATE REPRESENTATION

OFF

ON

NUMBER SYSTEMS

BASE <u>2</u> = 2 DIGITS (0, 1) BINARY

BASE <u>8</u> = 8 DIGITS (0, 1, 2, 3, 4, 5, 6, 7) OCTAL

BASE <u>10</u> = 10 DIGITS (0, 1, 2, 3, 4, 5, 6, 7, 8, 9) DECIMAL

BASE <u>16</u> = 10 DIGITS + 6 LETTERS (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F) HEXADECIMAL

1
2
3
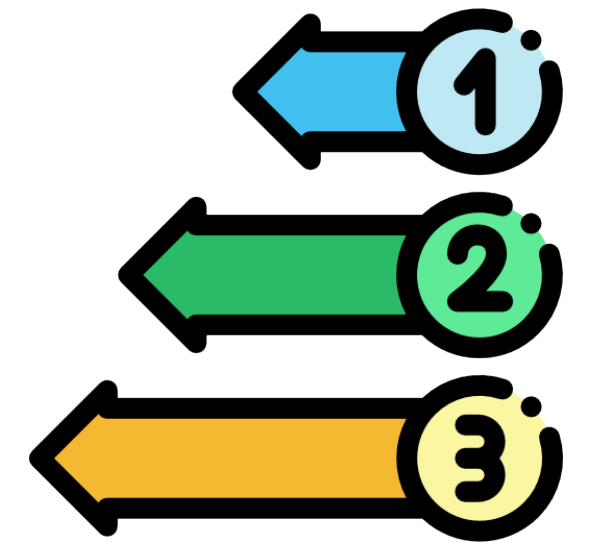
DECIMAL

HUMAN UNDERSTANDABLE VALUES

$80K/YEAR FOR A PROGRAMMER SALARY

EASY TO USE AND REMEMBER

JOHN OWES ME $50

EASY TO PERFORM CERTAIN OPERATIONS ON

21% TAXES FOR $5000 SALARY = 5000*21/100 = $1050

9

BINARY

COMPUTER LANGUAGE
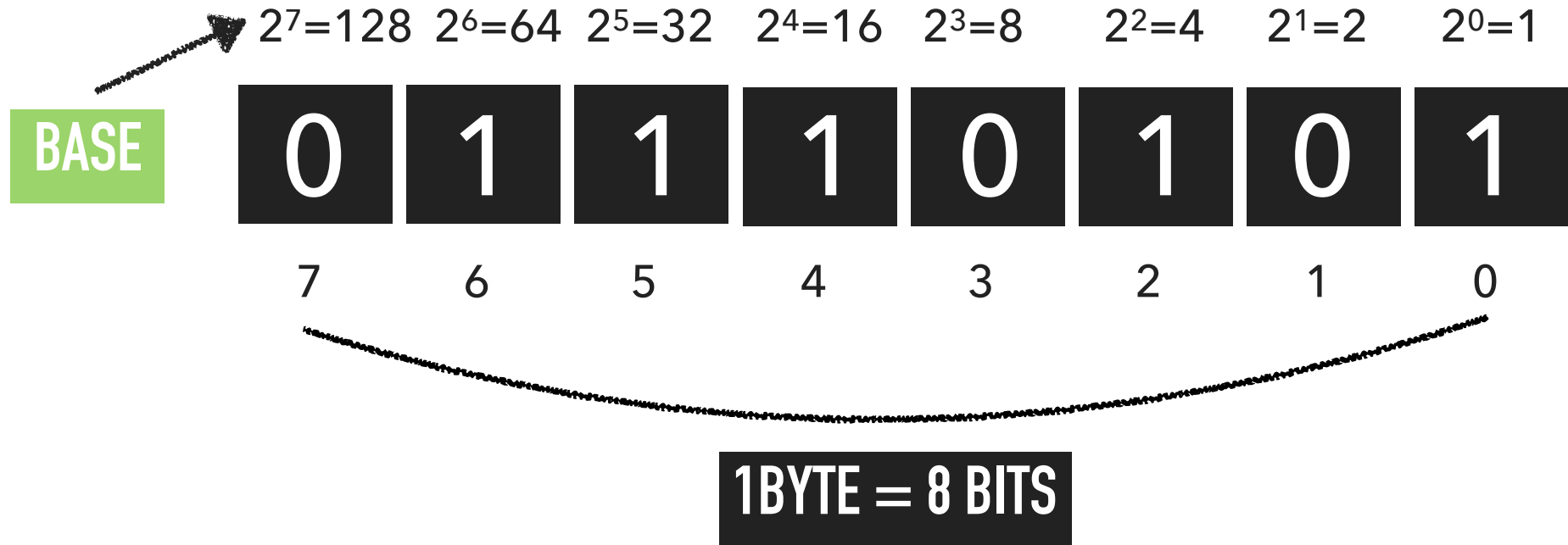**BINARY = ON/OFF = 0/1 = TRUE/FALSE = STATE1/STATE2 = BIT**
1 BYTE = 8 BITS

11001
01011
01011
1000

117 / 10 **=** **01110101 / 2** **=** **WTF?**

0 + 1 + 1 + 1 + 0 + 1 + 0 + 1 = $\underline{117}$

* * * * * * * *

$2^7=128$ $2^6=64$ $2^5=32$ $2^4=16$ $2^3=8$ $2^2=4$ $2^1=2$ $2^0=1$

$2^7=128$ $2^6=64$ $2^5=32$ $2^4=16$ $2^3=8$ $2^2=4$ $2^1=2$ $2^0=1$

BASE 0 1 1 1 0 1 0 1

7   6   5   4   3   2   1   0

1BYTE = 8 BITS

HEXADECIMAL

USED TO REPRESENT BIG NUMBERS (MEMORY ADDRESS FOR EXAMPLE)
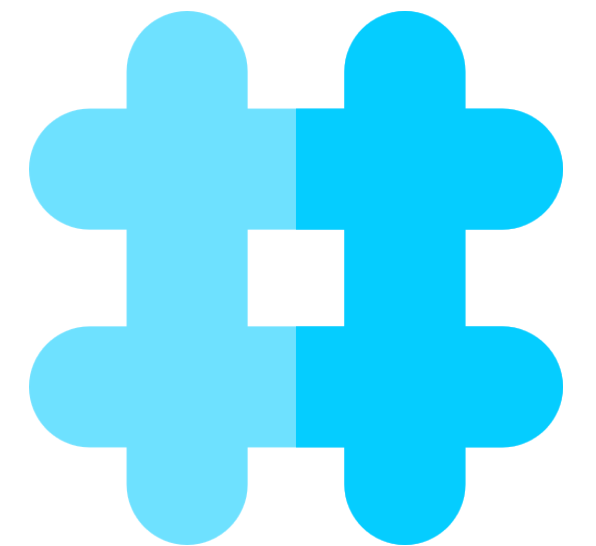
2FE / HEX **=** **766 / 10**

| / – DIVISION WITHOUT REMAINDER $25/2 = 12$ | % – MODULO – REMAINDER OF DIVISION $12*2=24; 25\%2 = 25-24 = 1$ |

$2*16^2$ **+** $15*16^1$ **+** $14*16^0$ **=** 766
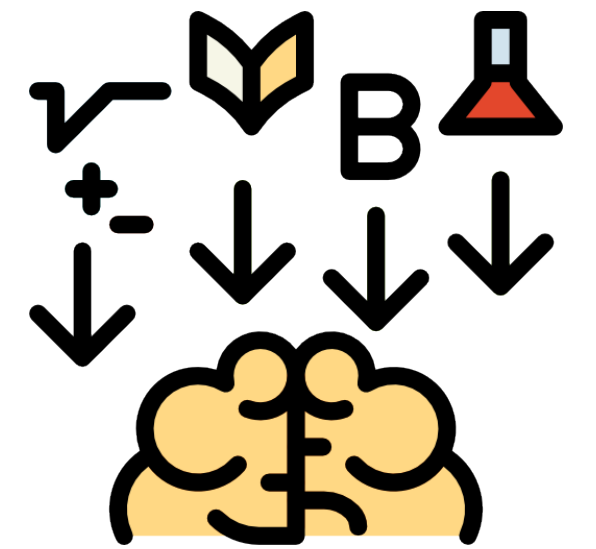
2   **F**   **E**

2
$766 / 16$ **=** 47
$766 \% 16$ **=** 14 **=>** **E**

1
$47 / 16$ **=** 2
$47 \% 16$ **=** 15 **=>** **F**

0
$2 / 16$ **=** 0
$2 \% 16$ **=** 2 **=>** **2**

= **2FE**

BASE 10 TO BASE N GENERALIZED

n / B   n - Decimal number

n % B   ,   B - Base

n = n / B on every iteration

Do this until n / B == 0

BASE 10 TO BASE N EXAMPLE

N = 16	823

	823 / 16	=	51		
2	823 % 16	=	7	=>	7
	51 / 16	=	3		
1	51 % 16	=	3	=>	3
	3 / 16	=	0		
0	3 % 16	=	3	=>	3

=	337

N = 2	25

	25 / 2	=	12	
7	25 % 2	=	1	
	12 / 2	=	6	
6	12 % 2	=	0	
	6 / 2	=	3	
5	6 % 2	=	0	
	3 / 2	=	1	
4	3 % 2	=	1	
	1 / 2	=	0	
3	1 % 2	=	1	
2	0			
1	0			
0	0			

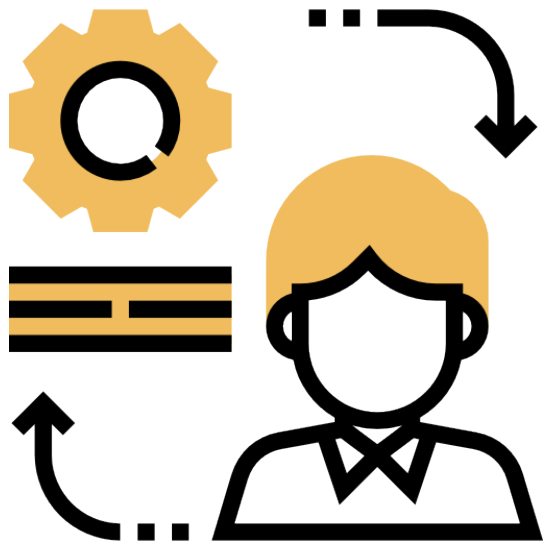| =	00011001

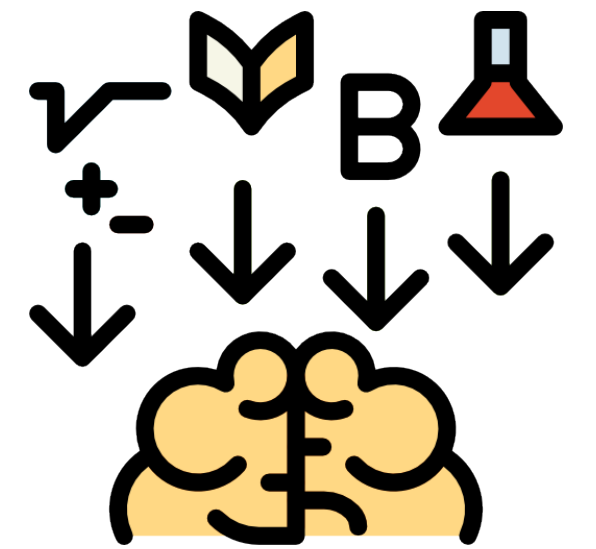# BASE N TO BASE 10 GENERALIZED

$$\sum_{i = n-1}^{0} A_i * B^{|i - (n - 1)|}$$

,

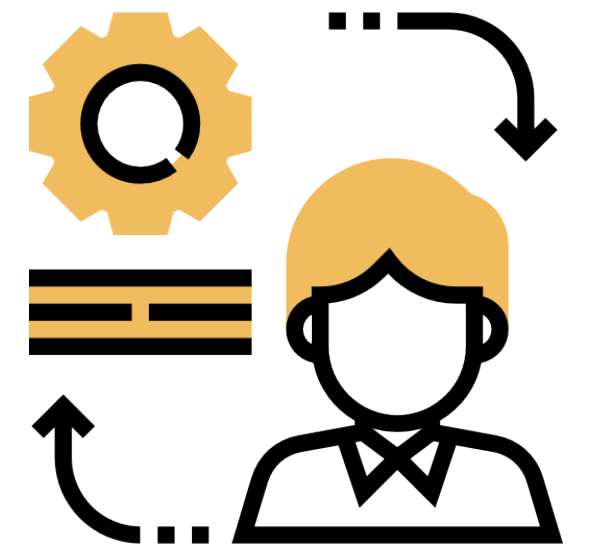n - number of symbols

A - list of symbols $\in$ B

B - base

BASE N TO BASE 10 EXAMPLE

N = 16 **ABE**

$14*16^0$ + $11*16^1$ + $10*16^2$ = 2750

N = 2 **0110 1010 1010 0111**

$1*2^0$ + $1*2^1$ + $1*2^2$ + $0*2^3$ + $0*2^4$ + $1*2^5$ + $0*2^6$ + $1*2^7$ + $0*2^8$

+ $1*2^9$ + $0*2^{10}$ + $1*2^{11}$ + $0*2^{12}$ + $1*2^{13}$ + $1*2^{14}$ + $0*2^{15}$ = 27303

EXAMPLES & CONVERSIONS

10: 115

2: 01110011   16: 73

16:3AB

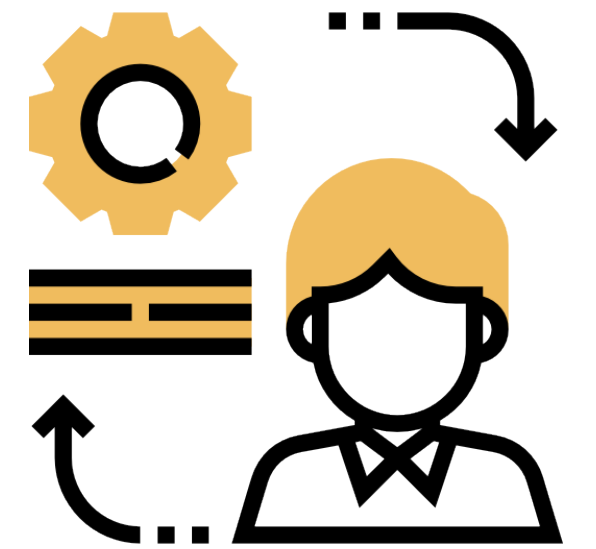2: 0000001110101011   10: 939

2: 11110010
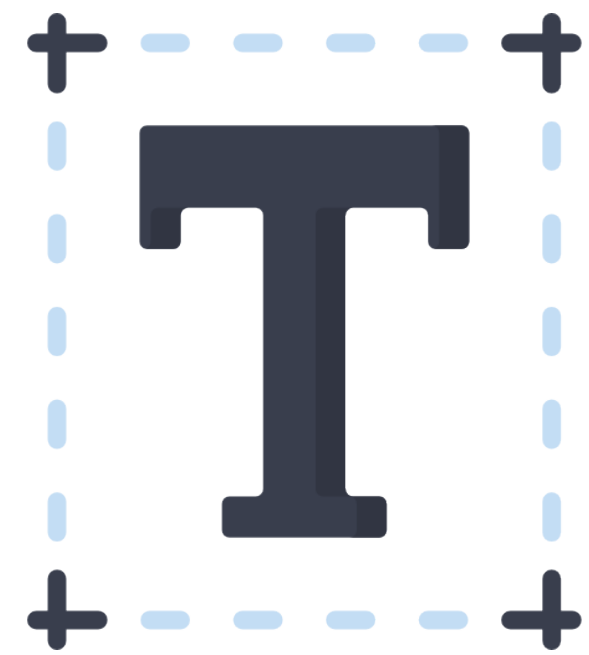
16:F2   10: 242

2: 11111111

16:FF   10: 255

16: ABC

2:000010101011100   10: 2748

ASCII & UTF-8 (ENCODING SCHEMES)

84

T

1B ASCII / EXTENDED ASCII

$0\text{-}127 = 2^{(8*1 - 1)} - 1$ – 7 BITS

$0\text{-}255 = 2^{(8*1)} - 1$ – 8 BITS

4B UTF-8

$0\text{-}4,294,967,295 = 2^{(8*4) - 1}$ – 8 BITS

ENCODING & DECODING EXAMPLE

HELLO	**72 69 76 76 79**
WORLD!	**87 79 82 76 68 33**

EXAMPLES & CONVERSIONS

72
H

01001000
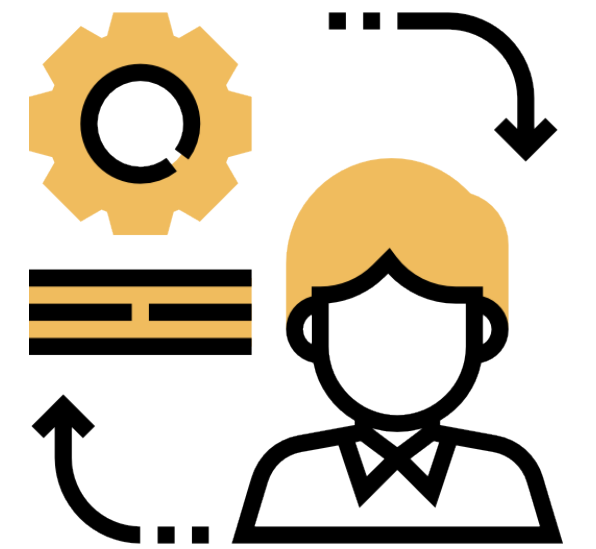
228 184 173
中

11100100 10111000 10101101

72 69 76 76 79
HELLO

01001000 01000101 01001100 01001100 01001111

PERSONAL ENCODING (STEVENC)

Steve 1	Steve 2	Meaning
Hand up	Hand down	Bring bear
Hand down	Hand up	Bring soda
Hand Up	Hand up	Bring bear & soda
Hand down	Hand down	Do not disturb

SUMMARY

💡 HOW COMPUTERS WORK?

💡 NUMBER SYSTEMS

💡 ENCODING SCHEMES