DIGITAL ELECTRONICS

Lecture 01 :

Syllabus :

1) Number System
2) Computer Arithmetic.
3) Boolean Algebra → Logic Gate
   → Minimisation
4) Combinational Logic
5) Sequential Logic
6) Finite State Machines

Digital Logic

finite

Digital has been derived from the word DIGIT.

"It represents a system with finite number of possibilities."

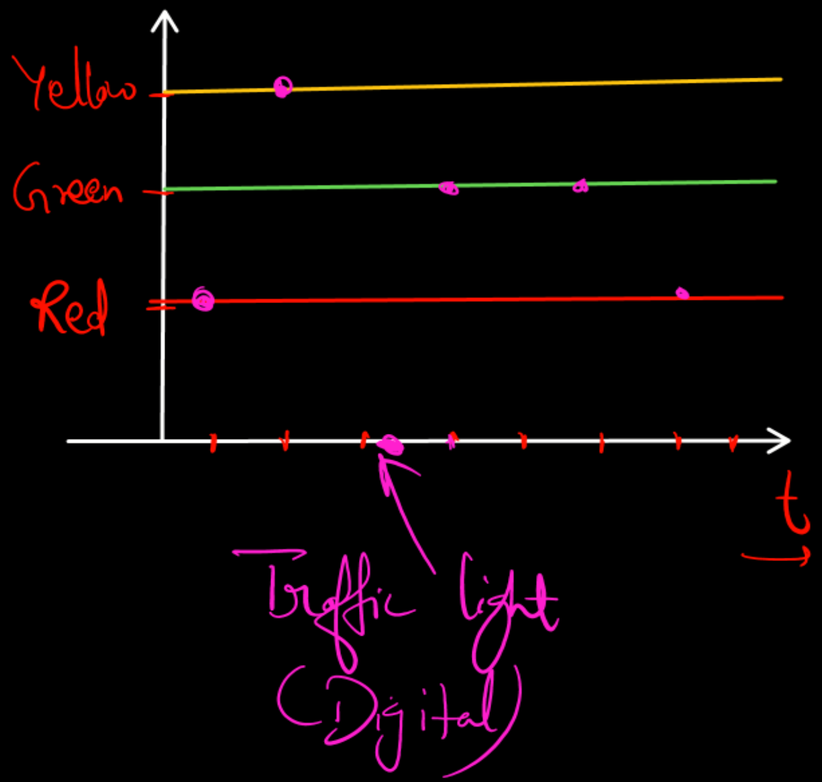
- Digits are always finite in number.

For Example – A traffic light has only finite number of possibilities i.e. Red, Green and Orange. At any point of time there are only three possibilities, either the light is Red or Green or Yellow.

Another Example – A bulb can either ON or OFF. So, It has two number of possibilities at a time.

finite

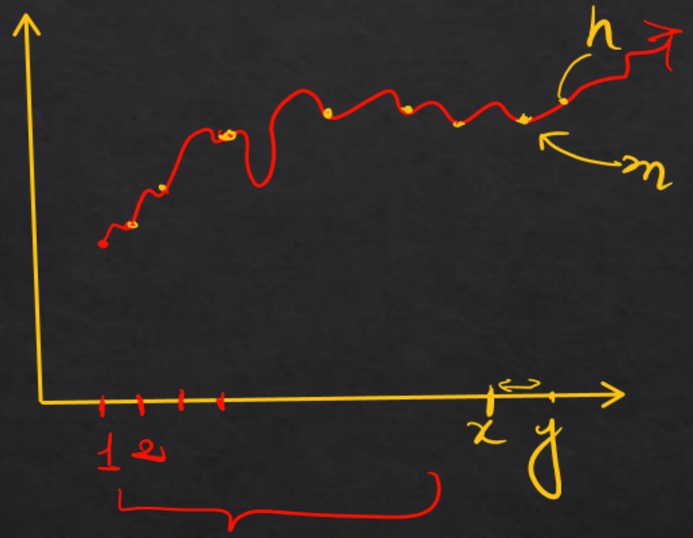
- Tube-light, traffic light, switch, gearbox etc. are examples of digital.



$Y = \{R, G, B\}$

Analogue v/s Digital

↳ There are infinite no. of Possibilities.



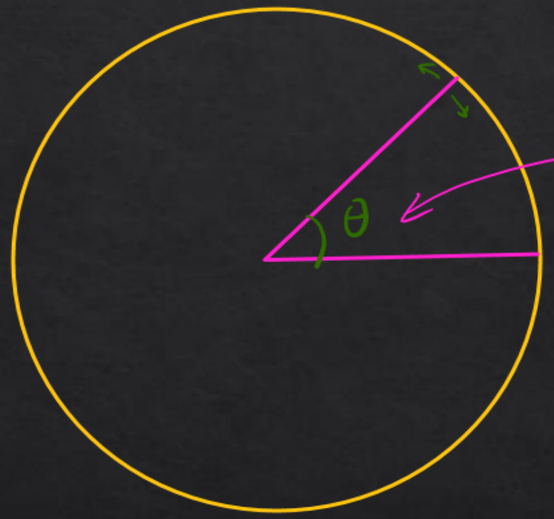
* Analogue are Continuous.

Eg There are infinite numbers between two real number.

Each breakdown of time has a possible outcome

Analogue v/s Digital

Analogue → what will be the value of θ



θ is analogue, because,
there are infinite numbers lie b/w
0 to 360

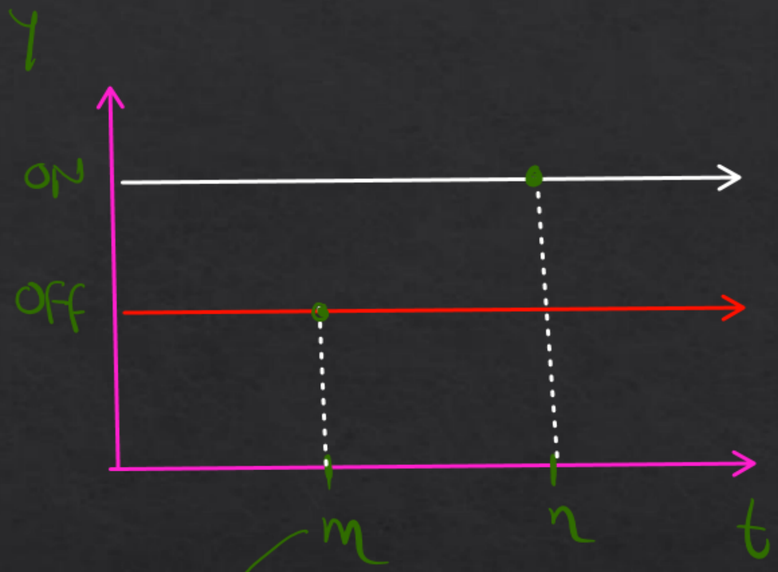
0.1000... to 259.9999...

Analogue v/s Digital

Bulb
- 2 states
  - ON
  - OFF

$Y = \{ON, OFF\}$

Bulb represent digital theory as it has only 2 possibilities.



$Y(m) = OFF$

$Y(n) = ON$

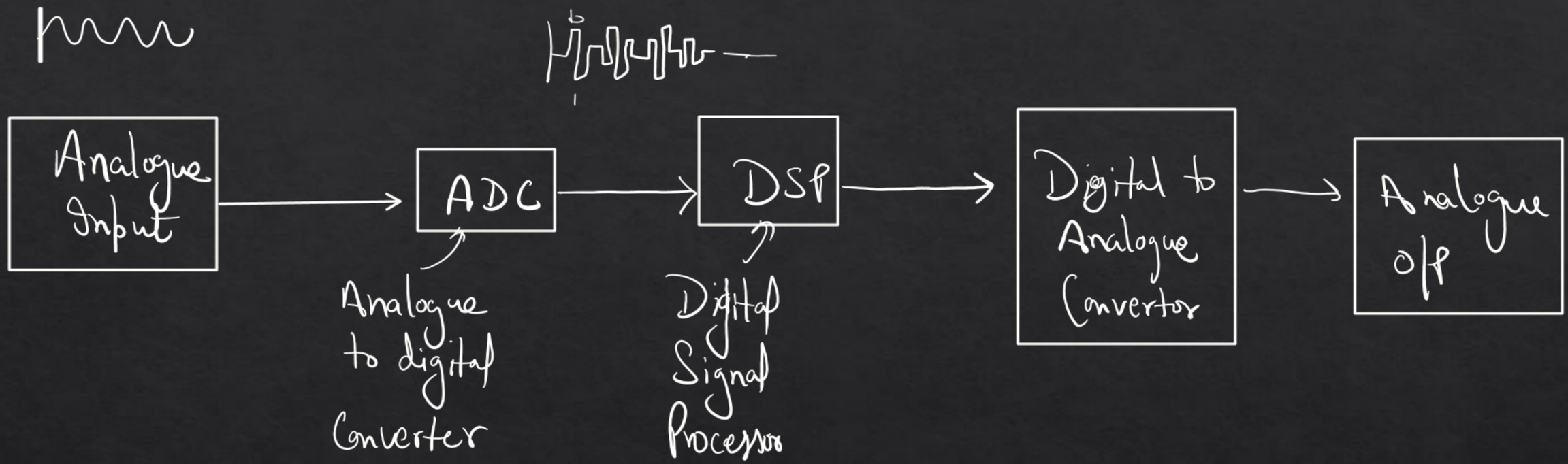
$Y = \{ON, OFF\}$

$Y(m) = ON$

$Y(n) = OFF$

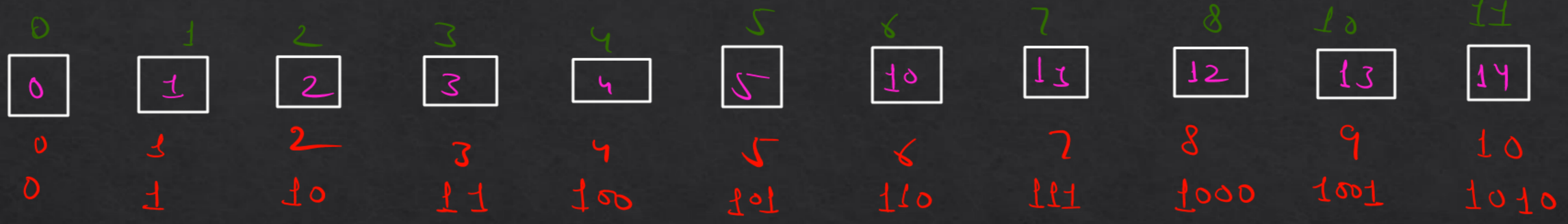
$Y(n) = ON$

Converting Analogue to Digital



Fundamental Principle of Counting

Number → language that represent quantity.



N.S ⇒ 0-9 → 10 Boxes

N.S ⇒ 0 to 8 → 11 Boxes

N.S ⇒ 0 to 5 → 14 Boxes

N.S ⇒ 2 Possible Numbers = [0, 1] → 1010 Boxes

Fundamental Principle of Counting ← begin from 0

Decimal Number System → Numbers in a digit can be 10
↳ 10
↳ 0 to 9
↳ {0 1 2 3 4 5 6 7 8 9}

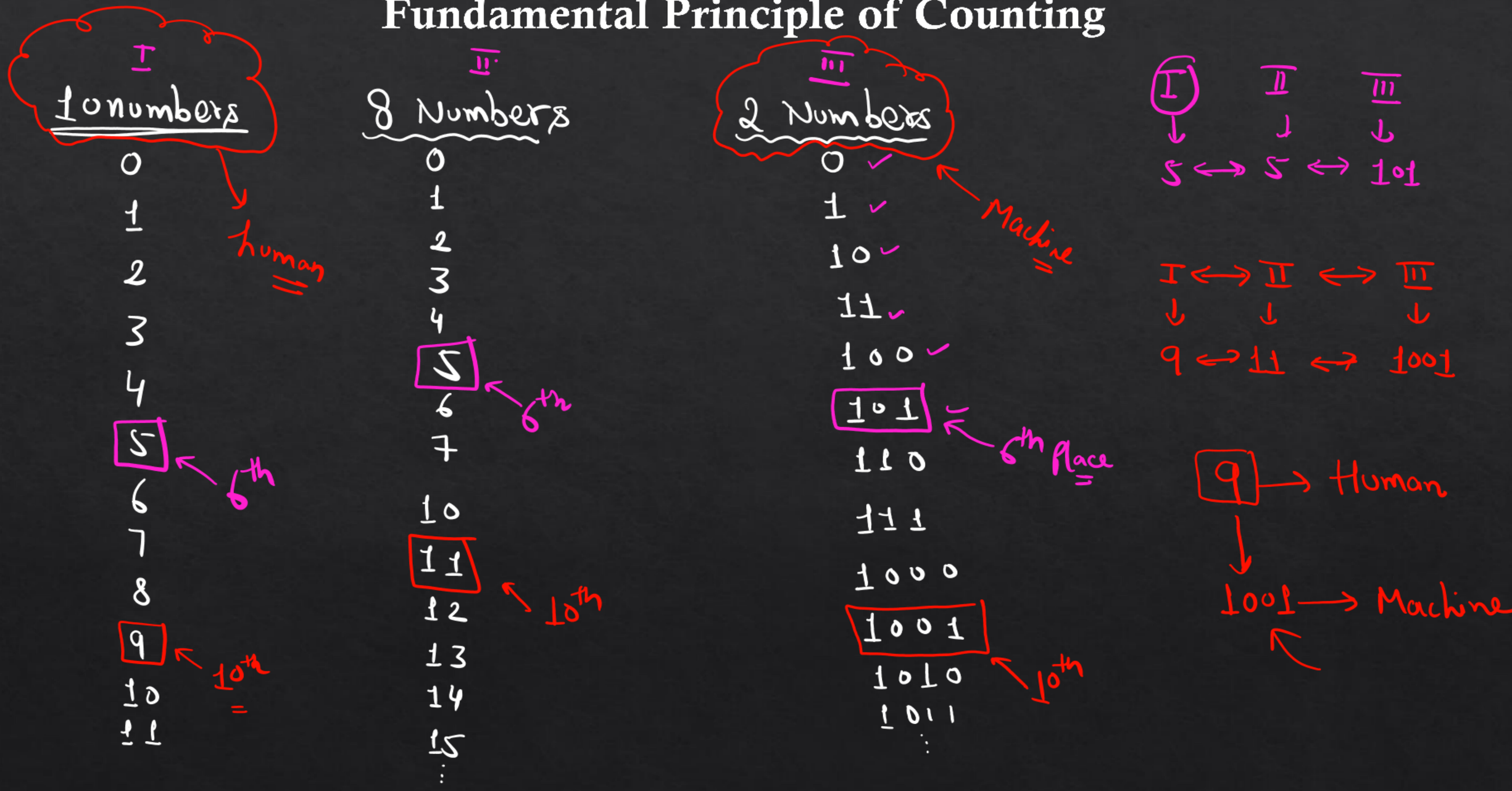
If there are 8 possible Numbers in a digit in a number system then it will become Octal Number System.
8 possible digits = {0 1 2 3 4 5 6 7}

Similarly, if there are two possible numbers in a digit of a number System, then it will become Binary Number System.
↳ 2

2 digits → {0, 1}

Counting → 0, 1, 10, 11, 100, 101, 110, 111, 1000 .....

Fundamental Principle of Counting

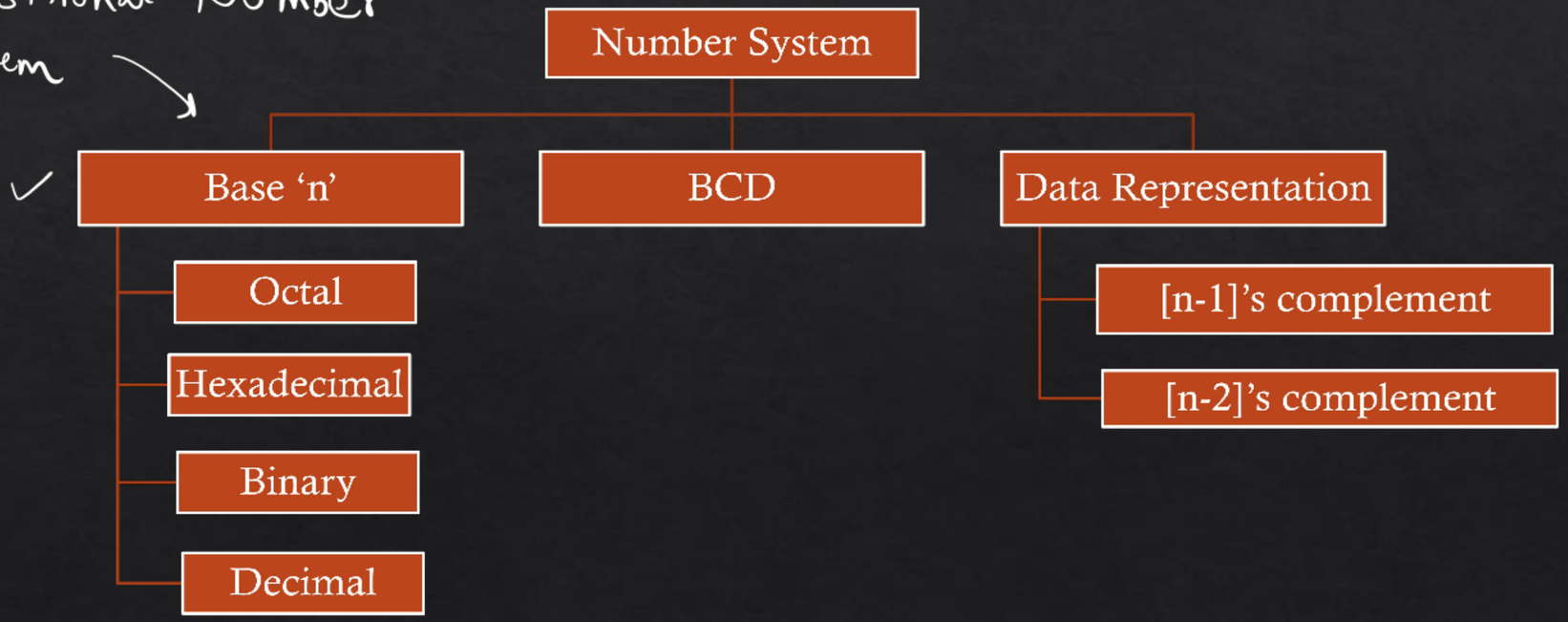


Number Systems

"*A number system is a mathematical approach which is used to represent numbers in different formats that are based on combinatorics.*"

- Sometimes we represent numbers as a, b, c, d, e… or a1, a2, a3… an, or i, ii, iii, iv… for 0,1,2,3,4 … n. Similarly we use different number system to represent a number which is used by the computers for arithmetic operations.
- In a computer we use different number system to represent numbers. Following are the categories of number system in computer science -

Positional Number System



Number System of different base

Number → 3 digit Number

0 to 9

10 Possible Numbers

Base - 10 Number

But there are No 9 & 8

Number → 3 digit

0 to 7

0 to 7

0 to 7

0 to 7

8 possible Number

Base 8 number

Number → 3 digits Number

exist

{0 & 1}

0 or 1

0 or 1

0 to 1

2 possible Numbers

Base-2 Number

Number → 3digit

0 to 16

0 to F

16 Possible Number

Base 16 Numer

10 - A 13 - D
11 - B 14 - E
12 - C 15 - F

Number System of different base

In a positional Number System the Base value represent the range of the possible numbers that can be stored in a single digit of the number system.

⇒ Base is also called as Radix

format to represent a number → $(\text{Number})_{\text{radix}}$

$(27)_{10}$ ← Number, 10 ← Radix, decimal

$(34)_{8}$ ← Number, 8 ← Radix, Octal

$(1011)_{2}$ ← Radix = 2 ⇓ Binary Number System

Number System of different base

Checking the validity of a Number :

$(28)_{10}$ ⟶ Valid ✓ Base = 10 ⟶ 0 to 9

$(29)_8$ ⟶ Base 8 ⟶ Every digit must has 8 possible Number
↳ 0 1 2 3 4 5 6 7

↳ Invalid
↳ Not possible

$(1012201)_2$ ⟶ Base = 2 {0, 1}

↳ Invalid (1012201 with Base 2 is Not possible)

Number System of different base

To check the validity of a number system, each & every digit of that number system must be lesser than the radix.

$$[x_n \cdots x_3\ x_2\ x_1\ x_0]_r, \quad \boxed{x < r} \quad \boxed{x \geq 0}$$

$(3045)_{10} \rightarrow \{3, 0, 4, 5\} < 10$ ✓

$(2409)_8 \rightarrow 2\ 4\ 0 < 8$

$\boxed{9 > 8}$ ⊗ Invalid

Number System of different base

Range of Numbers in each digit

Base / Radix	Terminology	Range
2	Binary	0, 1
3	Trinary	0, 1, 2
8	Octal	0, 1, 2, 3, 4, 5, 6, 7 (0-7)
10	Decimal	0, 1, 2, 3, 4, 5, 6, 7, 8, 9 (0 to 9)
16	Hexa-Decimal ↓ ↓ 6 10 = (16)	[0 to F] → 0 1 2 3 4 5 6 7 8 9 A, B, C, D, E, F

Number System

$(15)_{10}$ → Validity → Valid → Decimal Number

$(16)_{8}$ → Valid → Octal

$(10)_{2}$ → Valid → Binary

$(1A)_{16}$ → Valid → Hexadecimal

$(38)_{8}$ → Invalid ✗

← The Octal Number is invalid