Introduction to

Binary number system

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Binary systems

Why binary systems are so important?

- There are many binary systems in our environment.
- The computer is binary.

no	yes
false	true
absent	present
close	open
switched off	switched on
insulator	conductor
electric current flows	no electric current
0	**1**

Decimal number system

10 different symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

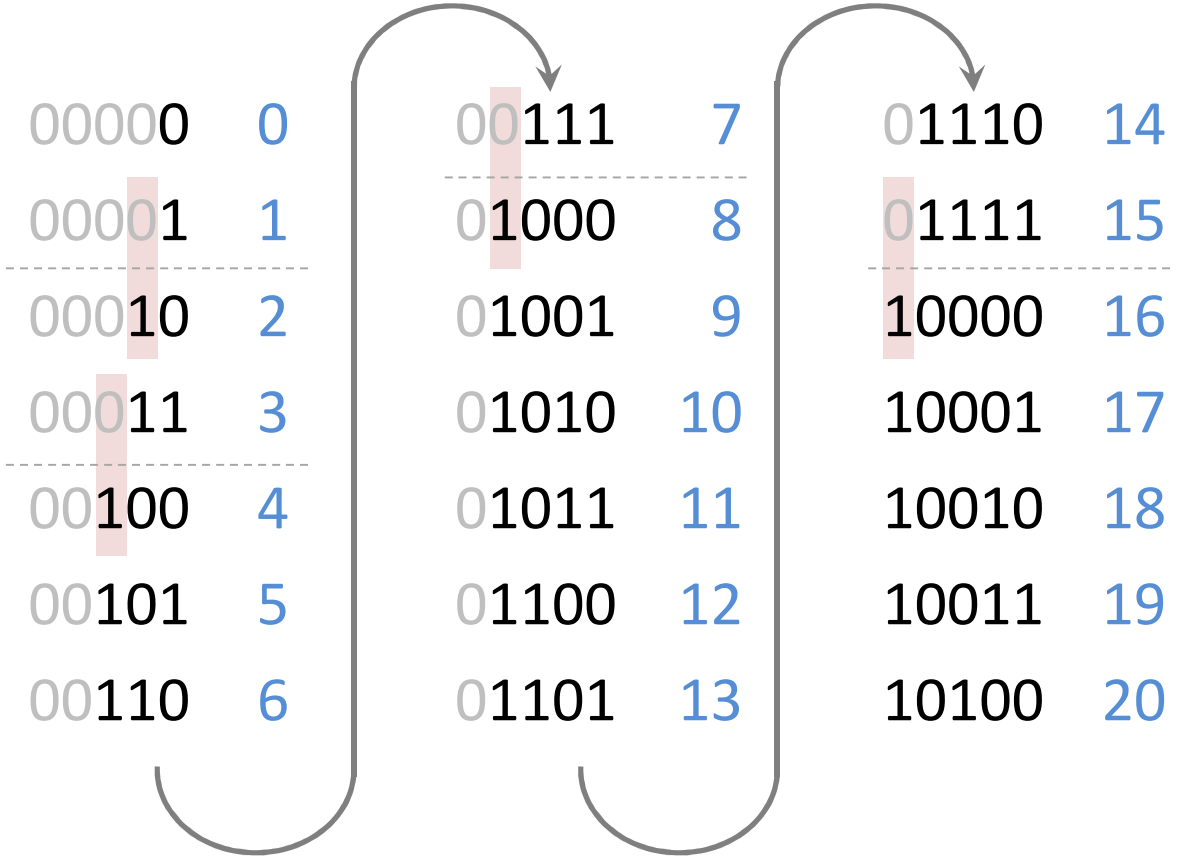
How do we count in decimal?

…	…	…	…	…
08	18	098	598	0998
09	19	099	599	0999
10	20	100	600	1000
11	21	101	601	1001
12	22	102	602	1002
…	…	…	…	…

Binary number system

Only 2 different symbols: 0, 1

How do we count using binary?



Conversion from decimal to binary

conversion of 217:	**217**	**2**
217 = 2*108+1	108	1
108 = 2*54+0	54	0
54 = 2*27+0	27	0
27 = 2*13+1	13	1
13 = 2*6+1	6	1
6 = 2*3+0	3	0
3 = 2*1+1	1	1
1 = 2*0+1	0	1

$217_{10} = 11011001_2$

Conversion from binary to decimal

Decimal (10):

$2495 = 2*1000+4*100+9*10+5*1$

$2495 = 2*10^3 + 4*10^2 + 9*10^1 + 5*10^0$

Binary (2):

$1010011_2 = 1*2^6 + 0*2^5 + 1*2^4 + 0*2^3 + 0*2^2 + 1*2^1 + 1*2^0$

$1010011_2 = 1*64 + 0*32 + 1*16 + 0*8 + 0*4 + 1*2 + 1*1$

$1010011_2 = 64+16+2+1 = 83_{10}$

Numbers in computer

- Bit is similar to a digit of a binary number. (0 or 1)
- Byte is 8 bit (a maximum 8 digit long binary number).
- Numbers on a byte (8 bit):
  00000000 - 11111111
  (0-255)
  256 different values
- Numbers on 4 bytes (32 bit):
  00000000000000000000000000000000 - 11111111111111111111111111111111
  (0-4294967295)
  4.294.967.296 different values

Logical operations

Logical values:

- true: 1
- false: 0

Logical operations:

- **AND** (&)
- OR (|)
- NOT (^)

Table of truth (X & Y = Z):

X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

Elephant is a fruit	and	it is small.	False statement.
Elephant is a fruit	and	it is large.	False statement.
Elephant is an animal	and	it is small.	False statement.
Elephant is an animal	and	it is large.	True statement.

Logical ‘AND’ operation on bytes

Example 1:

```
  1 0 0 1 0 1 1 0        150
& 0 0 0 0 0 0 0 0      &   0
  0 0 0 0 0 0 0 0          0
```

Example 2:

```
  1 0 0 1 0 1 1 0        150
& 1 1 1 1 1 1 1 1      & 255
  1 0 0 1 0 1 1 0        150
```

Example 3:

```
  1 0 0 1 0 1 1 0        150
& 1 1 1 1 0 0 0 0      & 240
  1 0 0 1 0 0 0 0        144
```