DATA REPRESENTATION

Number System

In general term computer represent information in different types of data forms i.e. number , character ,picture ,audio , video etc.

Computers are made of a series of switches/ gates. Each switch has two states: ON(1) or OFF(0).That's why computer works on the basis of binary number system(0/1).But for different purpose different number systems are used in computer world to represent information. E.g. Octal, Decimal, Hexadecimal.

NUMBER SYSTEM		
SYSTEM	BASE	DIGIT
Binary	2	0 1
Octal	8	0 1 2 3 4 5 6 7
Decimal	10	0 1 2 3 4 5 6 7 8 9
Hexadecimal	16	0 1 2 3 4 5 6 7 8 9 A B C D E F

Decimal Number System

Characteristics

- Ten symbols
- 0 1 2 3 4 5 6 7 8 9

Positional

- $2945 \neq 2495$
- $2945 = (2*10^3) + (9*10^2) + (4*10^1) + (5*10^0)$

(Most) people use the decimal number system Why?

THIS A POSITIONAL NUMBER SYSTEM .and that's of great advantage

..simple shifting the position of decimal.It become complex either case to use number system <10 or >10.

Binary Number System

Characteristics

- Two symbols
- 0 1

Positional

- Positional
- $1010_2 \neq 1100_2$

Most (digital) computers use the binary number system Why?

Computers are made of a series of switches/ gates. Each switch has two states: ON(1) or OFF(0).That's why computer works on the basis of binary number system(0/1).

Decimal-Binary Equivalence

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Decimal	Binary
16	10000
17	10001
18	10010
19	10011
20	10100
21	10101
22	10110
23	10111
24	11000
25	11001
26	11010
27	11011
28	11100
29	11101
30	11110
31	11111

Binary – Decimal Conversion

Using positional notation

$100101_2 = (1*2^5)+(0*2^4)+(0*2^3)+(1*2^2)+(0*2^1)+(1*2^0)$

$= 32 + 0 + 0 + 4 + 0 + 1$

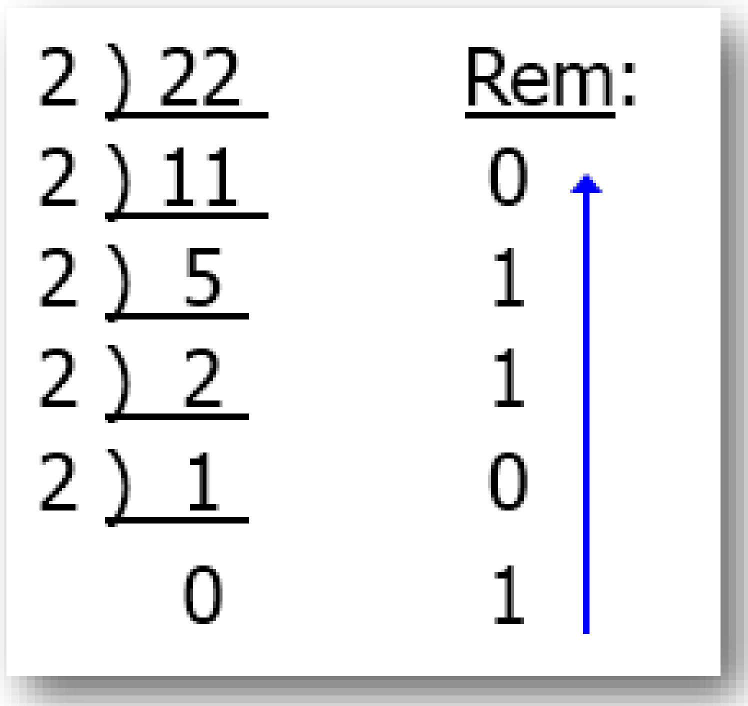
$= 37$

Decimal-Binary Conversion

Using the Division Method:

Divide decimal number by 2 until you reach zero, and then collect the remainders in reverse.

$22_{10} = 10110_2$



Hexadecimal Number System

Characteristics

- Sixteen symbols
- 0 1 2 3 4 5 6 7 8 9 A B C D E F

Positional

$A13D_{16} \neq 3DA1_{16}$

Computer programmers often use the hexadecimal number system,Why?

Computers only work on the binary number system. The hexadecimal number system is commonly used to describe locations in computer memory. They are also used in assembly language instructions.

Decimal-Hexadecimal Equivalence

Decimal	Hex
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	A
11	B
12	C
13	D
14	E
15	F

Decimal	Hex
16	10
17	11
18	12
19	13
20	14
21	15
22	16
23	17
24	18
25	19
26	1A
27	1B
28	1C
29	1D
30	1E
31	1F

Decimal	Hex
32	20
33	21
34	22
35	23
36	24
37	25
38	26
39	27
40	28
41	29
42	2A
43	2B
44	2C
45	2D
46	2E
47	2F

Hexadecimal to decimal

$$25_{16} = (2*16^1) + (5*16^0)$$
$$= 32 + 5$$
$$= 37$$

Decimal to hexadecimal

$$37 / 16 = 2 \text{ R } 5$$

Read from bottom to top: 25_{16}

$$2 / 16 = 0 \text{ R } 2$$

Binary - hexadecimal

Four-bit Group	Decimal Digit	Hexadecimal Digit
0000	0	**0**
0001	1	**1**
0010	2	**2**
0011	3	**3**
0100	4	**4**
0101	5	**5**
0110	6	**6**
0111	7	**7**
1000	8	**8**
1001	9	**9**
1010	10	**A**
1011	11	**B**
1100	12	**C**
1101	13	**D**
1110	14	**E**
1111	15	**F**

Binary to hexadecimal

Convert 110100110_2 to hex

Starting at the right end, split into groups of 4:

1 1010 0110 ->

0110 = 6

1010 = A

0001 = 1 (pad empty digits with 0)

$110100110_2 = 1A6_{16}$

Hexadecimal to Binary

Convert $3D9_{16}$ to binary

Convert each hex digit to 4 bits:

3 = 0011

D = 1101

9 = 1001

0011 1101 1001 ?

$3D9_{16}$ = 1111011001_2 (can remove leading zeros)

Octal Number System

Characteristics

- Eight symbols
- 0 1 2 3 4 5 6 7

Positional

- $1743_8 \neq 7314_8$

Computer programmers often use the octal number system,Why?

Octal and hex use the human advantage that they can work with lots of symbols while it is still easily convertible back and forth between binary.

Decimal-Octal Equivalence

Decimal	Octal
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	10
9	11
10	12
11	13
12	14
13	15
14	16
15	17

Decimal	Octal
16	20
17	21
18	22
19	23
20	24
21	25
22	26
23	27
24	30
25	31
26	32
27	33
28	34
29	35
30	36
31	37

Decimal	Octal
32	40
33	41
34	42
35	43
36	44
37	45
38	46
39	47
40	50
41	51
42	52
43	53
44	54
45	55
46	56
47	57

Octal to decimal

357_8

positional powers of 8: 8^2 8^1 8^0

decimal positional value: 64 8 1

Octal number: 3 5 7

$$(3 \times 64) + (5 \times 8) + (7 \times 1)$$

$$= \quad 192 + 40 + 7 = 239_{10}$$

Decimal to octal

Using the Division Method:

Example 1: $214_{10} = 326_8$

8)	214	Rem:
8)	26	6
8)	3	2
	0	3

Binary-Octal Conversion

E.g.

001010000100111101_2

1 2 0 4 7 5_8

Octal to binary

1 2 0 4 7 5_8

001010000100111101_2

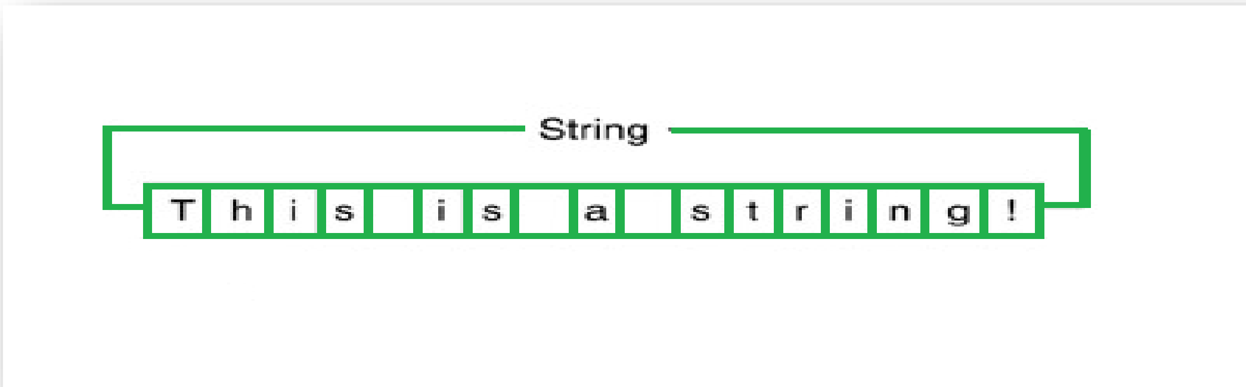
Binary addition

$$
\begin{array}{rr}
 & 1 \\
3 & 0011_2 \\
+\ 10 & +\ 1010_2 \\
\text{--} & \text{--------} \\
13 & 1101_2
\end{array}
$$

Start at right column
Proceed leftward
Carry 1 when necessary

Encoding Schemes/ String representation

String is any finite sequence of characters.Any string includes etters, numerals, symbols and punctuation marks.



Computers are designed to work internally with numbers. In order to handle characters, we need to choose a number for each character. There are many ways to do this ,which are knows as encoding schemes.

Encoding schemes

Following are some Encoding schemes

- ASCII
- UNICODE
- ISCII

Encoding Scheme

- ASCII
- It is most common coding system (Pronounced ass-key).
- ASCII = American National Standard Code for Information Interchange
- It is Defined in ANSI document X3.4-1977. It is a 7-bit code.Its 8th
- bit is unused (or used for a parity bit)
- $2^7 = 128$ codes
- Two general types of codes:
- 95 are “Graphic” codes (displayable on a console)
- 33 are “Control” codes (control features of the console or
- communications channel)

Encoding Scheme

ASCII

	000	001	010	011	100	101	110	111
0000	NULL	DLE		0	@	P	`	p
0001	SOH	DC1	!	1	A	Q	a	q
0010	STX	DC2	"	2	B	R	b	r
0011	ETX	DC3	#	3	C	S	c	s
0100	EDT	DC4	$	4	D	T	d	t
0101	ENQ	NAK	%	5	E	U	e	u
0110	ACK	SYN	&	6	F	V	f	v
0111	BEL	ETB	'	7	G	W	g	w
1000	BS	CAN	(	8	H	X	h	x
1001	HT	EM	)	9	I	Y	i	y
1010	LF	SUB	*	:	J	Z	j	z
1011	VT	ESC	+	;	K	[	k	{
1100	FF	FS	,	<	L	\	l	|
1101	CR	GS	-	=	M	]	m	}
1110	SO	RS	.	>	N	^	n	~
1111	SI	US	/	?	O	_	o	DEL

Encoding Scheme

ASCII CHART

MOST SIGNIFICANT BIT

	000	001	010	011	100	101	110	111
0000	NULL	DLE		0	@	P	`	p
0001	SOH	DC1	!	1	A	Q	a	q
0010	STX	DC2	"	2	B	R	b	r
0011	ETX	DC3	#	3	C	S	c	s
0100	EDT	DC4	$	4	D	T	d	t
0101	ENQ	NAK	%	5	E	U	e	u
0110	ACK	SYN	&	6	F	V	f	v
0111	BEL	ETB	'	7	G	W	g	w
1000	BS	CAN	(	8	H	X	h	x
1001	HT	EM	)	9	I	Y	i	y
1010	LF	SUB	*	:	J	Z	j	z
1011	VT	ESC	+	;	K	[	k	{
1100	FF	FS	,	<	L	\	l	|
1101	CR	GS	-	=	M	]	m	}
1110	SO	RS	.	>	N	^	n	~
1111	SI	US	/	?	O	_	o	DEL

LEAST SIGNIFICANT BIT

Encoding Scheme

ASCII

"Hello, world" Example

		Binary		Hexadecimal		Decimal
H	=	01001000	=	48	=	72
e	=	01100101	=	65	=	101
l	=	01101100	=	6C	=	108
l	=	01101100	=	6C	=	108
o	=	01101111	=	6F	=	111
,	=	00101100	=	2C	=	44
	=	00100000	=	20	=	32
w	=	01110111	=	77	=	119
o	=	01100111	=	67	=	103
r	=	01110010	=	72	=	114
l	=	01101100	=	6C	=	108
d	=	01100100	=	64	=	100

Encoding Scheme

UNICODE

It is a worldwide character-encoding standard .Its main objective is to enable a single, unique character set that is capable of supporting all characters from all scripts, as well as symbols, that are commonly utilized for computer processing throughout the world.

ISCII

ISCII stands for Indian Script Code for Information Interchange for Indian languages. It is an 8-bits code to represent Indian scripts.

The Department of Electronics (DOE) has established standard and standard are in action from 1983.

These codes are used for 10 Indian scripts- Devanagri, Punjabi, Gujrati, Udia, Bengali, Asami, Telgu, Kannad, Malayalam and Tamil. C-DAC (established in August- September, 1988) developed standard for font coding in 1990 is called ISFOC (Indian Standards for Font Coding).