Numbering Systems

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Comp 230

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SUCCEED

You will never know if you don't keep trying, the next time might be your time to succeed.

Outline

- Converting Fractions.
- Adding Binary Fractions.
- Binary Subtraction.
- Data Representation.
- Characters and Integers Representation.
- Floating Point Representation.
- Summary

Converting Fractions

- When converting a fractional decimal value to binary, we need to use a slightly different approach. Instead of dividing by 2 ,we repeatedly multiply the decimal fraction by 2.

Let's take an example !

Converting Fractions

Convert **11.375_{10}** to it's binary equivalents.

First convert 11 to binary .

We know from the last lecture $\mathbf{11_{10}} = \mathbf{1011_2}$

Now convert $.375_{10}$ to binary

Converting Fractions

0.375 * 2 = 0 .750
0.750 * 2 = 1 .500
0.500 * 2 = 1 .000

$.375_{10}$ = $.011_2$

11.375_{10} = **1011.011_2**

Converting Fractions

- Convert the following numbers to their binary equivalents.

- ❑ $(26.75_{10}) = \mathbf{11010.11_2}$
- ❑ $(37.375_{10}) =$ **H.W**

Converting Fractions

- Exercise:
- Convert the following decimal number to binary?

$$(0.2)_{10} = (0.\overline{0011})_2$$

$$(0.3)_{10} = (0.0\overline{1001})_2$$

Adding Binary Fractions

- Example:
- 1011.0+0.011=

```
    1011.0
+      0.011
  ----------------
    1011.0 11
```

Adding Binary Fractions

- Example:
- 110.01+1.011=

1

110.01

\+ 1.011

111.101

Binary Subtraction

- Solve the following 8-bit subtraction problem using 2's complement representation.

$01111111_2 - 76_{10} = ???$

Think if we rewrite the above problem as

$01111111_2 + (-76)_{10}$

Binary Subtraction

Example: 01111111_2 + $(-76)_{10}$

76 → 01001100

$$
\begin{array}{lr}
 & {}^{1\,1} \\
\text{1's complement} \rightarrow & 10110011 \\
\text{2's complement} \rightarrow + & 1 \\
\hline
 & 10110100 \rightarrow (-76)
\end{array}
$$

Binary Subtraction Cont.

01111111_2 + $(-76)_{10}$

```
   1 11 1
   01111111          127
+  10110100        -  76
---------------    ----------
  100110011           51
```

Overflow

Binary Subtraction Cont.

Example: 00110010_2 + $(-125)_{10}$

125 → 01111101

1's complement → 10000010

2's complement → + 1

10000011→(-125)

Binary Subtraction Cont.

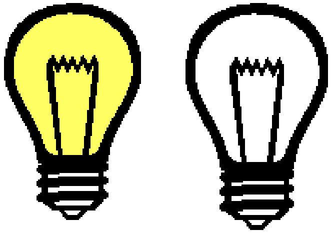
$00110010_2 + (-125)_{10}$

	1		
	00110010		50
+	10000011	-	125
	-------------------		-----------
	10110101		-75

- The 2's comp for the result (10110101) is 01001011 equivalent to $(75)_{10}$

Data Representation

❖**Computer understand two things: on and off .**



❖**Data represented in binary form .**

❖**Bit is the basic unit for storing data 0→off ,1→on .**

❖**Byte is a group of 8 bits. That is, each byte has 256(2^8) possible values.**

❖**Two bytes form a word**

Parity bit

- Used for error detection
- Two types: 1. Odd parity (number of 1's are odd)

  2. Even parity (number of 1's are even)

Characters Representation

Using the **even parity** bit to represent the character **Q** (**Q = 81 in ASCII**) in memory (Hexadecimal) ?

$$(81)_{10}=(01010001)_2$$

	Parity bit		
Q	1	1010001	$= D1_{16}$

Memory

D1

A=65	a=97
B=66	b=98
.	.
.	.

Note: ASCII for A=65 and a=97

American Standard Code for Information Interchange

Characters Representation

Using the **odd parity** bit to represent **your name** in memory ?

Ex. Ahmad

	Parity bit		
A	1	1000001	= $C1_{16}$

	Parity bit		
h	0	1101000	= 68_{16}

	Parity bit		
m	0	1101101	= $6D_{16}$

	Parity bit		
a	0	1100001	= 61_{16}

	Parity bit		
d	0	1100100	= 64_{16}

A 01000001
h 01101000
m 01101101
..

Memory

C1
68
6D
61
64

Integers Representation

Represent the following integer in memory using 2 byte?

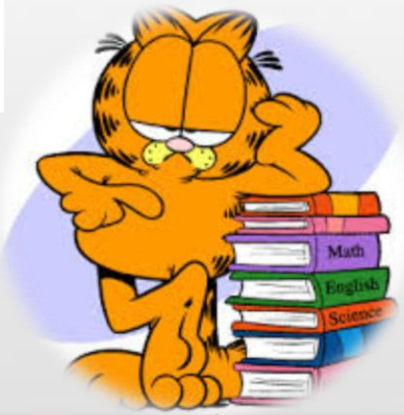
92
92 = 1011100

Answer

0000 0000 01011100

0 0 5 C

Memory
5C
00



Integers Representation

Represent the following integer in memory using 2 byte?

-94

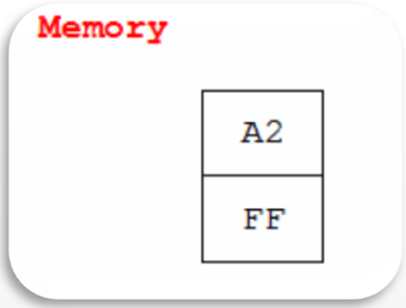
94 = 0000000001011110

1's → 1111111110100001

2's →+ 1

1111111110100010

F F A 2



Floating Point Representation

32 bits divided into three sections

X	XXXXXXXX	XXXXXX…..X
1 bit For sign	8 bits For Exponent	23 bits For Mantissa

0 for Positive

1 for Negative

Floating Point Representation

32 bits divided into three sections

X	XXXXXXXX	XXXXXX…..X
1 bit For sign	8 bits For Exponent	23 bits For Mantissa

2^8 =256

0-255

What about negative ??

Floating Point Representation

255/2=127.5 we take the integer part 127

0--------------------- 255

0--------------------- 255
-127 -127

-127 --------------- 128

Let's take an example !

Floating Point Representation

Use the 32-bit floating representation to represent the following the binary number and show how it will represented in the memory?

$(26.75)_{10}$

Answer:
Convert the number from decimal to binary

Floating Point Representation

$(26.75)_{10} = (11010.11)_2$

$(11010.11)_2 = (1.101011 * 2^4)_2$ **Scientific notation**

Exponent = 127+4=131

$(131)_{10} = (10000011)_2$

0	10000011	10101100000000000000000

4	1	D	6	0	0	0	0

Memory

00
00
D6
41

H.W

Lab 1 . P8,9

Q.5,6,7,9,11

Summary

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