A Review of Number Systems

TEXT2 (Assembly language for x86 processors) : Chapter one

- The use of the microprocessor requires a working knowledge of binary, decimal and hexadecimal numbering systems.

Examples (conversion to decimal):

- What is decimal value of the following ?
- 125.7_8
- 11011.0111**b**
- .101**b**
- .001101**b**
- 6A.C**H**

Examples: Conversion from decimal

- What is 20 in base 2?
- What is it in base 8?
- What is 106 in base 16?
- Convert the number 0.125 to:
  - Binary
  - Octal
  - Hexadecimal

Binary-coded Hexadecimal (BCH)

- BCH is used to represent hexadecimal data in binary code.
- It allows for easy conversion between binary and hexadecimal.
- Generally, a BCH number is a hexadecimal number written so that each digit is represented by a 4-bit binary number.

Examples

- Convert 29FC to binary.
- Convert 1000 0011 1101 . 1110 to hexadecimal.

Signed Integers

- A signed integer can have either a positive or a negative value.
- In the x86 processor architecture, the MSB indicates the sign: 0 is positive and 1 is negative.
- Humans simply put a – sign in front of a number to show it is negative. What about the computer.
- *Two's-complement* representation is used (1's complement was used in the past)
- This representation is based on the mathematical principle that the two's complement of an integer is its additive inverse.

- The two’s complement of a binary integer is formed by inverting (complementing) its bits and adding 1.
- What is the two’s complement representation of 00000001?
- How will -1 be represented in an x86 processor using 8 bits?
- The same principles can be applied to all number systems.
    - What is the two’s (or sixteen’s) complement of the following hexadecimal numbers?
        - 95C3, 5CC?

Converting Signed binary to decimal

- The following algorithm can be used to calculate the decimal equivalent of a signed binary integer:
  - If the highest bit is a 1, the number is stored in two's-complement notation.
  - Create its two's complement a second time to get its positive equivalent.
  - Then convert this new number to decimal as if it were an unsigned binary integer.
  - If the highest bit is a 0, you can convert it to decimal as if it were an unsigned binary integer.
- Example: What is the value of the signed binary 11110000 in decimal?

- How would you convert a signed Decimal to Binary?
- How would you convert a signed Hexadecimal value to Decimal?
- How would you convert a signed Decimal to Hexadecimal?

NOTE

You can tell whether a hexadecimal integer is positive or negative by inspecting its most significant (highest) digit.
If the digit is ≥ 8, the number is negative; if the digit is ≤ 7, the number is positive. For example, hexadecimal 8A20 is negative and 7FD9 is positive.

- If computers only store binary data, how do they represent characters?
- They use a *character set*, which is a mapping of characters to integers.
- The two standards in use today are **ASCII** and **Unicode** Data.
- In ASCII, a unique 7-bit integer is assigned to each character.

Examples

  - ‘F’ is represented as 41**h** while ‘1’ is represented as 31**h**
- *ASCII strings are* stored in memory as a succession of bytes containing ASCII codes.
- Example: How will the string “ABC123” be stored?

A PART OF THE ASCII TABLE

decimal	⇨	1	16	32	46	64	80	96	112
⇩	hexa-decimal	0	1	2	3	4	5	6	7
0	0	null	▶	space	0	@	P	`	p
1	1	☺	◀	!	1	A	Q	a	q
2	2	☻	↕	"	2	B	R	b	r
3	3	♥	!!	#	3	C	S	c	s
4	4	♦	Π	$	4	D	T	d	t
5	5	♣	§	%	5	E	U	e	u
6	6	♠	▬	&	6	F	V	f	v
7	7	•	↨	'	7	G	W	g	w
8	8	◘	^	(	8	H	X	h	x
9	9	○	↓	)	9	I	Y	i	y
10	A	◙	→	*	:	J	Z	j	z
11	B	♂	←	+	;	K	[	k	{
12	C	♀	∟	,	<	L	\	l	|
13	D	♪	↔	-	=	M	]	m	}
14	E	♫	▲	.	>	N	^	n	~
15	F	☼	▼	/	?	O	_	o	Δ

- There has been a need for some time to represent a wide variety of international languages in computer software.
- As a result, the *Unicode* standard was created as a universal way of defining characters and symbols.
- It defines codes for characters, symbols, and punctuation used in all major languages.
- Three encoding forms are available in Unicode: UTF-8, UTF-16 and UTF-32