Binary Numbers

- Assume 1-bit numbers:

  Only two different numbers can be represented:

  0
  1

- Assume 2-bit numbers:

  Four different numbers can be represented:

  00 - 0
  01 - 1
  10 - 2
  11 - 3

- Assume 3-bit numbers:

  Eight different numbers can be represented:

  000 - 0
  001 - 1
  010 - 2
  011 - 3
  100 - 4
  101 - 5
  110 - 6
  111 - 7

Hexadecimal Numbers

- Assume 4-bit binary numbers:

  Sixteen different numbers can be represented:

Binary	Decimal	Hexadecimal
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

- Example:

  $(0100001010100101011011110001)_2 = (?)_{16}$

  0100 0010 1010 0101 0110 1111 0001

  $= (4\ 2\ A\ 5\ 6\ F\ 1)_{16}$

- Example:

  $(AF52C)_{16} = (?)_2$

  A F 5 2 C

  $= (1010\ 1111\ 0101\ 0010\ 1100)_2$

Signed Numbers

The leftmost bit is used to indicate the sign of the number:

0 - positive
1- negative

Negative numbers are represented in two's complement form.

Bit Pattern	*Decimal Value*
10000000000000000000000000000000	(-2^{31} = -2,147,483,648)
10000000000000000000000000000001	($-2^{31}-1$ = -2,147,483,647)
10000000000000000000000000000010	($-2^{31}-2$ = -2,147,483,646)
.	
.	
.	
11111111111111111111111111111101	(-3)
11111111111111111111111111111110	(-2)
11111111111111111111111111111111	(-1)
00000000000000000000000000000000	(0)
00000000000000000000000000000001	(1)
00000000000000000000000000000010	(2)
00000000000000000000000000000011	(3)
.	
.	
.	
01111111111111111111111111111101	($2^{31}-3$ = 2,147,483,645)
01111111111111111111111111111110	($2^{31}-2$ = 2,147,483,646)
01111111111111111111111111111111	($2^{31}-1$ = 2,147,483,647)

Representing integers as bit patterns.

- Note:
  Real numbers (e.g., 256.78) use floating point notation to represent the mantissa and the exponent of the number.

  $256.78 = 2.5678 \times 10^2$