SIGNED BINARY

Representation of Integers

SIGNED BINARY

1) No “Sign” in computer hardware
2) Map binary numbers to signed decimal values

- Sign Magnitude
- One’s Complement
- Two’s Complement
- Excess K

SIGN MAGNITUDE

- Left most bit is Sign Bit

  0 is positive
  1 is negative

- Remaining bits are magnitude (absolute value)

- i.e.

+5 = 0 101

-5 = 1 101

SIGN MAGNITUDE

- Two representations for zero
- Range is $\mathbf{-2^n - 1}$ to $\mathbf{2^n - 1}$
- i.e. for n = 3 bits: **-3** to **+3**

Sign Magnitude

Converting from Sign Magnitude to Decimal

leftmost - bit is the sign

- remaining bits are the magnitude.
  - convert binary to decimal

Exercise:

Convert 0100 to Decimal

Convert 1011 to Decimal

Sign Magnitude

Converting from Decimal to Sign Magnitude

leftmost - bit is the sign

- remaining bits are the magnitude.
  - convert decimal to binary

Exercise:

Convert +3 to Sign Magnitude

Convert -2 to Sign Magnitude

Fill in the Chart

Binary	Unsigned	Sign Magnitude	One's Complement	Two's Complement	Excess N
011					
010					
001					
000					
100					
101					
110					
111					

One's Complement

- Left most bit is Sign Bit

  0 is positive
  1 is negative

- Remaining bits are magnitude (absolute value)

- If value is positive, then same as Sign Magnitude
- If value is negative, then magnitude bits are complemented or "flipped"

+5 = 0 101

-5 = 1 010

One’s Complement

Converting from One’s Complement to Decimal

leftmost - bit is the sign

- remaining bits are the magnitude.
  - If positive, then convert binary to decimal
  - If negative, flip all bits, convert to decimal

Exercise:

Convert 0100 to Decimal

Convert 1011 to Decimal

One’s Complement

Converting from One’s Complement to Decimal

leftmost - bit is the sign

- remaining bits are the magnitude.
  - If positive, then convert binary to decimal
  - If negative, flip all bits, convert to decimal

Exercise:

Convert +3 to One’s Complement

Convert -2 to One’s Complement

Fill in the Chart

Binary	Unsigned	Sign Magnitude	One's Complement	Two's Complement	Excess N
011	3	+3			
010	2	+2			
001	1	+1			
000	0	+0			
100	4	-0			
101	5	-1			
110	6	-2			
111	7	-3			

Two's Complement

- Left most bit is Sign Bit

  0 is positive
  1 is negative

- Remaining bits are magnitude (absolute value)

- If value is negative, then magnitude bits are complemented or "flipped" **and +1**

+5 = 0 101

-5 = 1 011

Two's Complement

Converting from Two's Complement to Decimal

leftmost - bit is the sign

- remaining bits are the magnitude.
  - If positive, then convert binary to decimal
  - If negative, flip all bits, convert to decimal and +1

Exercise:

Convert 0100 to Decimal

Convert 1011 to Decimal

Two's Complement

Converting from Decimal to Two's Complement

leftmost - bit is the sign

- remaining bits are the magnitude.
  - If positive, then convert magnitude to binary
  - If negative, convert to binary and then flip all bits and +1

Exercise:

Convert +3 to Two's Complement

Convert -2 to Two's Complement

Fill in the Chart

Binary	Unsigned	Sign Magnitude	One's Complement	Two's Complement	Excess N
011	3	+3	+3		
010	2	+2	+2		
001	1	+1	+1		
000	0	+0	+0		
100	4	-0	-3		
101	5	-1	-2		
110	6	-2	-1		
111	7	-3	-0		

Excess K

a digital coding scheme where all-zero corresponds to the minimal negative value.

K represents the minimal negative value.

Excess 3

Excess 3	Decimal
101	2
100	1
11	0
10	-1
1	-2
0	-3

Fill in the Chart

Binary	Unsigned	Sign Magnitude	One's Complement	Two's Complement	Excess 5
011	3	+3	+3	+3	
010	2	+2	+2	+2	
001	1	+1	+1	+1	
000	0	+0	+0	+0	
100	4	-0	-3	-4	
101	5	-1	-2	-3	
110	6	-2	-1	-2	
111	7	-3	-0	-1	