Recitation 3

Two's complement

$$B2T_w(\vec{x}) \doteq -x_{w-1}2^{w-1} + \sum_{i=0}^{w-2} x_i 2^i$$

Flip the bits, add 1:
e.g.:
+1 : 0001
-1: 1111
+2: 0010
-2 : 1110

One's complement

- Inverting all the bits in the binary representation of the number:

e.g.:

+1 : 0001

-1: 1110

+2: 0010

-2: 1101

Arithmetic

- Addition: $$x +_w^u y = \begin{cases} x + y, & x + y < 2^w \\ x + y - 2^w, & 2^w \le x + y < 2^{w+1} \end{cases}$$
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- Subtraction: $$-_w^u x = \begin{cases} x, & x = 0 \\ 2^w - x, & x > 0 \end{cases}$$
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- Multiplication: $x *_w^u y = (x \cdot y) \bmod 2^w$
  - Left shift: x*8 = x << 3
- Division by power of two: right shift
  - x/8 = x >> 3

Mode	x		y		$x \cdot y$		Truncated $x \cdot y$	
Unsigned	5	[101]	3	[011]	15	[001111]	7	[111]
Two's comp.	−3	[101]	3	[011]	−9	[110111]	−1	[111]
Unsigned	4	[100]	7	[111]	28	[011100]	4	[100]
Two's comp.	−4	[100]	−1	[111]	4	[000100]	−4	[100]
Unsigned	3	[011]	3	[011]	9	[001001]	1	[001]
Two's comp.	3	[011]	3	[011]	9	[001001]	1	[001]

k	>> k (Binary)	Decimal	$-12340/2^k$
0	1100111111001100	−12340	−12340.0
1	*1*100111111100110	−6170	−6170.0
4	*1111*10011111100	−772	−771.25
8	*11111111*11001111	−49	−48.203125