Interpreting Signed Integer Patterns

If the representation and bit pattern are given, we know the value

Sign & magnitude

If MSB=0, value = +magnitude (0110➔ +110 i.e. +6)
If MSB=1, value = -magnitude (1011➔ –011 i.e. -3)

One's complement

If MSB=1, flip each bit to get the value (1011➔ – 0100 i.e. -4)
same as subtracting from modulus-1 (for 4 bits, modulus-1 = 16-1=15)
(1111 – 1011) = 0100 or 15 - 11 = 4
If MSB=0, use bit pattern as the value (0110➔ + 0110 i.e. +6)

Two's complement

If MSB=1, flip each bit and add 1 to get the value (1011➔ – 0101 i.e. -5)
Same as subtracting from modulus (16 – 11 = 5)
If MSB=0, use bit pattern as the value (0111➔ + 0111 i.e. +7)

Biased Representation

Biased is also referred to as excess representation

- Representation is value + bias
- The threshold (bias) must be specified
- The number of available bits (n) & threshold determine the range
- Value is recovered by subtracting bias from representation
- midpoint (2^{n-1}) as bias gives same range as n-bit two's complement

In general, range = -bias to $(2^n - 1)$ - bias n = number of bits

Not using midpoint as bias gives a lopsided range

All zero bits represent the lower limit (0 – bias)

All one bits represent the upper limit $(2^n - 1)$ - bias

Biased Representation Example

Example: if number of bits n=4, and bias = $2^3 = 8$ (excess-8)

+5 is represented as 5 + 8 = 13 (1101)

-3 is represented as -3 + 8 = 5 (0101)

Given a bit pattern and the bias, we know the value

Value = representation – bias

1110➔ 14 – 8 = +6 (the pattern is 6 greater than 8)

0110➔ 6 – 8 = -2 (the pattern is 2 less than 8)

Range = -bias to $(2^n – 1)$-bias (-8 to 15-8= 7) in this case