

Chapter 3

1 Binary Representation

$$N = 2^n$$

n — The number of binary digits

N — The total number of binary representations

e.g.

Three bits ($n=3$) can represent eight (2^3) binary numbers.

000	(0)
001	(1)
010	(2)
011	⋮
100	⋮
101	⋮
110	⋮
111	(7)

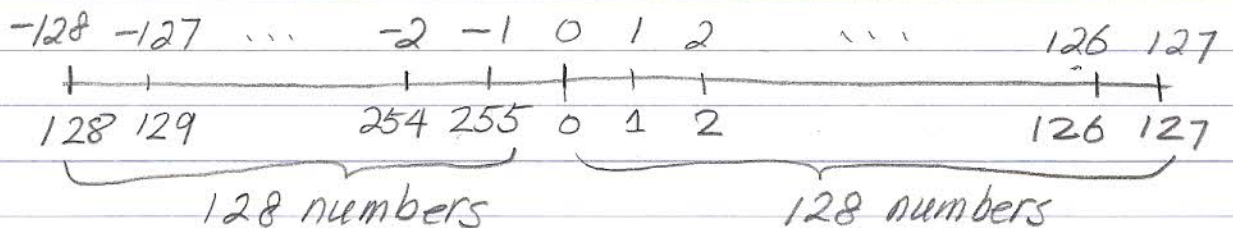
} 8 binary numbers 0-7

2. Two's complement

Use positive numbers to represent both positive and negative numbers.

If we use 8 bits, $2^8 = 256$ numbers

We use half of 256 numbers ($=128$) to represent 0, 1, 2, ..., 127 and the remaining half to represent -1, -2, ..., -127.



The data range $[-128, 127]$

If 8 bits are used

127		01111111	(127)
		01111110	(126)
2		00000010	(2)
1		00000001	(1)
0		00000000	(0)
-1		11111111	(255)
-2		11111110	(254)
-3		11111101	(253)
-127		10000001	(127)
-128		10000000	(128)

converting positive to negative or
negative to positive

- (1) flip all bits
- (2) Add 1

e.g. $2 \implies -2$

$$\begin{array}{r}
 \boxed{00000010} \quad (2) \\
 \downarrow \text{flipping} \\
 11111101 \\
 + 00000001 \quad \text{Add 1} \\
 \hline
 \boxed{11111110} \quad (-2)
 \end{array}$$

e.g.

$$3 - 1 = 3 + (-1) = 2$$

$$\begin{array}{r} 00000011 \\ + 11111111 \\ \hline 00000010 \end{array} \quad (2)$$

$$\begin{array}{r} (-1) \\ 11111111 \\ \downarrow \\ 00000000 \\ + \quad \quad \quad 1 \\ \hline 00000001 \quad (1) \end{array}$$

Note that we drop the last carry and keep only eight bits

3. Color

RGB = (Red, green, blue)

Each component uses a scale of 0-255 (8 bit binary number)

3 x 8 bits \Rightarrow 24-bit true color depth

e.g. (0, 255, 0) is green (full contribution from green)

Binary: (00000000, 11111111, 00000000)

Hex (00, FF, 00)

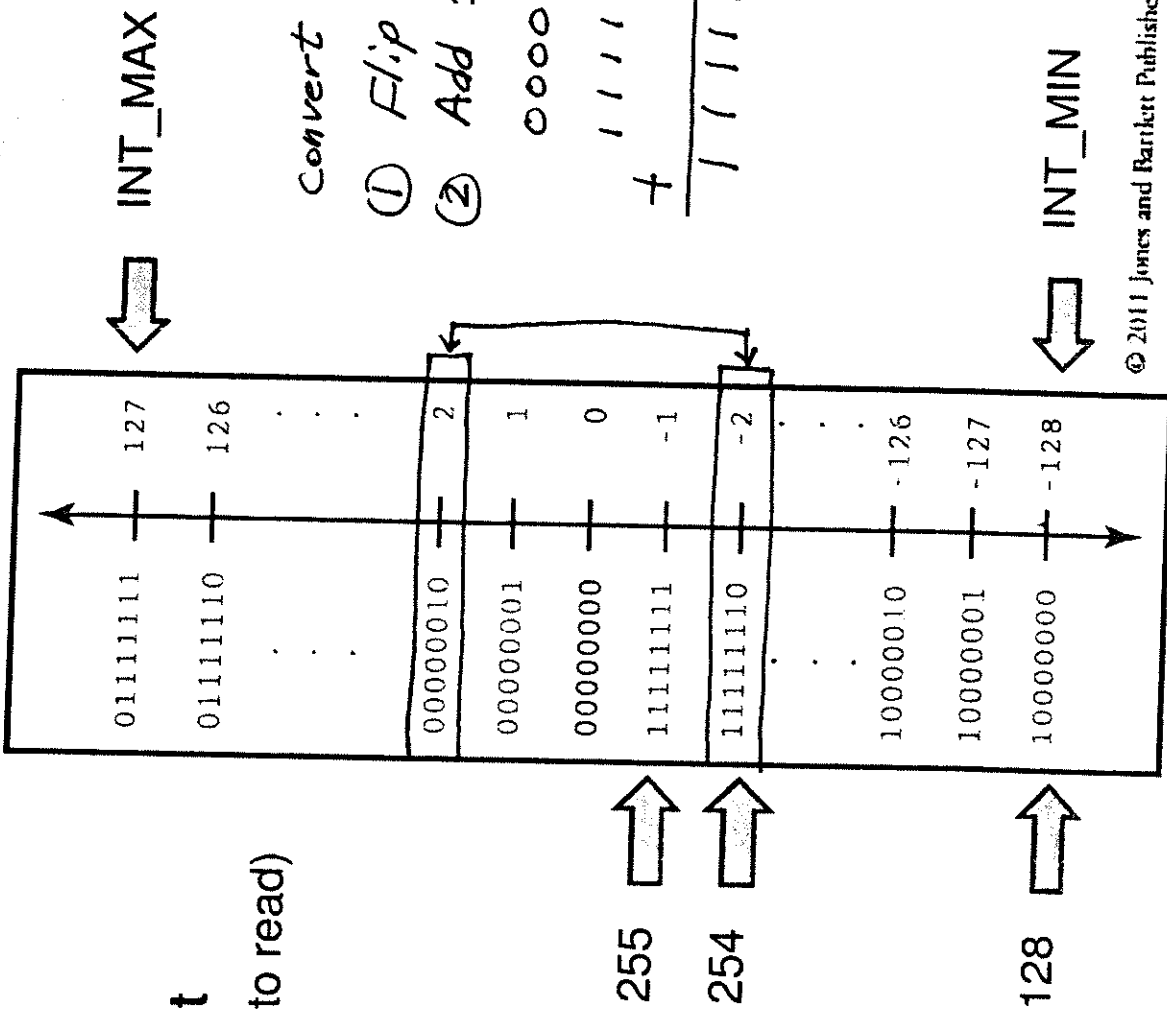
color code in HTML: #00FF00

4. picture

use pixel (picture element) as unit to measure the resolution of a picture.

picture size vs picture quality
How large vs how detailed

Representing Negative Values



Two's Complement
(Vertical line is easier to read)