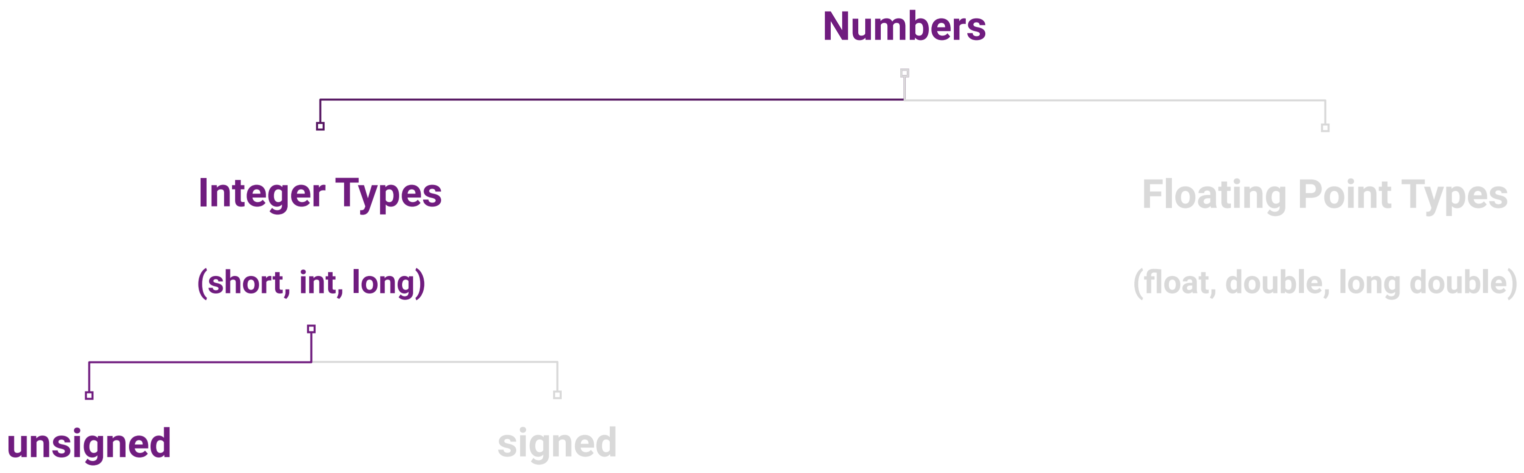
INTRO TO BINARY SYSTEMS

Previous Lecture Review

- Different numeral systems (decimal, binary, hexa).
- Converting Between Counting Systems
- importance of binary and hexa
- Main memory units (mem_content vs mem_address)
- Some important notes:
    - n bits → 2^n possibilities (n-bit address can refer to 2^n diff mem. locations)
    - $2^{n+m} = 2^n \times 2^m$
    - $\log_2(n \times m) = \log_2 n + \log_2 m$

$2^{num\_add\_bits} \rightarrow$ mem_siz

log (mem_size) → num_add_bits



Numbers

Integer Types

(short, int, long)

Floating Point Types

(float, double, long double)

unsigned

signed

$(7)_d \rightarrow$

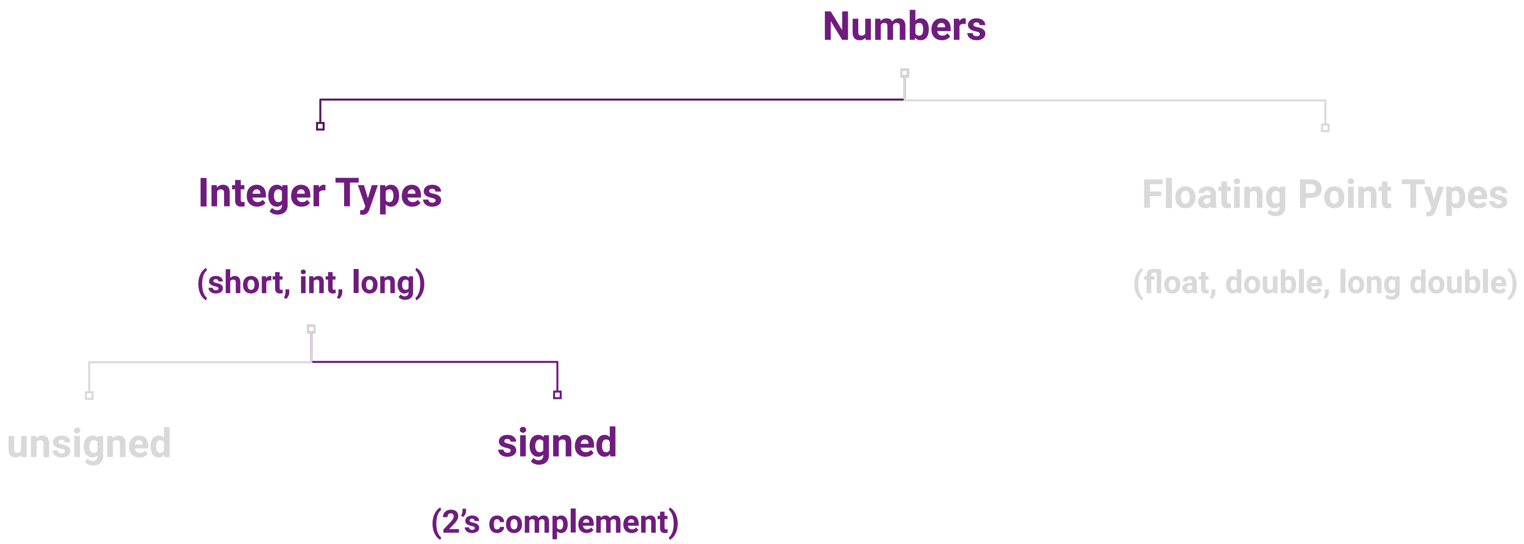
0	0	0	0	0	1	1	1

$(10)_d \rightarrow$

0	0	0	0	1	0	1	0

$(258)_d \rightarrow$

0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0



Numbers

Integer Types

(short, int, long)

Floating Point Types

(float, double, long double)

unsigned

signed

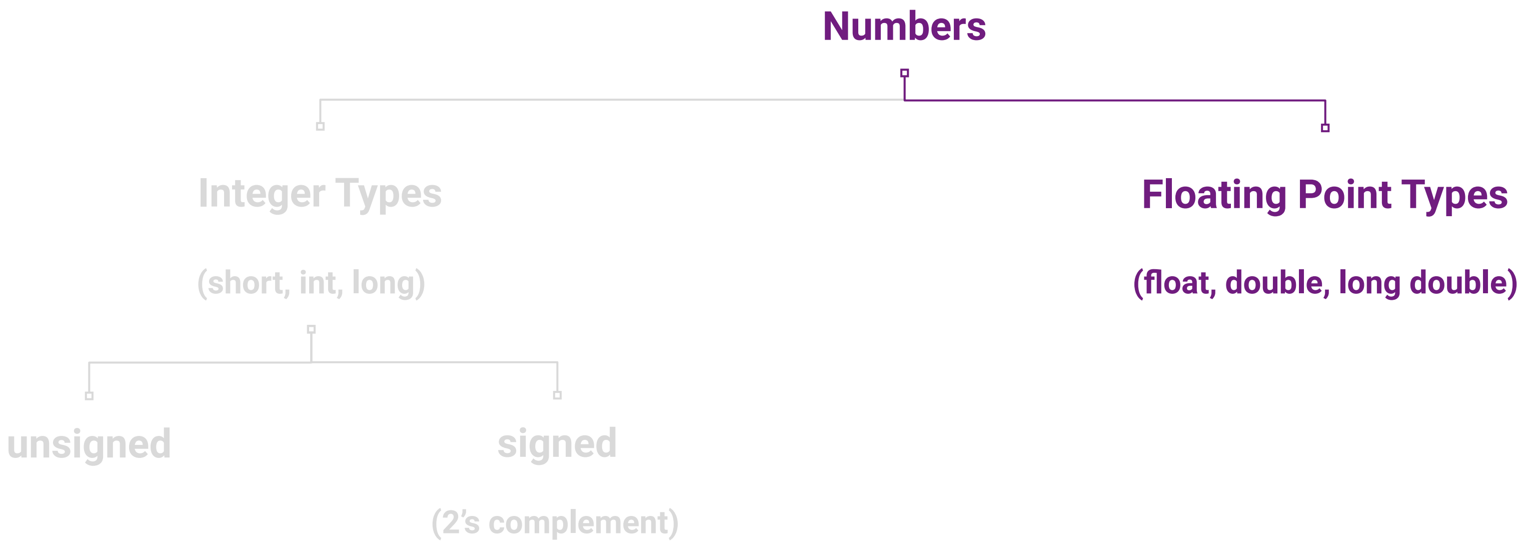
(2's complement)

$(+7)_d \rightarrow$ 0 0 0 0 0 1 1 1

$(-7)_d \rightarrow$ 1 1 1 1 1 0 0 1

$(+40)_d \rightarrow$ 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0

$(-40)_d \rightarrow$ 1 1 1 1 1 1 1 1 1 1 0 1 1 0 0 0



Numbers

Integer Types

(short, int, long)

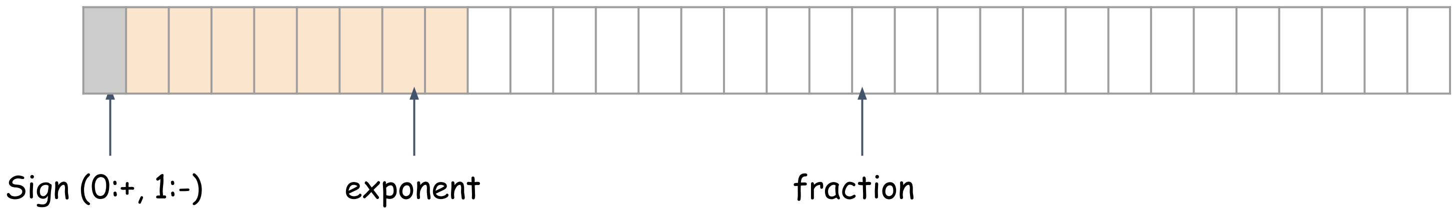
unsigned

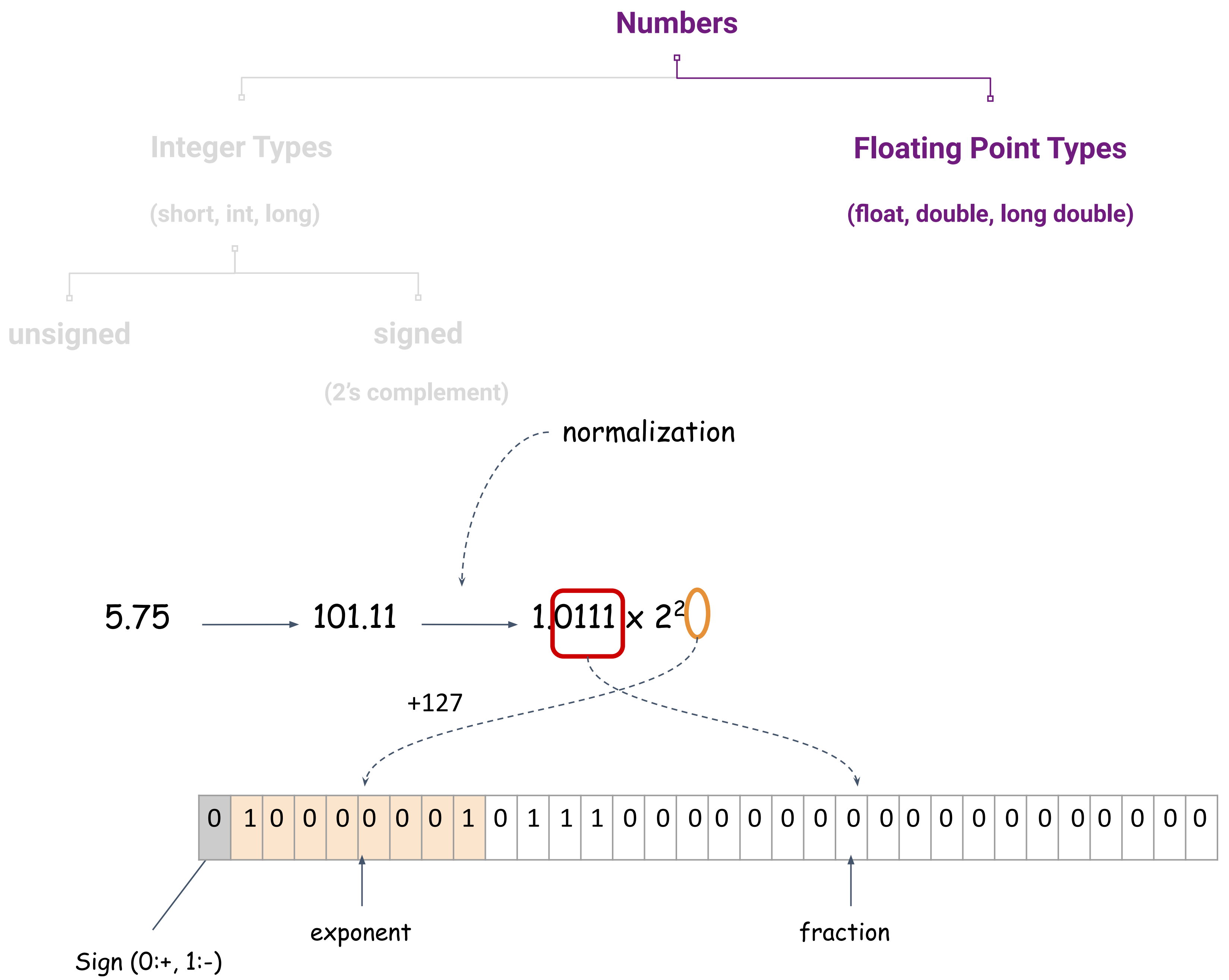
signed

(2’s complement)

Floating Point Types

(float, double, long double)





Numbers

Integer Types

(short, int, long)

unsigned

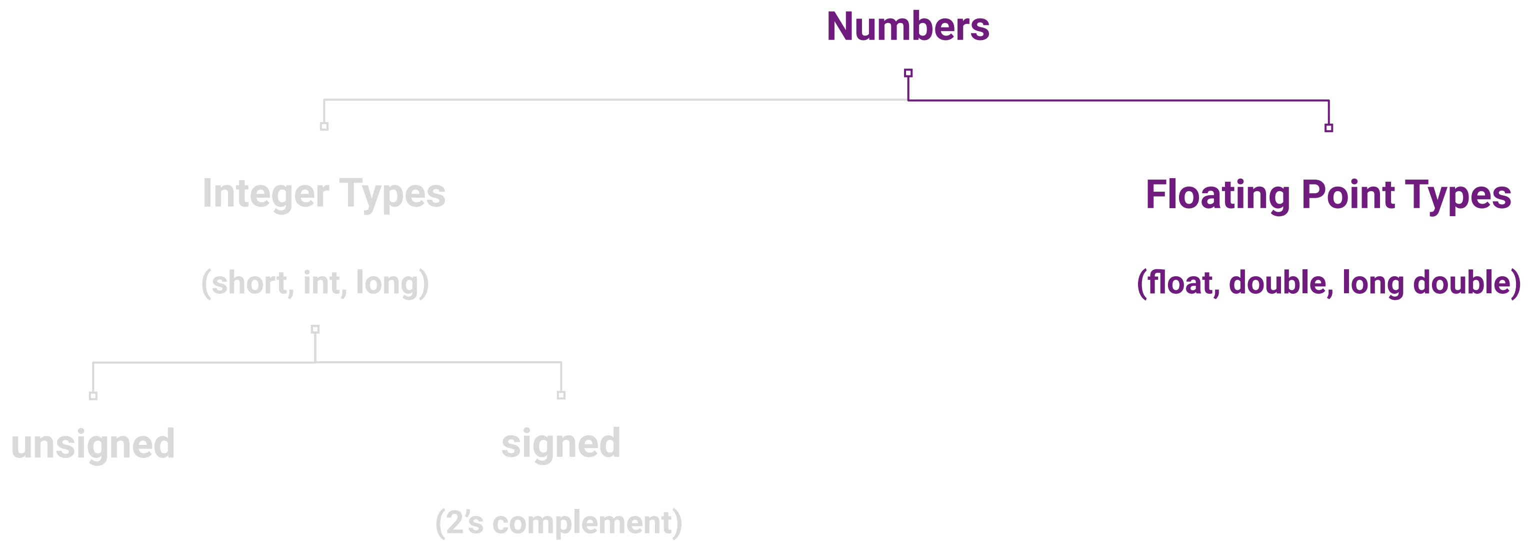
signed

(2's complement)

Floating Point Types

(float, double, long double)

0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Numbers

Integer Types

(short, int, long)

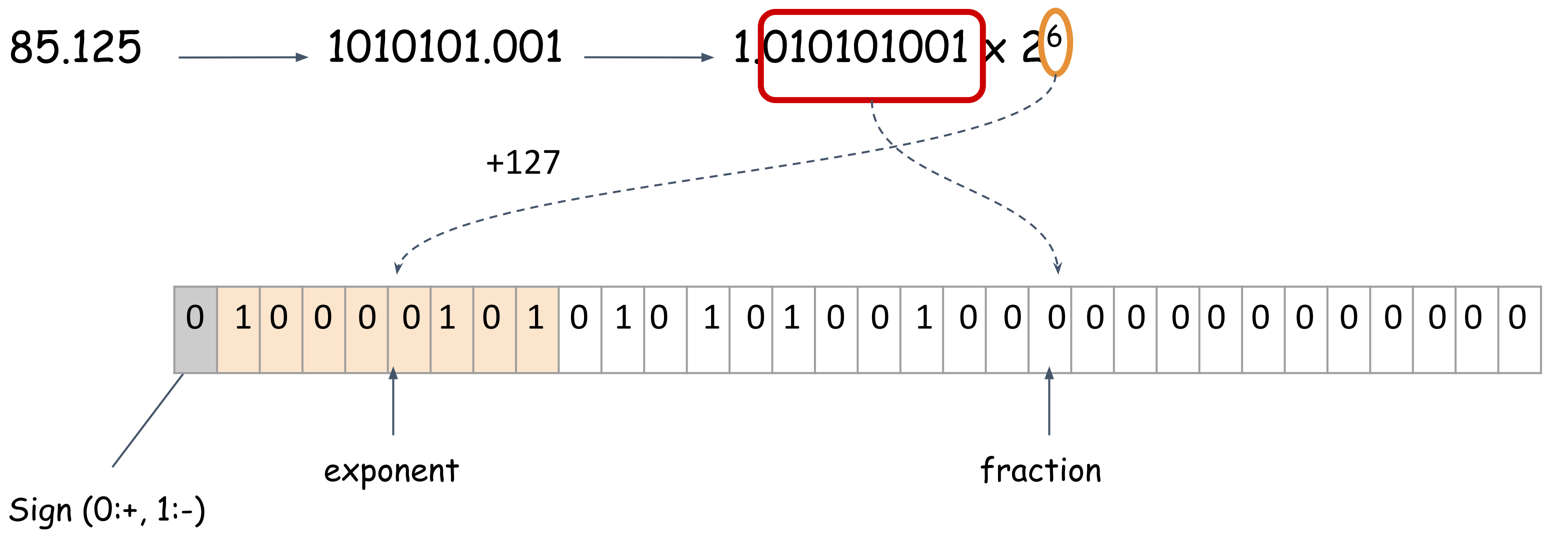
unsigned

signed

(2's complement)

Floating Point Types

(float, double, long double)



$$85.125 \longrightarrow 1010101.001 \longrightarrow 1.\boxed{010101001} \times 2^{6}$$

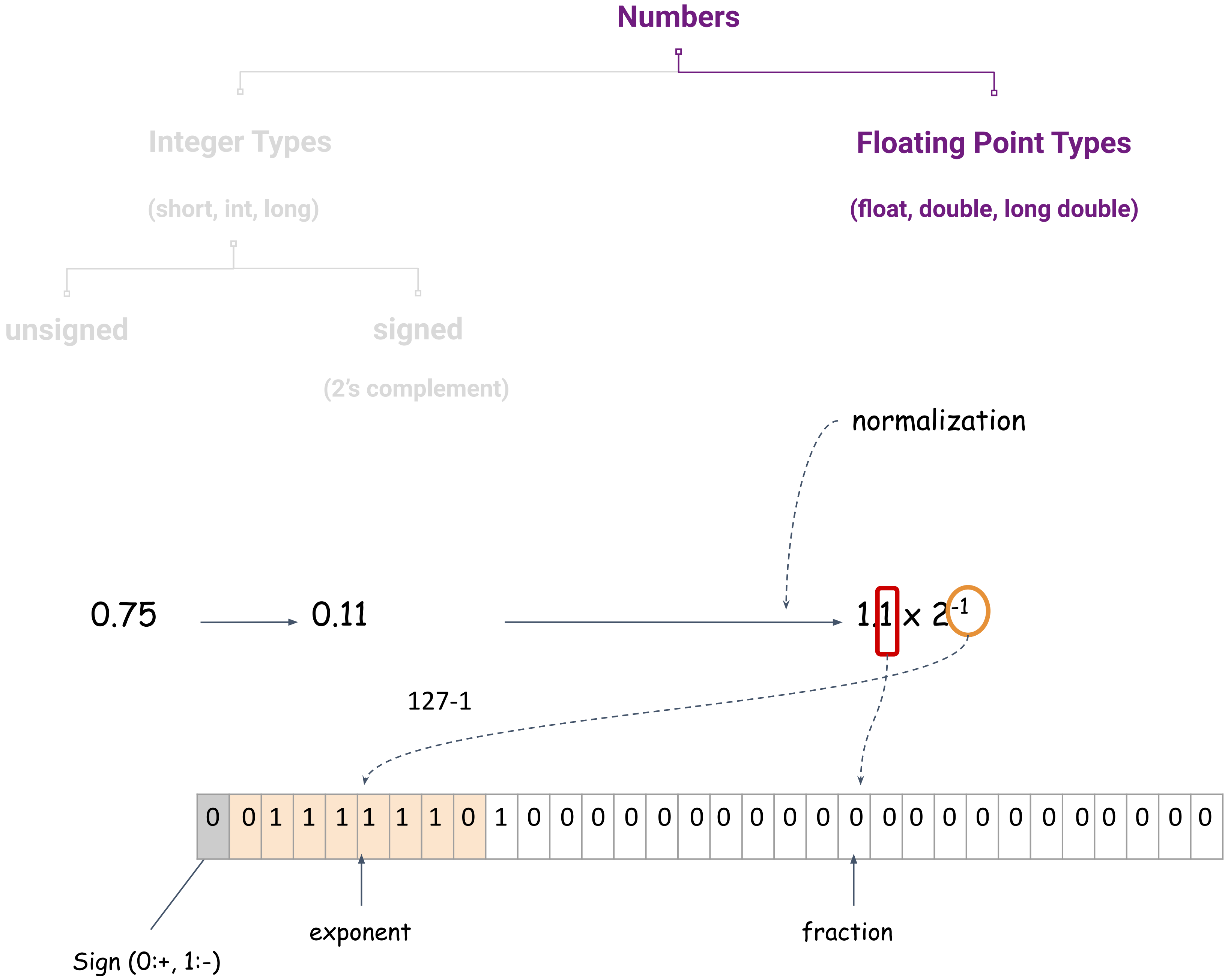
+127

0	1	0	0	0	0	1	0	1	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sign (0:+, 1:-)

exponent

fraction



Numbers

Integer Types

(short, int, long)

unsigned

signed

(2’s complement)

Floating Point Types

(float, double, long double)

normalization

0.75 → 0.11 → 1.1 × 2^{-1}

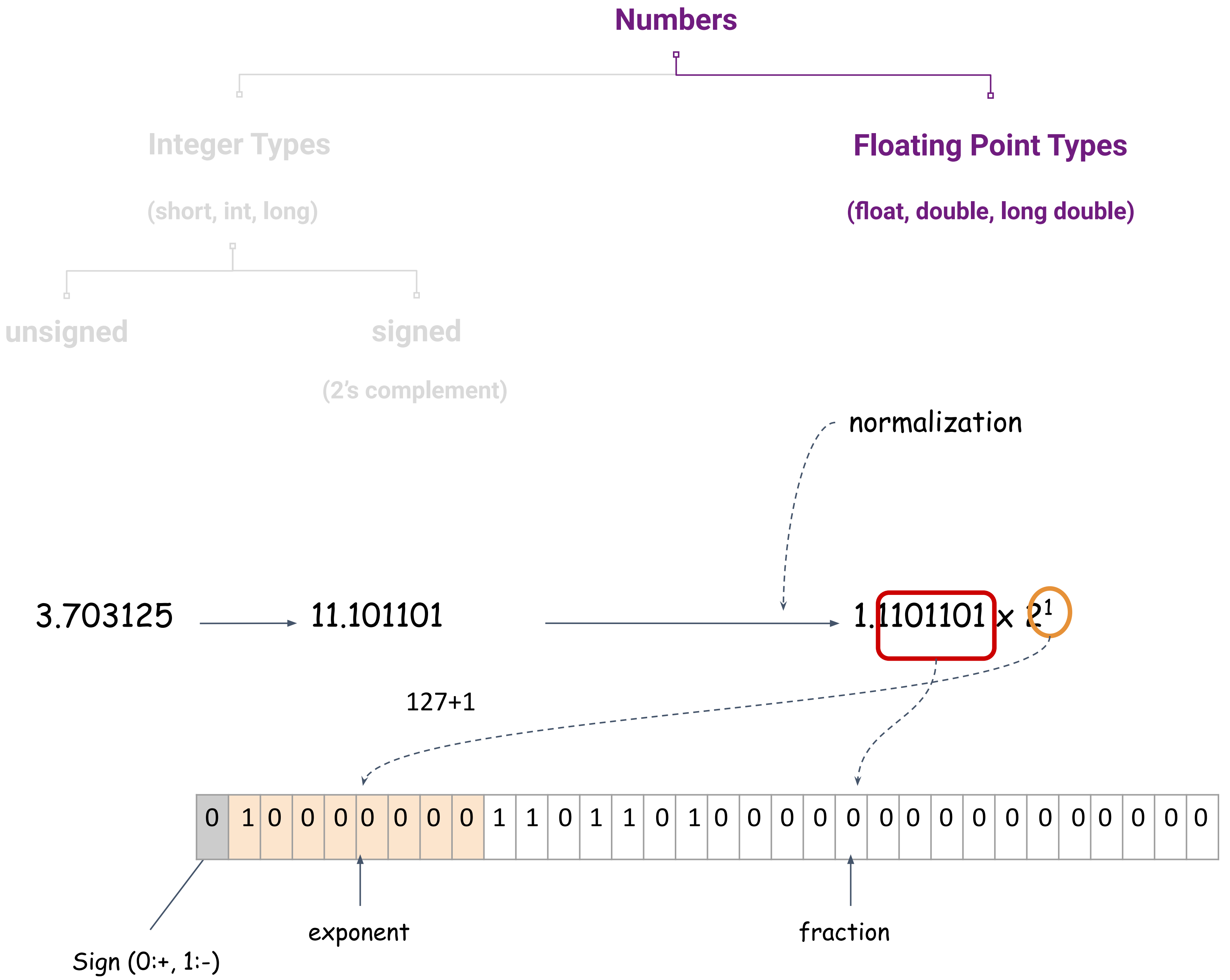
127-1

0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sign (0:+, 1:-)

exponent

fraction

Numbers
Integer Types
(short, int, long)
unsigned
signed
(2's complement)
Floating Point Types
(float, double, long double)
normalization
3.703125
11.101101
1.1101101 × 2^1
127+1
0 1 0 0 0 0 0 0 0 1 1 0 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
exponent
fraction
Sign (0:+, 1:-)

Numbers

Integer Types

(char, short, int, long)

unsigned

$(5)_d$	/	%
5/2	2	1
2/2	1	0
1/2	0	1

0	0	0	0	0	1	0	1

signed

(2's complement)

$(+5)_d$	/	%
5/2	2	1
2/2	1	0
1/2	0	1

0	0	0	0	0	1	0	1

$(-5)_d$

1	1	1	1	1	0	1	1

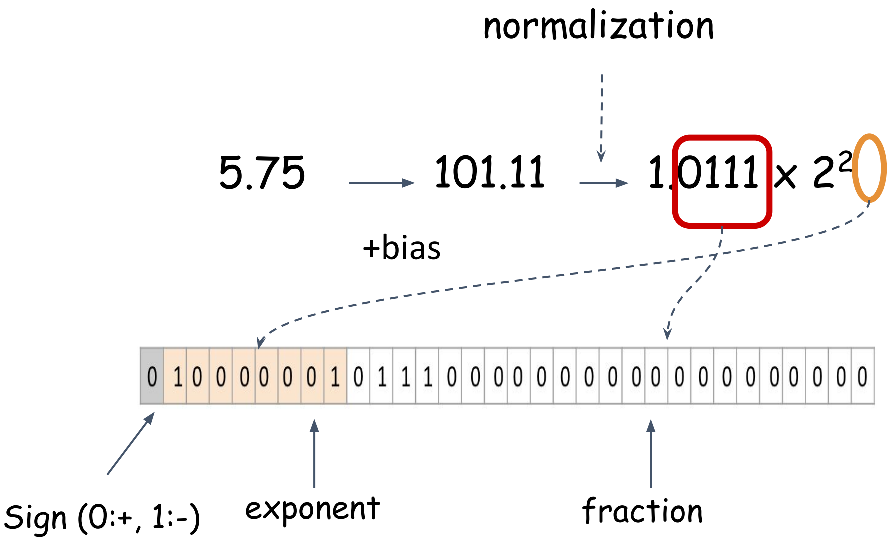
Floating Point Types

(float, double, long double)

5.75

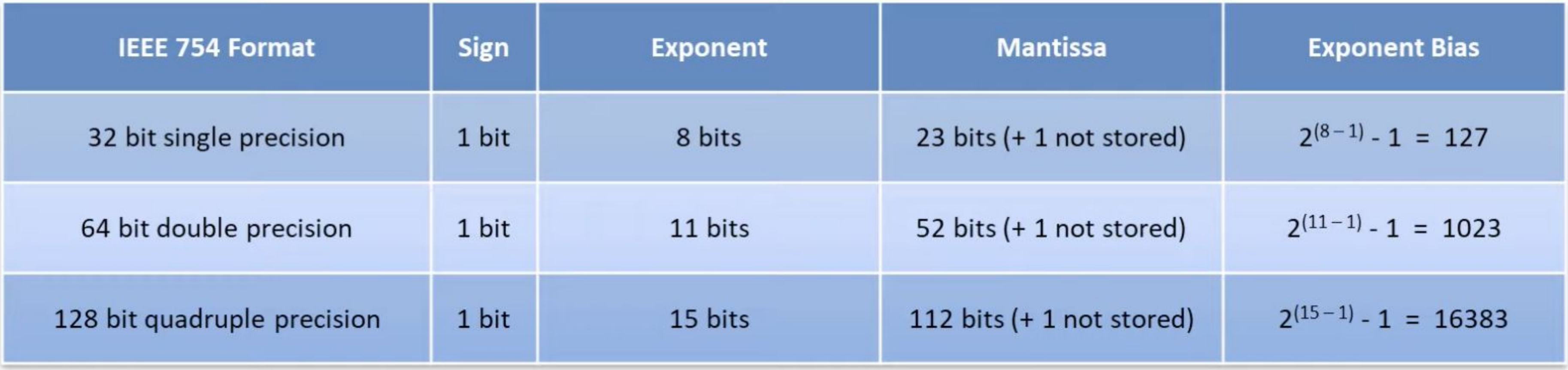
$(5)_d$	/	%
5/2	2	1
2/2	1	0
1/2	0	1

$(0.75)_d$	x	
0.75 x 2	1.50	1
0.50 x 2	1.0	1



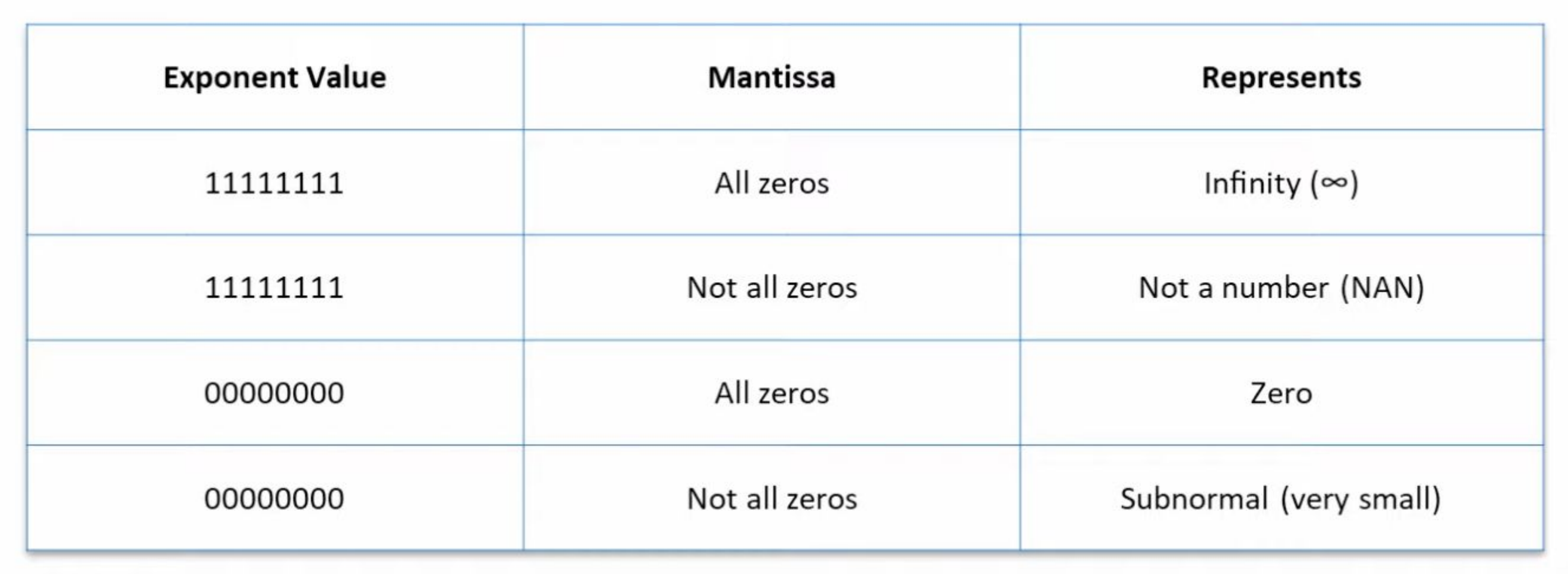
0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Ranges



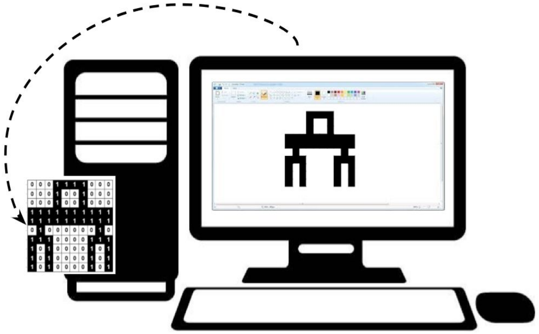
IEEE 754 Format	Sign	Exponent	Mantissa	Exponent Bias
32 bit single precision	1 bit	8 bits	23 bits (+ 1 not stored)	$2^{(8-1)} - 1 = 127$
64 bit double precision	1 bit	11 bits	52 bits (+ 1 not stored)	$2^{(11-1)} - 1 = 1023$
128 bit quadruple precision	1 bit	15 bits	112 bits (+ 1 not stored)	$2^{(15-1)} - 1 = 16383$

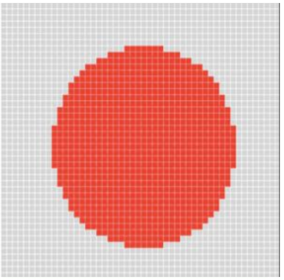
Reserved Exponent Values



Exponent Value	Mantissa	Represents
11111111	All zeros	Infinity (∞)
11111111	Not all zeros	Not a number (NAN)
00000000	All zeros	Zero
00000000	Not all zeros	Subnormal (very small)

Representation of Images





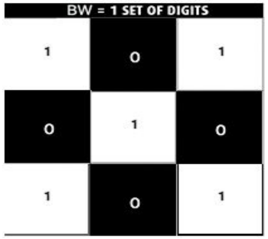
RASTER

COMPRISED OF PIXELS

LOSES QUALITY WHEN SCALED

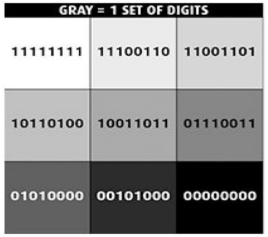
CAN'T CONVERT TO VECTOR

BMP, JPG, GIF, PNG



BW = 1 SET OF DIGITS

1	0	1
0	1	0
1	0	1



GRAY = 1 SET OF DIGITS

11111111	11100110	11001101
10110100	10011011	01110011
01010000	00101000	00000000

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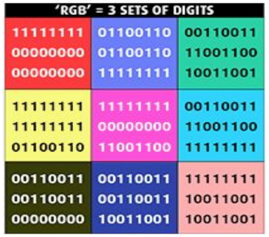
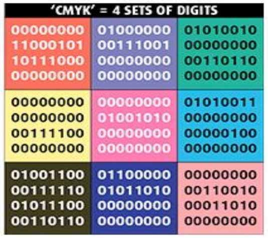


'RGB' = 3 SETS OF DIGITS

11111111 00000000 00000000	01100110 01100110 11111111	00110011 11001100 10011001
11111111 11111111 01100110	11111111 00000000 11001100	00110011 11001100 11111111
00110011 00110011 00000000	00110011 00110011 10011001	11111111 10011001 10011001

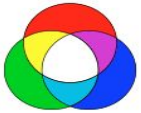


'CMYK' = 4 SETS OF DIGITS

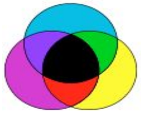
00000000 11000101 10111000 00000000	01000000 00111001 00000000 00000000	01010010 00000000 00110110 00000000
00000000 00000000 00111100 00000000	00000000 01001010 00000000 00000000	01010011 00000000 00000100 00000000
01001100 00111110 01011100 00110110	01100000 01011010 00000000 00000000	00000000 00110010 00011010 00000000

1-BIT COLOR

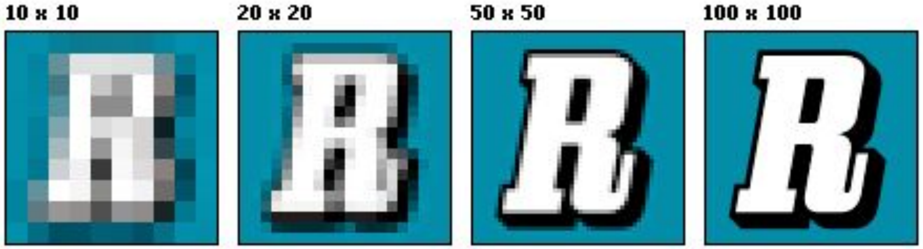
GRAYSCALE



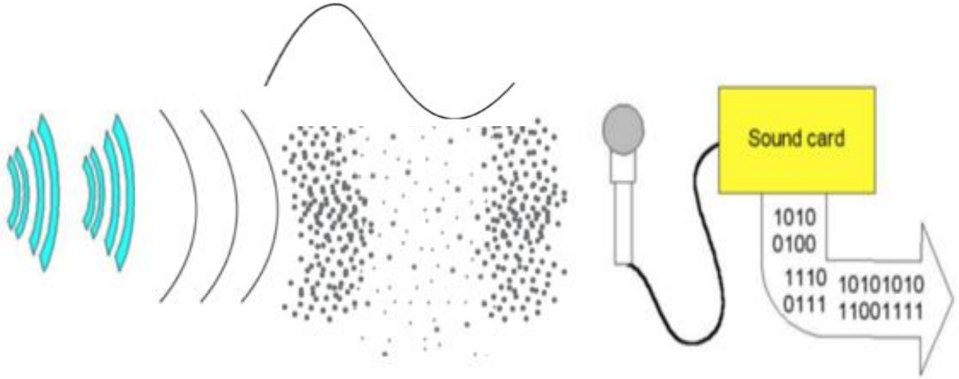
RGB

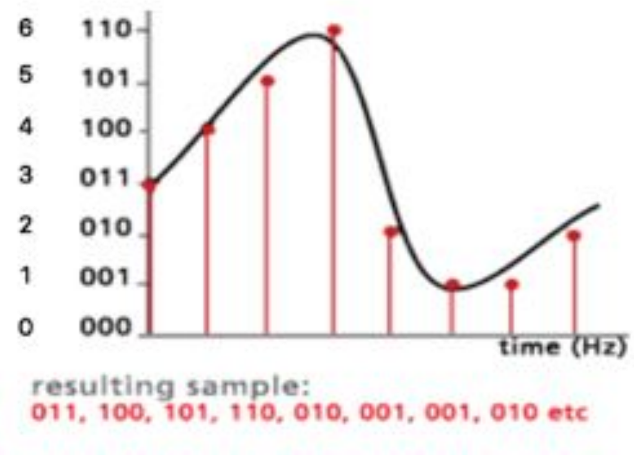


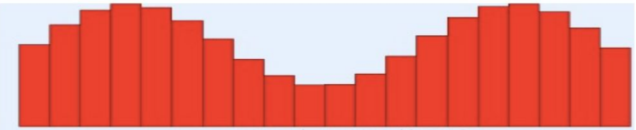
CMYK

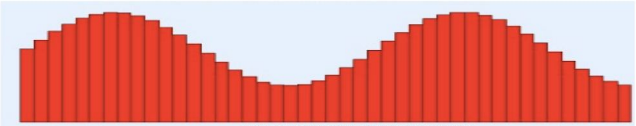


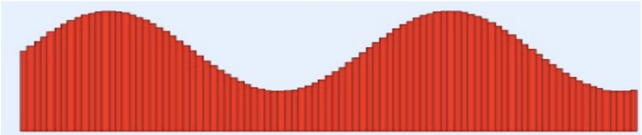
Representation of Sounds



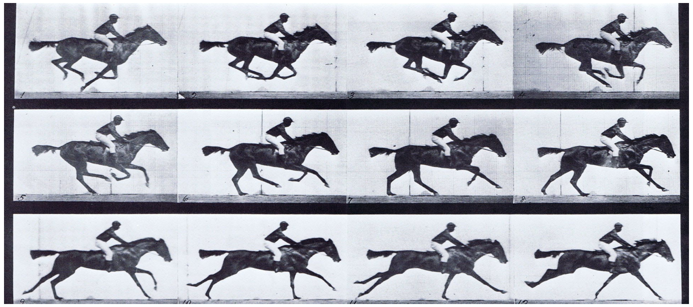



100 Samples per Second (100 Hz)

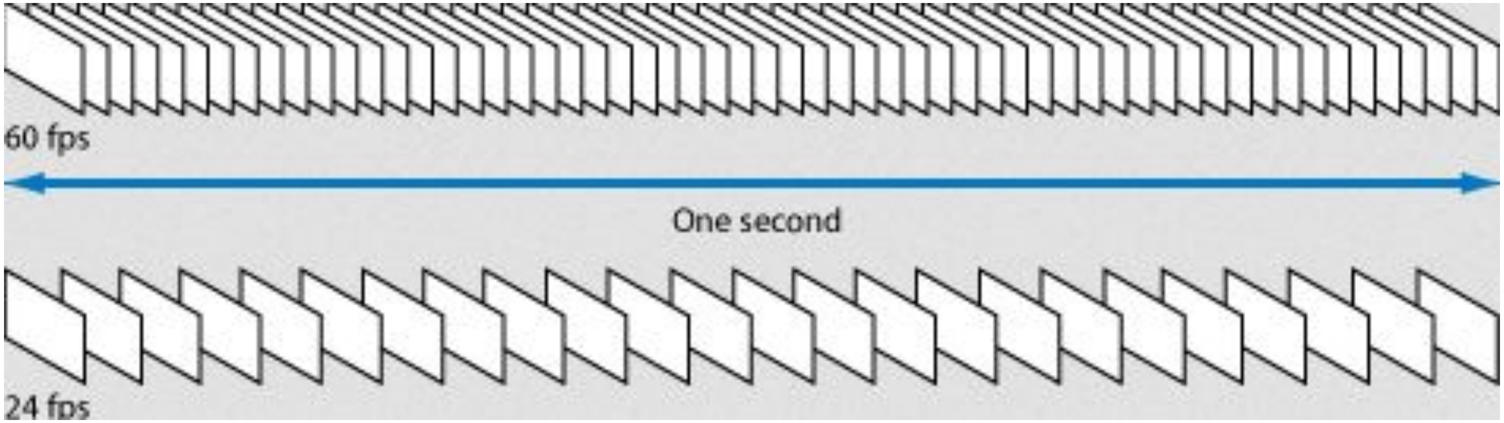

200 Samples per Second (200 Hz)


400 Samples per Second (400 Hz)

Representation of Videos



Bits store data for each video frame



video frame rate (fps)