Bits and Bytes - Understanding ML Data Types

Fundamental Unit: **1 Byte = 8 Bits**

FP32

Float 32-bit

4 Bytes

PyTorch/TensorFlow default for training

FP16

Float 16-bit

2 Bytes

Half precision, 50% memory

INT8

Integer 8-bit

1 Byte

Quantized, 75% memory savings

Data Type Impact

- Memory usage
- Processing speed
- Model accuracy

Example Calculation:
1B parameters × FP32
= 1B × 4 bytes = 4GB

Byte Representation: Signed vs Unsigned

Unsigned Byte (8-bit)

Signed Byte (8-bit)

Range: 0 to 255

Binary: **00000000** to **11111111**

Only positive values

Range: -128 to 127

Uses **two's complement**

First bit = sign bit

Hexadecimal (Base-16) Representation

1 Byte = 2 Hex Digits (0-9, A-F)

`0x00`	`0x0F`	`0x10`	`0xFF`
Decimal: 0	Decimal: 15	Decimal: 16	Decimal: 255

ASCII Code Examples

Each character = 1 Byte (8 bits)

A	**B**	**a**	**0**	**Space**
65 (0x41)	66 (0x42)	97 (0x61)	48 (0x30)	32 (0x20)

Bit-Level Representation

8-bit Integer (INT8)

32-bit Float (FP32)

Decimal: 42

`00101010`

Decimal: -42 (signed)

`11010110`

Decimal: 127 (max)

`01111111`

Structure:

`S EEEEEEEE MMMMMMMMMMMMMMMMMMMMMMM`

1 Sign bit

8 Exponent bits

23 Mantissa bits

RGB Color Codes and Bytes

Each color channel = 1 Byte (0-255) • Total = 3 Bytes per pixel

Red

#FF0000

RGB(255, 0, 0)

Green

#00FF00

RGB(0, 255, 0)

Blue

#0000FF

RGB(0, 0, 255)

White

#FFFFFF

Gray

#808080

Theme Blue

#1E64C8

RGB(255, 255, 255)

RGB(128, 128, 128)

RGB(30, 100, 200)