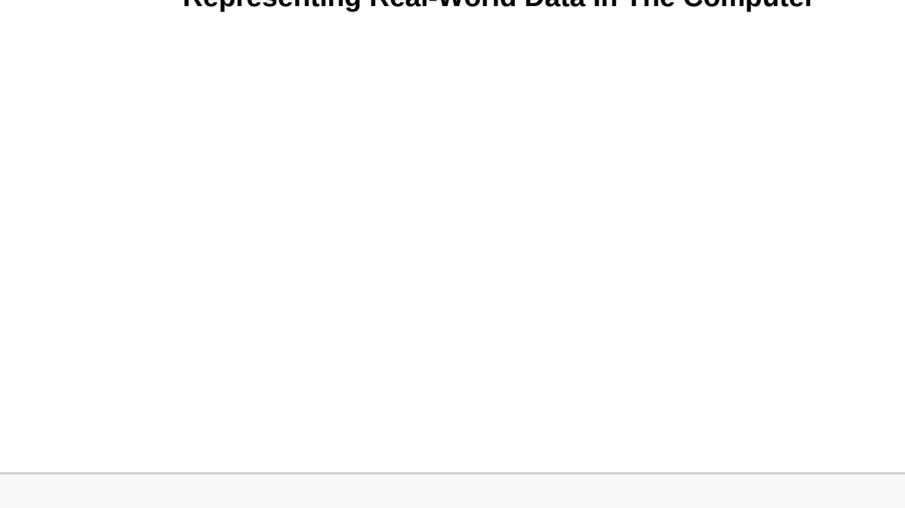
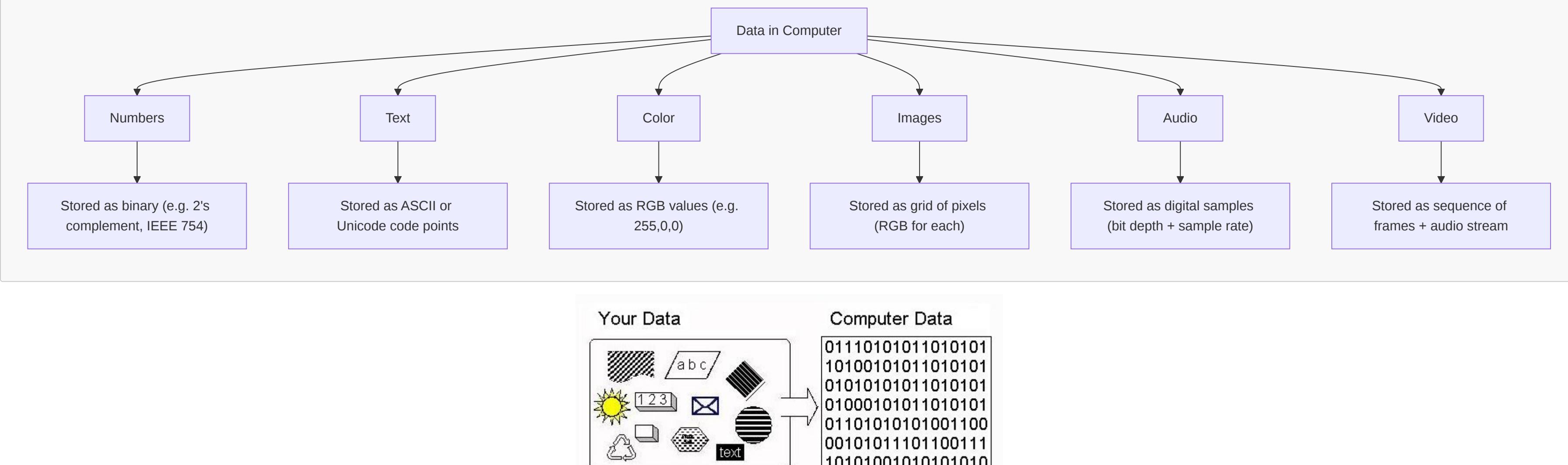
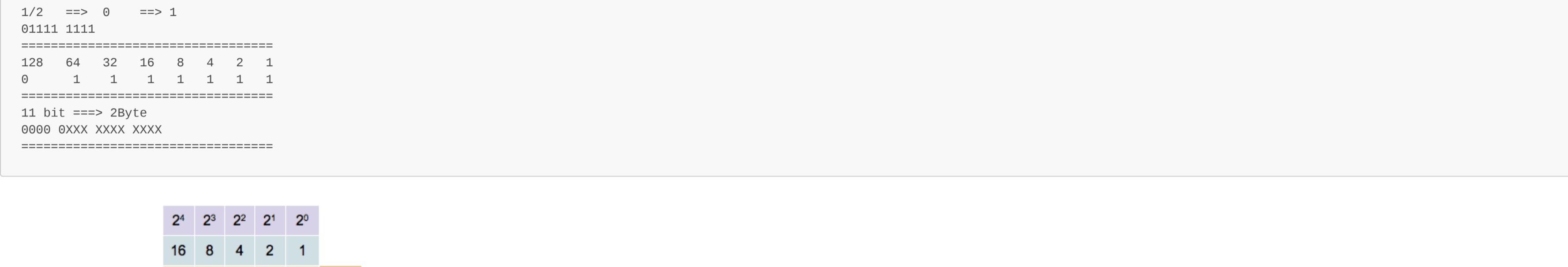


Type of Data ?



Representing Real-World Data in The Computer

Number Decimal to binary



```

127
divide      reminder
127/2 ==> 63 ==> 1
63/2 ==> 31 ==> 1
31/2 ==> 15 ==> 1
15/2 ==> 7 ==> 1
7/2 ==> 3 ==> 1
3/2 ==> 1 ==> 1
3/2 ==> 1 ==> 1
1/2 ==> 0 ==> 1
01111 1111
=====
128 64 32 16 8 4 2 1
0 1 1 1 1 1 1 1
=====
11 bit ==> 2 Byte
0000 XXXX XXXX XXXX
=====
```

• binary to Decimal

$$128 | 64 | 32 | 16 | 8 | 4 | 2 | 1$$

Convert to decimal:

```

11100000
10101010
11001100
00000111

```

• Hex Decimal (0->0000) (1->0001) (2->0010) (3->0011) (4->0100) (5->0101) (6->0110) (7->0111) (8->1000) (9->1001) (A->1010) (B->1011) (C->1100) (D->1101) (E->1110) (F->1111)

How Different Data Types Are Stored in Memory

Every piece of data (numbers, characters, etc.) is stored in binary form (0s and 1s) inside computer memory (RAM). Different data types occupy different sizes of memory and have specific storage formats.

1. Numbers

Type	Example	Binary Representation	How It's Stored
Integer	25	00011001	Stored directly as binary digits (2's complement for negatives).
Floating Point	12.5	0 10000010 100100000000000000000000	IEEE 754 format: 1 sign bit, exponent, and mantissa.

5 (8-bit) → 11111011 (2's complement) 12.5 (float) → 01000000101001000000000000000000

Integers type

Type	Typical Size	Example	Stored As (Binary)	Notes
int	4 bytes (32 bits)	25	00000000 00000000 00000000 00011001	Stored in 2's complement for negatives.
short	2 bytes	25	00000000 00011001	Smaller range
long	8 bytes	25	000...00011001 (64 bits)	Larger range

Floating Point Types (float, double)

Type	Size	Example	Stored As (Binary)	Notes
float	4 bytes	12.5	IEEE 754 format	1 bit sign + 8 bits exponent + 23 bits mantissa
double	8 bytes	12.5	IEEE 754 double precision	1 bit sign + 11 bits exponent + 52 bits mantissa

```

Example (float 12.5):
Sign = 0 (positive)
Exponent = 10000010
Mantissa = 10010000000000000000000000000000
Binary = 0 10000010 10010000000000000000000000000000

```

2. Text

- Text characters are stored as numbers, according to encoding systems like:

Encoding	Example	Binary
ASCII	'A' → 65	01000001
Unicode (UTF-8)	'A' → 65	01000001

'あ' (Japanese) 11100011 10000010 10000010

Hi" → H (01001000) i (01101001) Memory: 01001000 01101001

• Character Types (char)

Type	Size	Example	Stored As (Binary)	Notes
char	1 byte (8 bits)	'A'	01000001	Stored as ASCII or Unicode value
wchar_t / char16_t	2-4 bytes	'あ'	Unicode (UTF-16/UTF-32)	Used for wide characters

- string : Strings are arrays of characters stored sequentially in memory. Example: "CAT"

Character	ASCII	Binary
C	67	01000011
A	65	01000001
T	84	01010100
\0 (null terminator)	0	00000000

Memory Layout: Address: 1000 1001 1002 1003 Content: 67 65 84 0

3. Colors

- Colors are stored as numbers too — usually RGB (Red, Green, Blue) values. Color => RGB (Red,Green,Blue) 0-255 => Binary

Color	RGB Values	Binary Representation
Red	(255, 0, 0)	11111111 00000000 00000000
Green	(0, 255, 0)	00000000 11111111 00000000
Blue	(0, 0, 255)	00000000 00000000 11111111

Color	RGB	Hex Color Code
Black	(0,0,0)	#00 00 00
Blue	(0,0,255)	#00 00 FF
Gray	(128,128,128)	#80 80 80
Green	(0,128,0)	#00 80 00
Purple	(128,0,128)	#80 00 80
Red	(255,0,0)	#FF 00 00
white	(255,255,255)	#FFF F F

- Each color channel is typically 1 byte (8 bits) → total 24 bits per pixel. So, one pixel = 24 bits = 3 bytes

4. Images

- Images are made up of pixels, and each pixel stores color information (RGB).
- Images = (Height)720 Pixel * (Width)1280 Pixel
- Pixel => Array of Color
- Images => Matrix of Color => Binary

Example: a 100x100 image = ~ 10,000 pixels × 3 bytes per pixel = 30,000 bytes (~30 KB)

• Stored as:

```

Pixel[0]: (255, 0, 0)
Pixel[1]: (0, 255, 0)
Pixel[2]: (0, 0, 255)
...

```

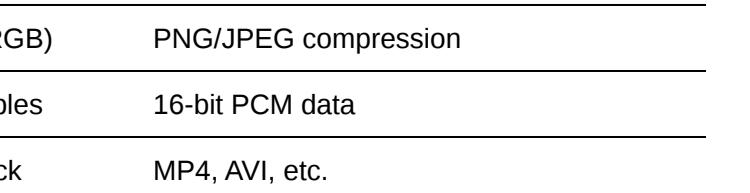
To convert an image into a matrix of colors, where each pixel in the image is represented by its RGB (Red, Green, Blue) values, you can use Python libraries like OpenCV or Pillow. The image will be loaded as an array (or matrix), where each element contains the RGB color value of a pixel.

pip install opencv-python or pip install pillow

C language (To convert an image to binary (black and white) in C, you can use the OpenCV library)

Write C program that :-

- loads an image,
- converts it to grayscale,
- applies binary thresholding to convert it to a binary image.



Colors	Code
Black	00001010
Dark Gray	00001011
Medium Gray	00001100
Light Gray	00001101
White	00001111
Red	00010000
Green	00010001
Blue	00010010

Graphics as a Collection of Pixel Bytes

5. Audio

Audio is stored as a series of samples (sound wave amplitudes) captured over time. Formats (like MP3, JPEG) compress this pixel data to save space.

Property	Meaning
Sample Rate	Number of samples per second (e.g. 44,100 Hz)
Bit Depth	Bits per sample (e.g. 16-bit, 24-bit)
Channels	Mono (1), Stereo (2)

• Example:

CD-quality audio → 44,100 samples/sec × 16 bits/sample × 2 channels = 1.4 million bits/sec = 176 KB/sec

Each sample = a binary number representing the sound's amplitude.

6. Videos

A video = sequence of images (frames) + audio. Audio is stored alongside it. • Stored as:

Frame 1: Image Data

Frame 2: Image Data