CS50T

By Eng. Rasha Abdeen

Youtube: Coders Camp
https://youtube.com/playlist?list=PLnrlZUDQofUvLtIMvVxZRYYju7ni0Xsxq

Multimedia

What is Multimedia?

Multimedia is the use of a computer to present and combine text, graphics, audio, and video with links and tools that let the user navigate, interact, create, and communicate.

1. Audio
2. Graphics
3. Video

Understanding How Computers Represent it

File Formats

Quality

Computers are good at interpret Audio, Graphics, and Video uses different file formats.

- File formats are just a way of storing 0s and 1s on disk so that certain software knows how to interpret it.

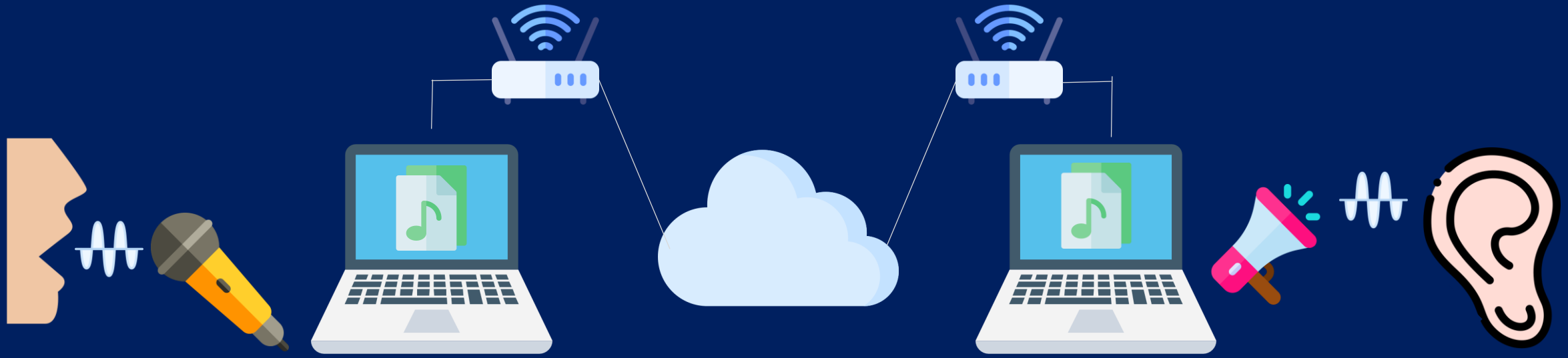
Multimedia

What is Multimedia?

Multimedia is the use of a computer to present and combine text, graphics, audio, and video with links and tools that let the user navigate, interact, create, and communicate.

1. Audio
    - Computers are good at recording, playing back, and generating audio
      Uses different file formats.
2. Graphics
3. Video

Multimedia



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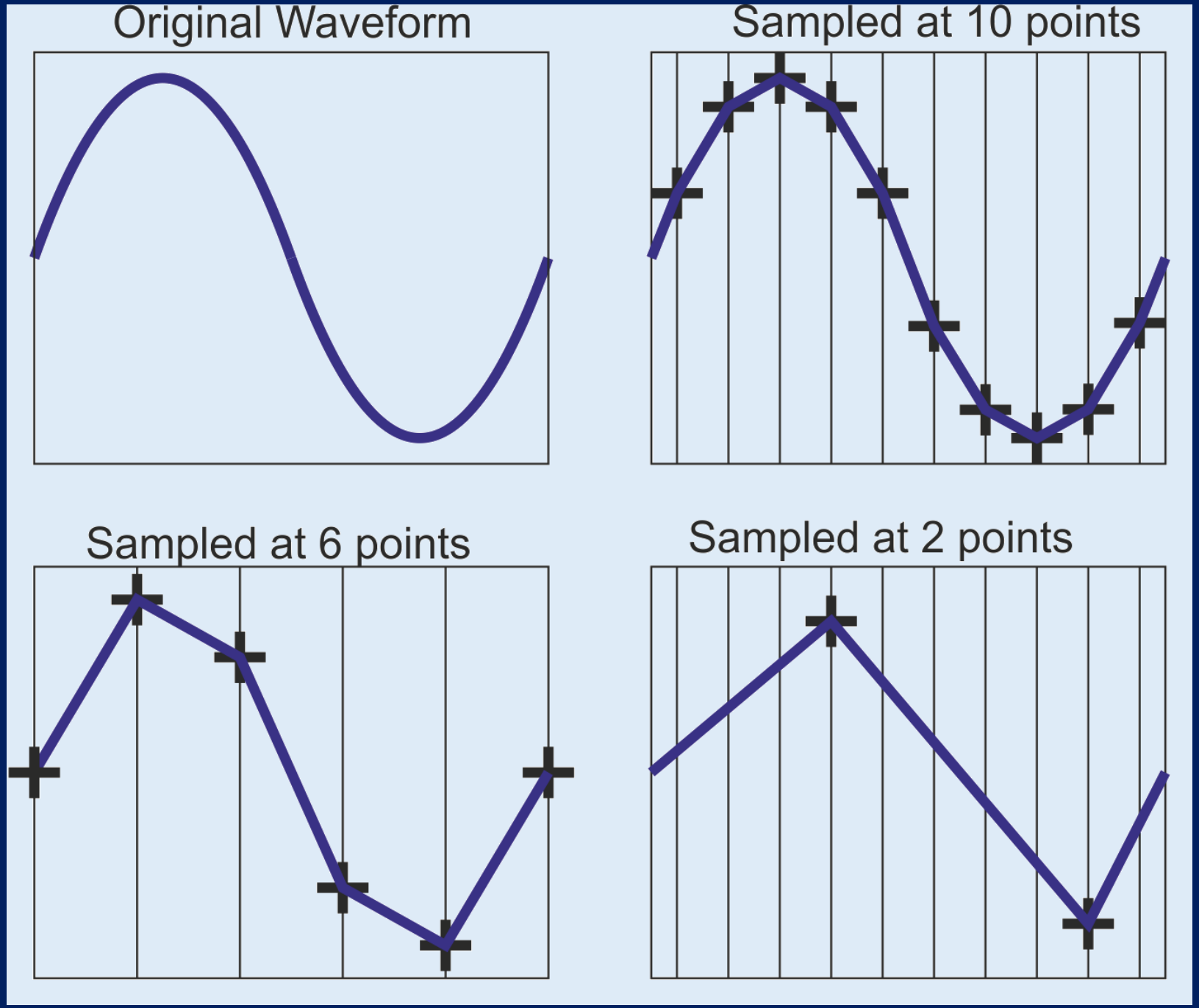
Audio:

1. **Sampling frequency:** Standard sample rate is 44.1 kHz or 44,100 samples per second.
2. **Bit depth**



Multimedia

Audio:

1. Sampling frequency:
   Number of times per seconds we take a digital snapshot of what a person would hear
2. Bit depth: (Resolution)
   Number of bits used for these individual snapshots

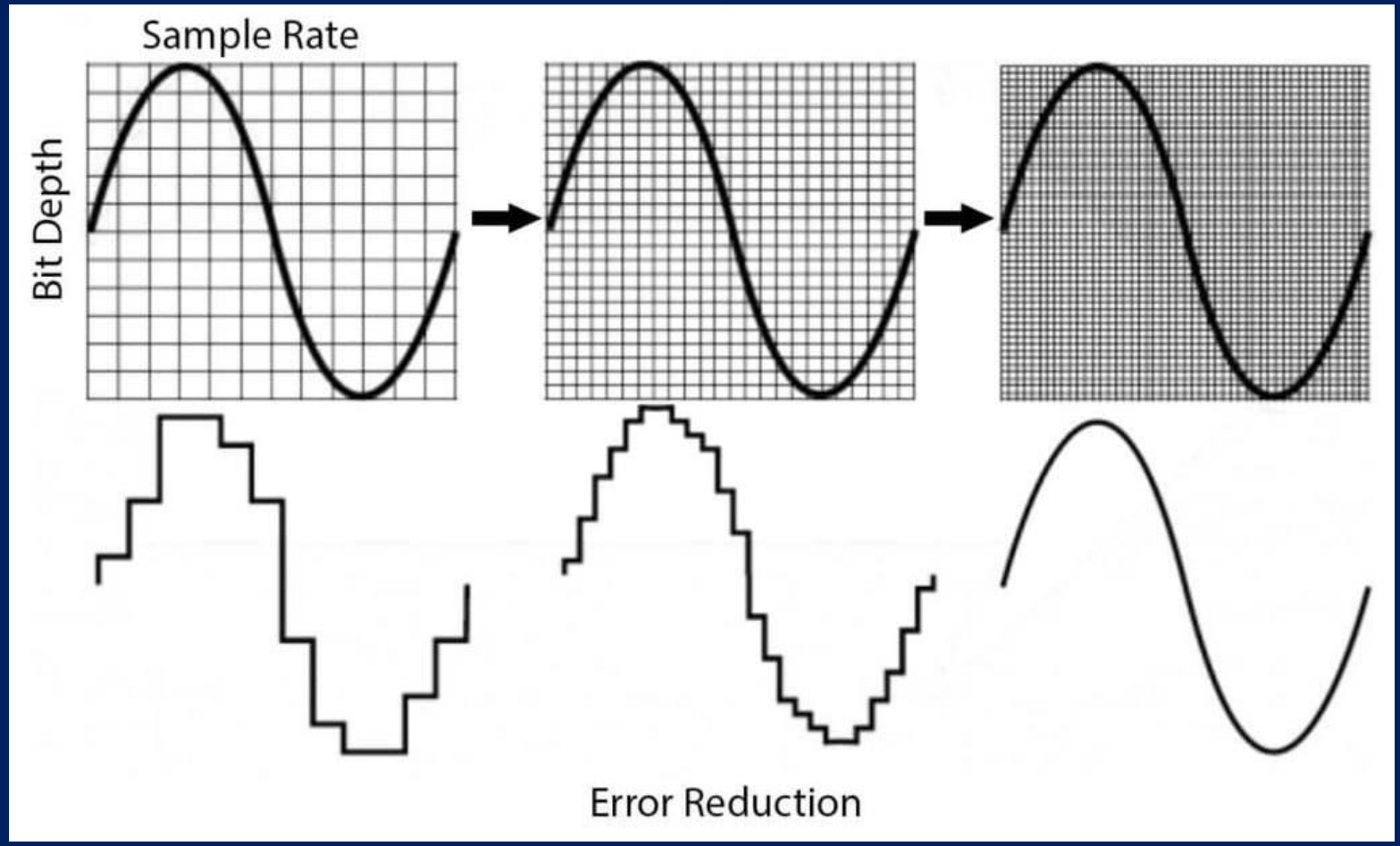
   44.1kHz/16-bit

Sampling frequency x bit depth = number of bits necessary to store one second of music.

A high sample rate and a higher bit depth both increase the amount of information in an audio file, and likewise increase the file size. Just like some photos have a high resolution, audio files with a high sample rate and high bit depth have more details and high quality.

Multimedia

Audio:



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Audio file formats allow you to modify what these parameters are.

#13:

1. What unit is sample rate measured in?
   A. Bits per second (bps)
   B. Hertz (Hz)
   C. Megabits per second (Mbps)
   D. Decibels (dB)

2. Which of the following is true if you increase the sample rate? (more than one should be selected)
   A. Better quality of recording
   B. Needs greater storage space
   C. Larger file size
   D. Decrease in quality

3. What sample rate is used for CD quality sound?
   A. 44,100 Hz
   B. 88,200 Hz
   C. 22,100 Hz

#13:

4. What is a sampling rate?
   A. The number of samples taken per second
   B. The number of bits per second needed to store sound
   C. The number of different volume levels per second
   D. The highest frequency in the sound file

5. The higher the resolution, the ____ the file size.
   A. Smaller
   B. Larger

6. Define the term 'bit depth'.
   A. Snapshots of sound are taken as the wave cannot be represented as a series of continuous changes.
   B. The number of samples taken each second
   C. The number of bits used per second of audio
   D. The number of bits available to record each sample

#13:

7. The resolution of a sound file is the same as...
   A. its bit depth
   B. its bit rate
   C. its highest frequency
   D. its sample rate

8. If a CD uses a bit depth of 16 bits, how many different levels of amplitude are available for each sample recording?

   A. 2^{16} = 65,536 different levels
   B. 16 different levels
   C. without the sample frequency we can't know
   D. 16 x the resolution of the file

Multimedia

Audio

Audio File Formats:

- MIDI
- MP3
- AAC
- WAV
- WMA

Multimedia

Audio

Audio File Formats:

- MIDI (Musical Instrument Digital Interface):
  - Way of storing musical notes for certain songs.
  - Can do this for different instruments.
  - Programs can render the notes for these instruments.

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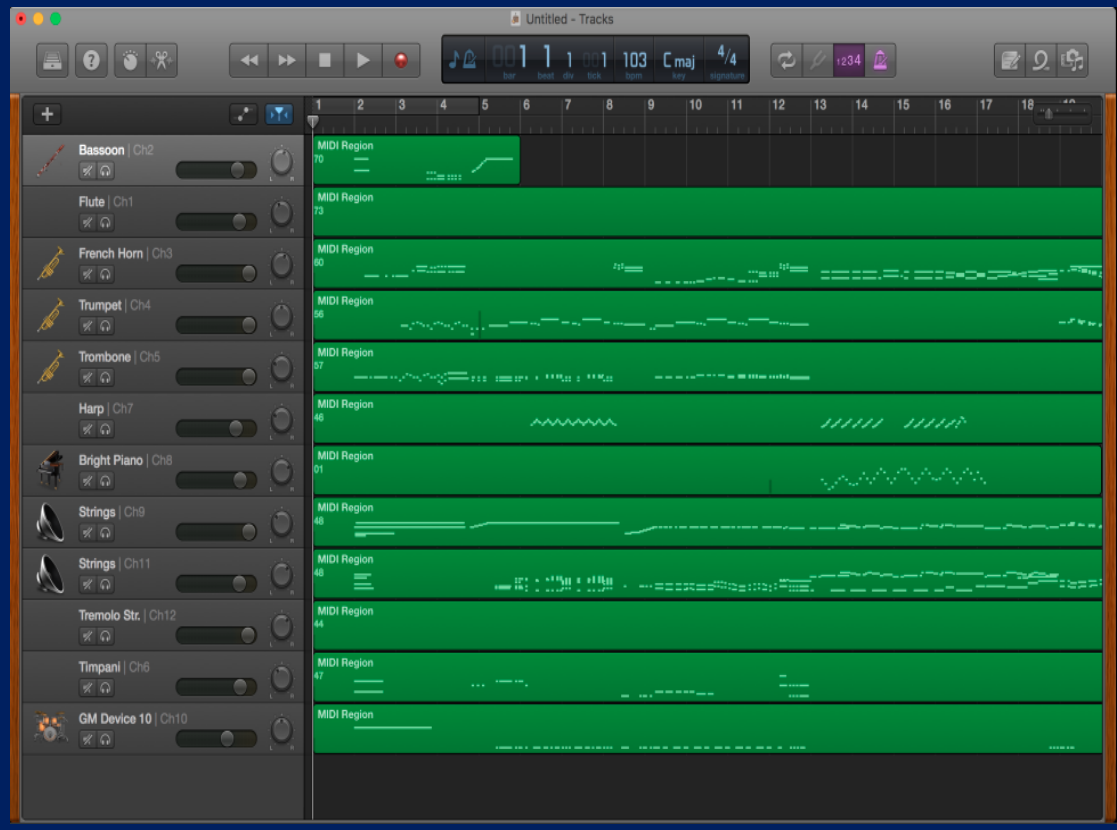
Audio

Audio File Formats:

- MIDI (Musical Instrument Digital Interface):



GarageBand:
https://youtu.be/kccUxGDsMAQ?t=69

- Doesn’t sound quite as good as the actual version
- Computer synthesizes the notes
- Not an actual recording
- Computer interprets notes in the MIDI file

Multimedia

Audio

Audio File Formats:

- MP3:
  - File format for audio that uses compression
    - This compression is said to be lossy
      - Discards 0s and 1s that humans can't necessarily hear
        - True audiophiles may disagree
      - Significantly reduce how many bits are necessary to store a song
      - Trade off between optimizing storage space and sacrificing quality
      - Losing the quality in the compression process

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Audio

Audio File Formats:

- AAC (Advanced Audio Coding):
  - AAC files tend to show better performance than MP3 files.
  - It is commonly used as a default audio file format in iTunes Store, Apple Music, iPhone, and PlayStation.

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Audio

Audio File Formats:

- WAV (Waveform Audio File Format):
  - WAV is an early sound format, but still used
  - Uncompressed data storage allowing high quality

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Audio

Audio File Formats:

- WMA (Windows Media Audio):
  - WMA is a lossless file format, while MP3 is lossy.
  - WMA often has a higher audio quality than MP3.

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Audio

Audio File Formats:

- MIDI
- MP3
- AAC
- WAV
- WMA

Anghami

Spotify

Streaming services such as Spotify don’t transfer a file to you but rather stream bits of information to you.

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2. Graphics
    1. How Computers Represent images?
    2. Quality
    3. File formats
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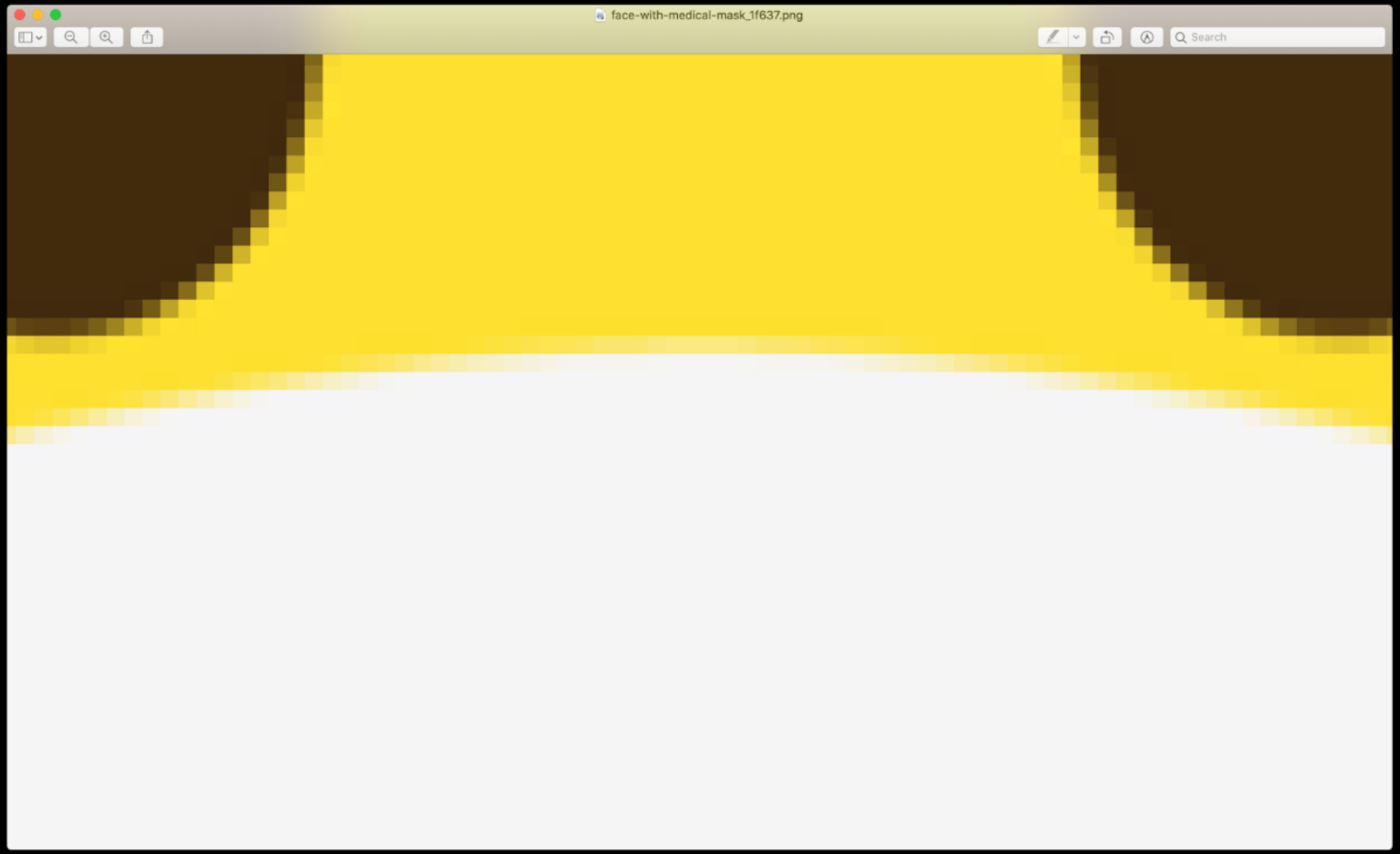
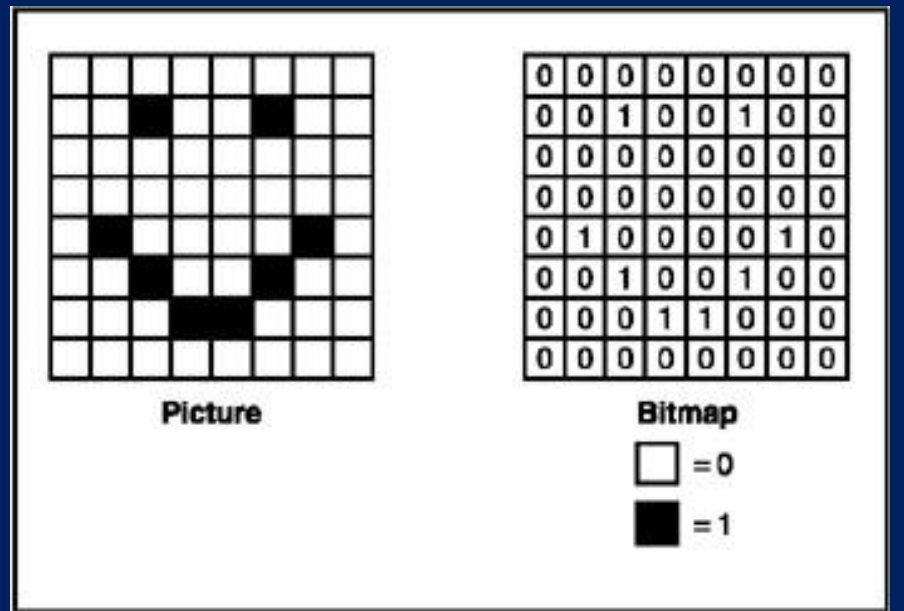

face-with-medical-mask_1f637.png
Search

Multimedia

Graphics

- A graphic, what we see with multimedia, is really just a bunch of pixels both horizontal and vertical
- In the simplest form, each of the dots or pixels is a bunch of 0s and 1s

How to represent color



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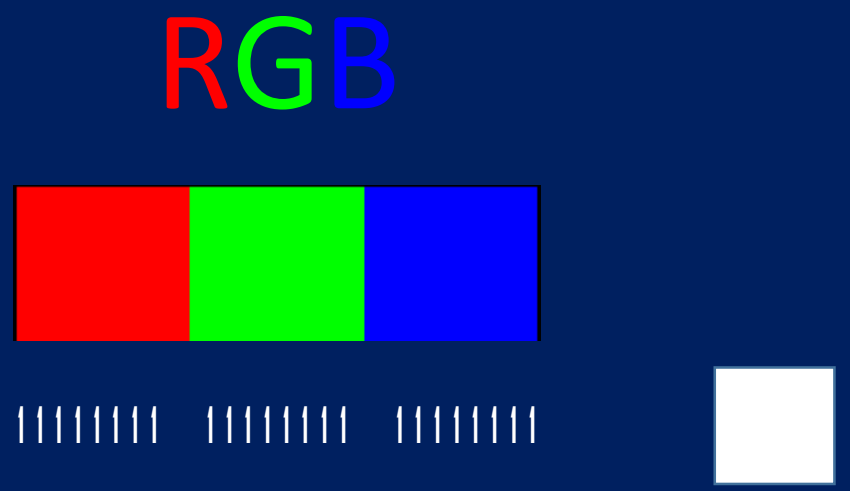
Graphics

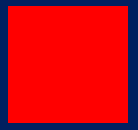


Multimedia

Graphics

RGB

11111111 00000000 00000000

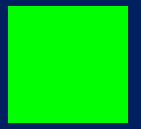


Multimedia

Graphics

RGB

00000000 11111111 00000000

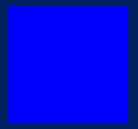


Multimedia

Graphics

RGB

00000000 00000000 11111111



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Graphics

RGB

01001000 01001001 00100001

72 73 33

Multimedia

Graphics

When we talk about image formats, we typically don't talk in terms of binary but rather something called hexadecimal (base-16, contains 16 digits)

Binary	Decimal	Hexadecimal
(0 , 1)	0, 1,2,3,4,5,6,7,8,9	0,1,2,3,4,5,6,7,8,9,a,b,c,d,e,f

- 0 is the smallest number we can represent in single digit
- f is the largest number (value of 15) we can represent in a single digit

- A lot of graphical editing software such as Photoshop use hexadecimal to represent colors

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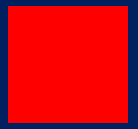
Graphics

RGB

Binary	1111	1111	00000000		00000000	
Decimal	15	15	0	0	0	0
Hexadecimal	f	f	0	0	0	0

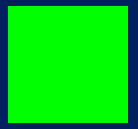


Multimedia

Graphics

RGB

Binary 00000000 11111111 00000000



Hexadecimal 00ff00

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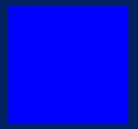
Graphics

RGB

Binary 00000000 00000000 11111111



Hexadecimal 0000ff

Multimedia

Graphics

- A graphic, what we see with multimedia, is really just a bunch of pixels both horizontal and vertical
- In the simplest form, each of the dots or pixels is a bunch of 0s and 1s

How to represent color

- All file formats are rectangular in nature, though transparent pixels can make images look to take on other shapes

Multimedia

Graphics

- This background for Windows XP was a bitmap file (.bmp)
  - Zooming in on this image show that it is just a grid of dots.

Resolution:

Image resolution is the detail an image holds.

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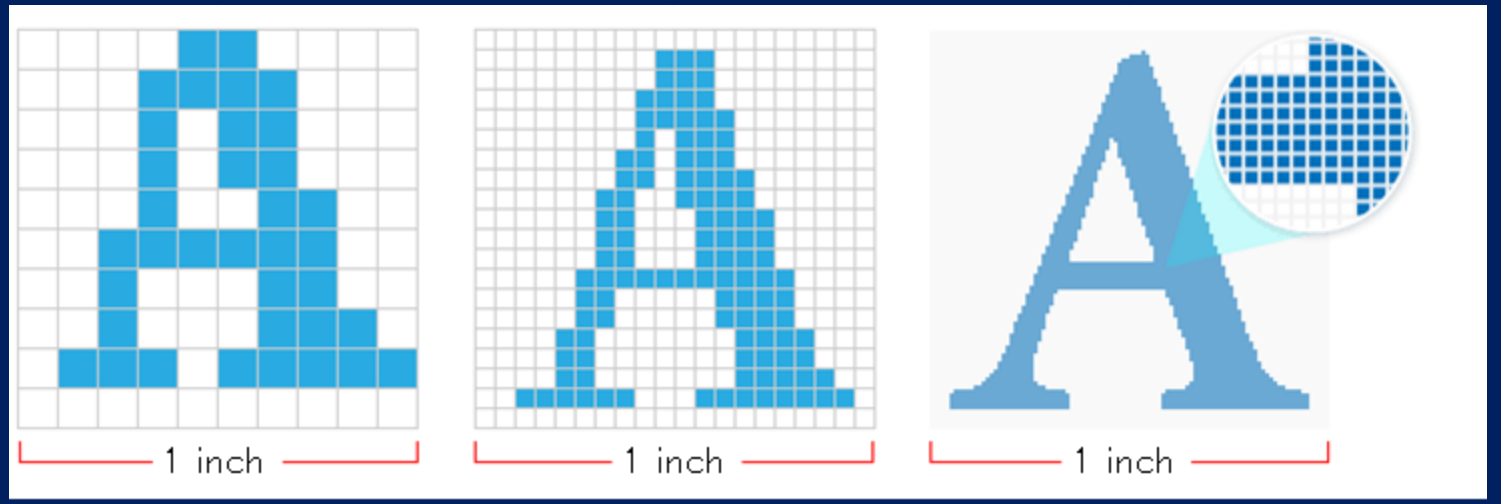
Multimedia

Graphics

- Image Resolution:
  Image resolution is the detail an image holds.

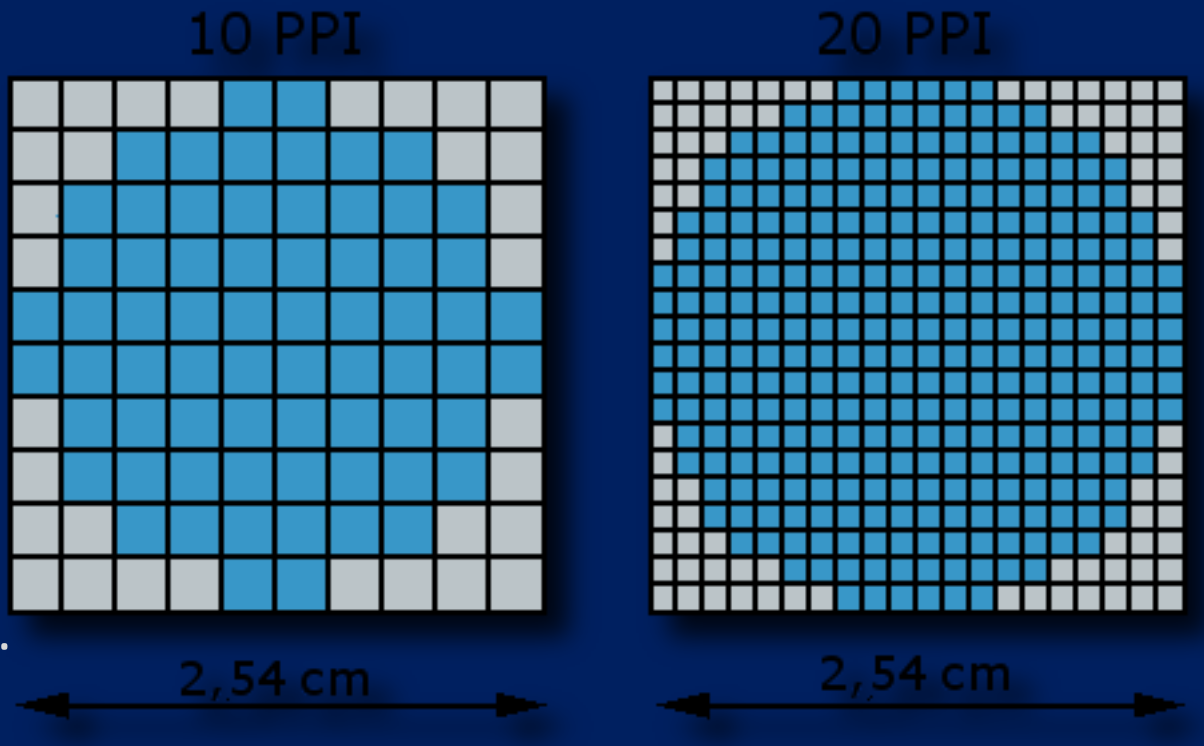


1920X1080 Pixels Resolution

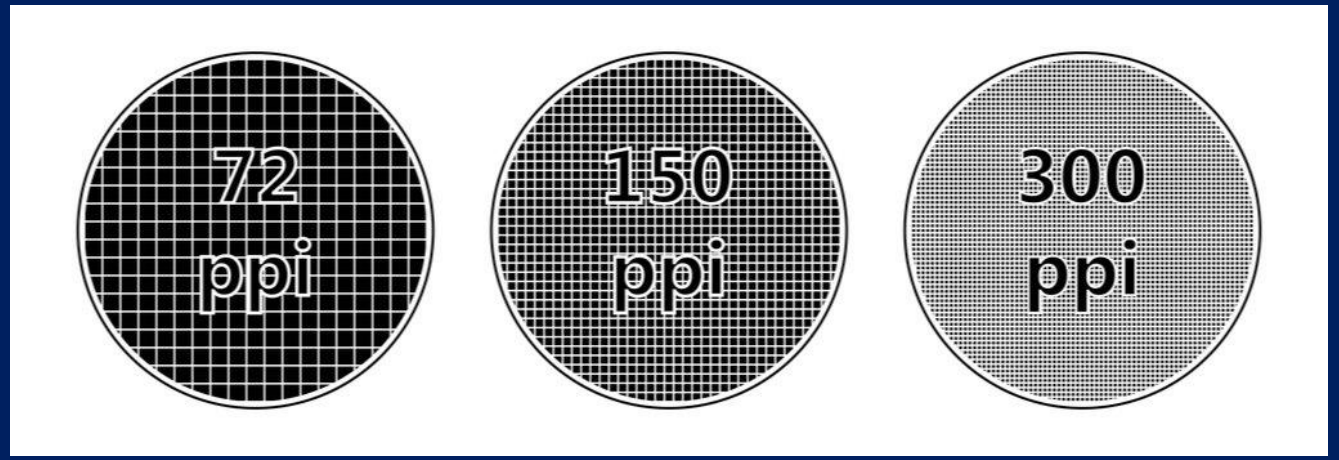
Multimedia

Graphics

- Image Resolution:
  Image resolution is the detail an image holds.



  - Image resolution is typically described in **PPI**, which refers to how many pixels are displayed per inch of an image.



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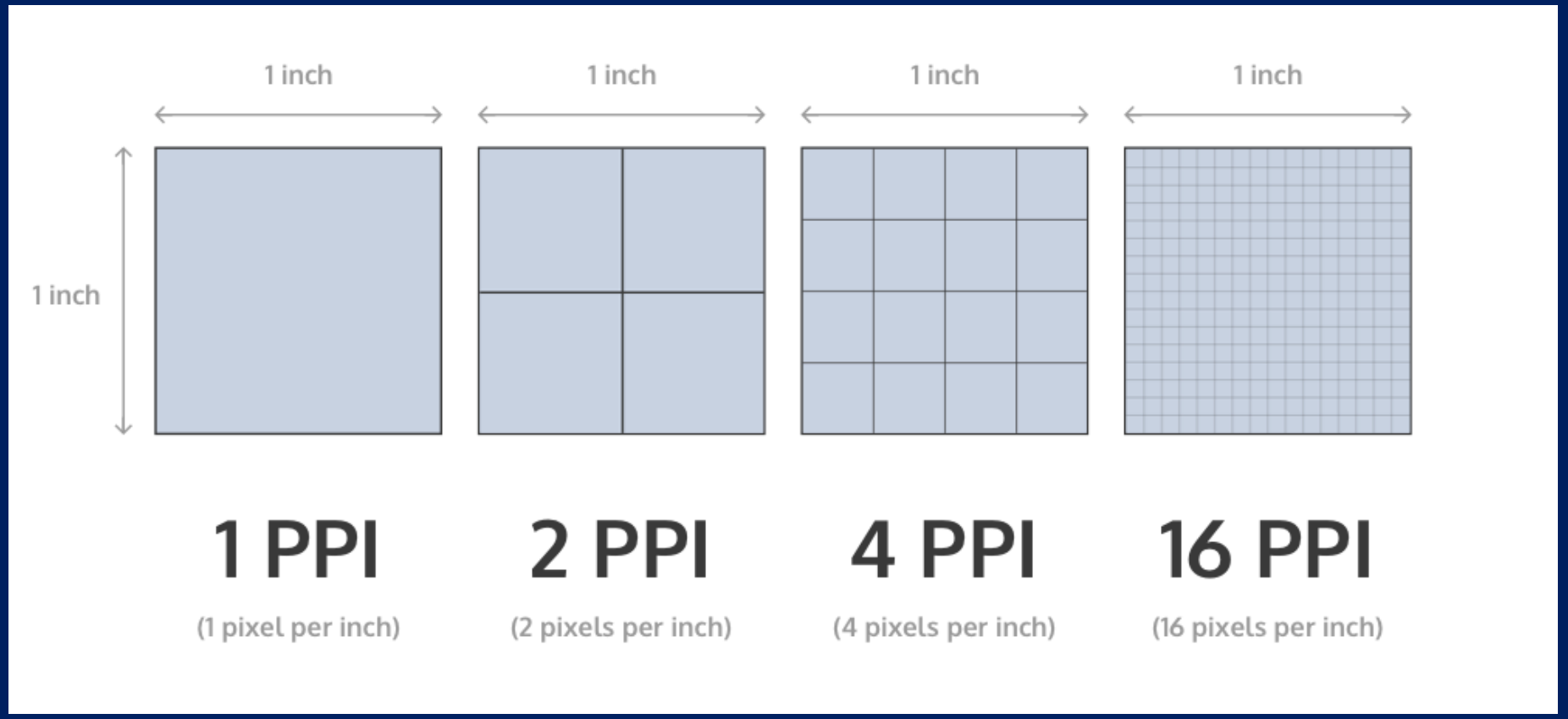
Graphics

- Image Resolution:



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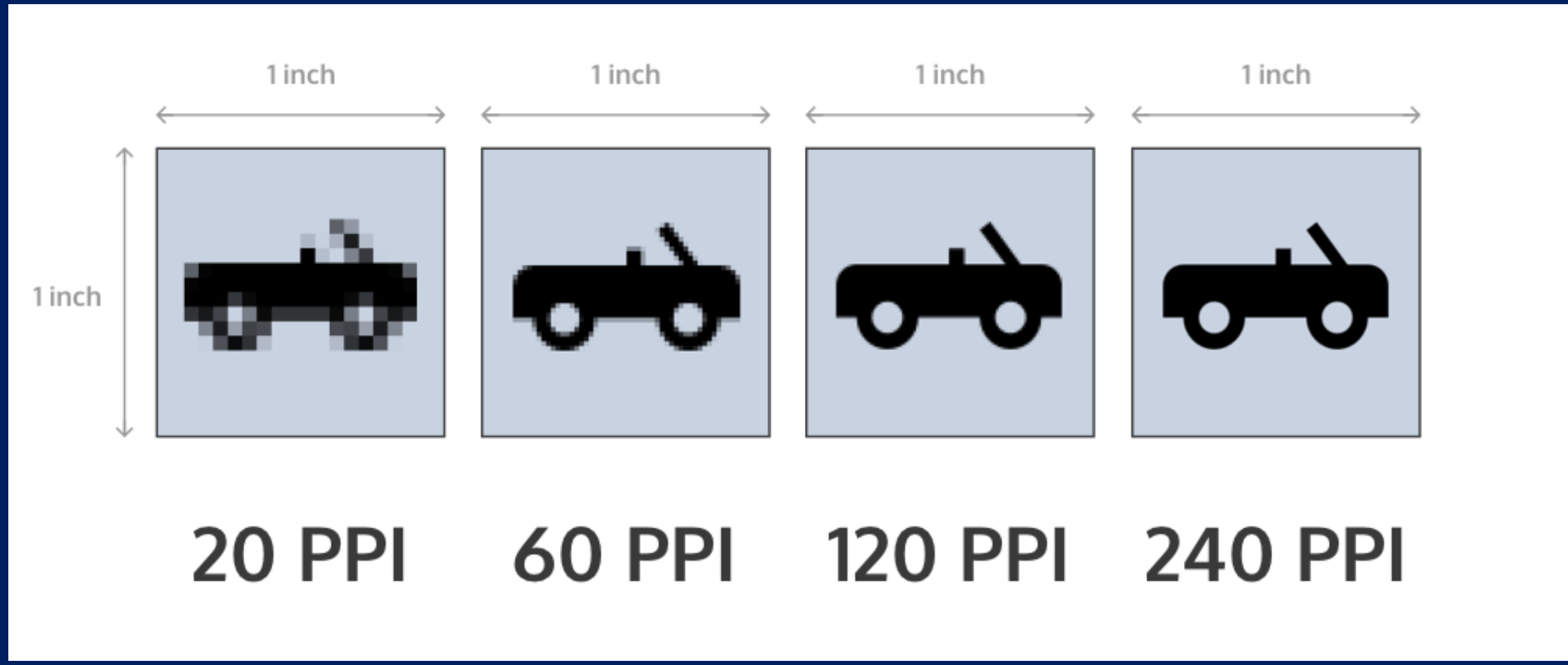
Graphics

- Image Resolution:



Multimedia

Graphics

Resolution:

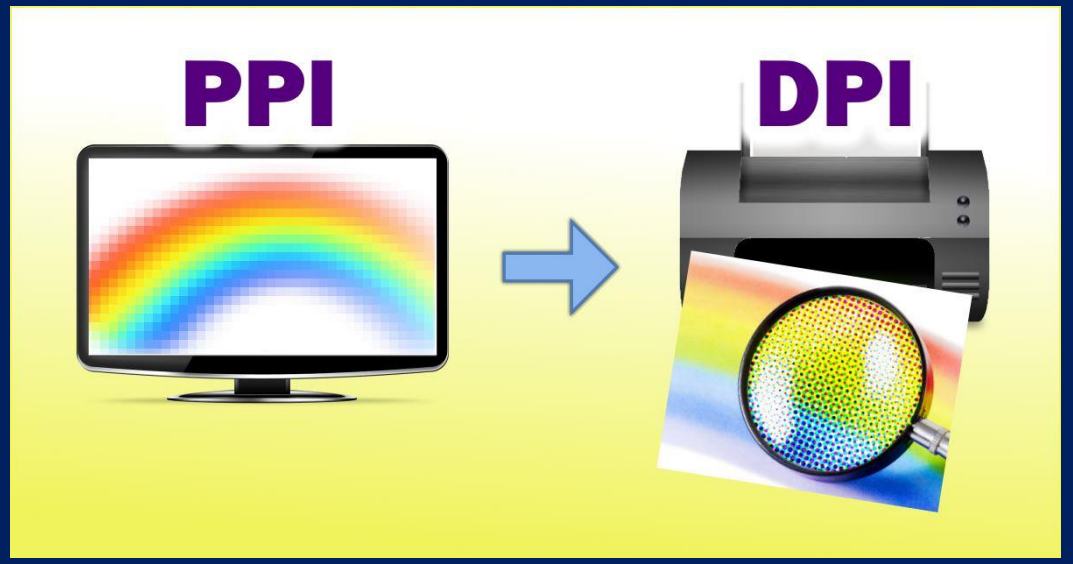
- Images
- Devices
  - Printers
  - TV
  - Phones

Multimedia

Graphics

Print Resolution:

Is measured in dots per inch (or “DPI”) which means the number of dots of ink per inch that a printer deposits on a piece of paper. So, 300 DPI means that a printer will output 300 tiny dots of ink to fill every inch of the print.

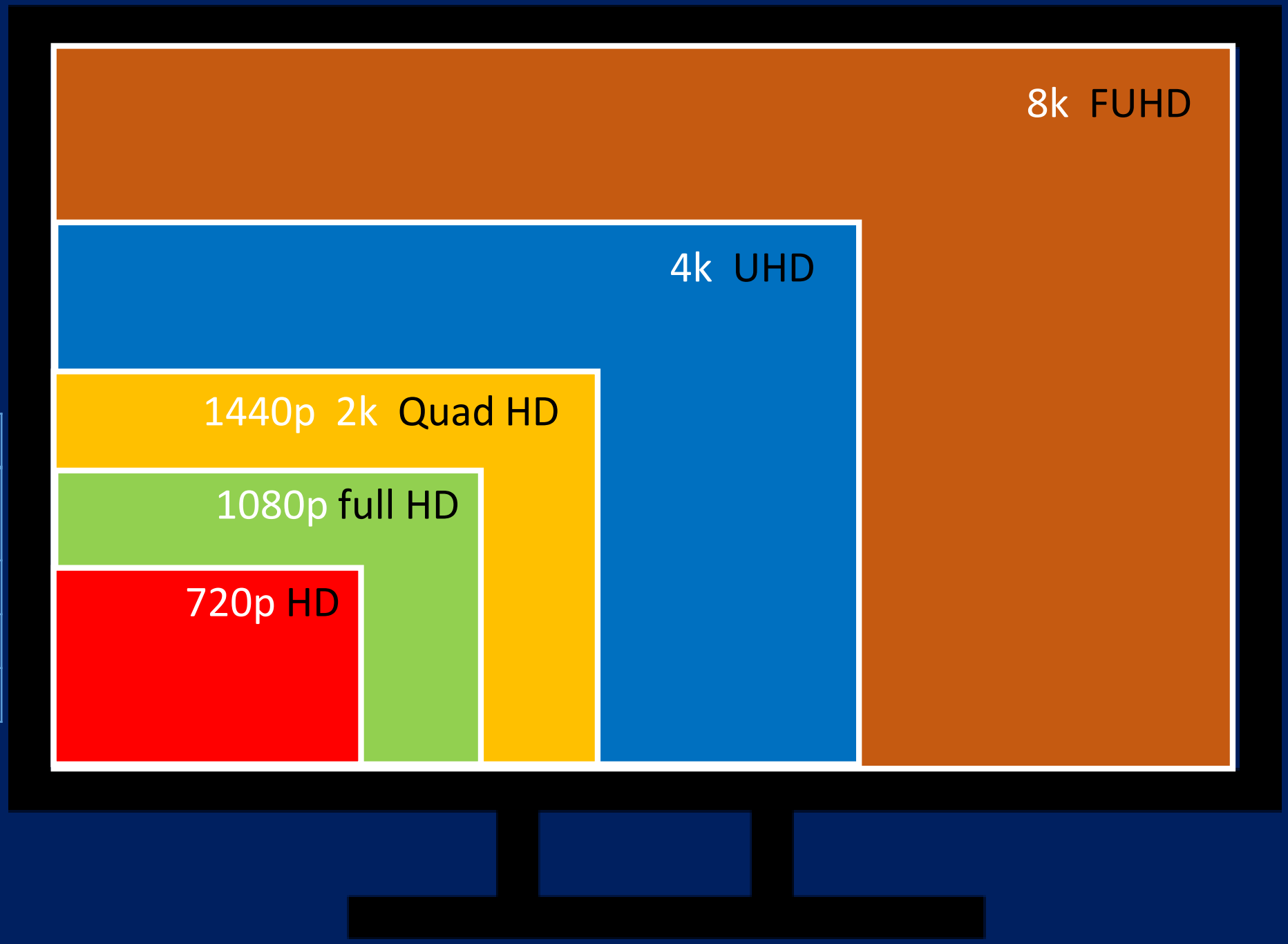


Multimedia

Graphics

TV Resolution:

1280x720	720p (HD)
1920x1080	1080p (Full HD)
2560x1440	2k (Quad HD)
3840 x 2160	4k (Ultra HD)
7680X4320	8k (Full UHD)



Multimedia

Graphics

Camera Resolution:

The resolution of digital cameras and camera phones is often measured in Megapixels.

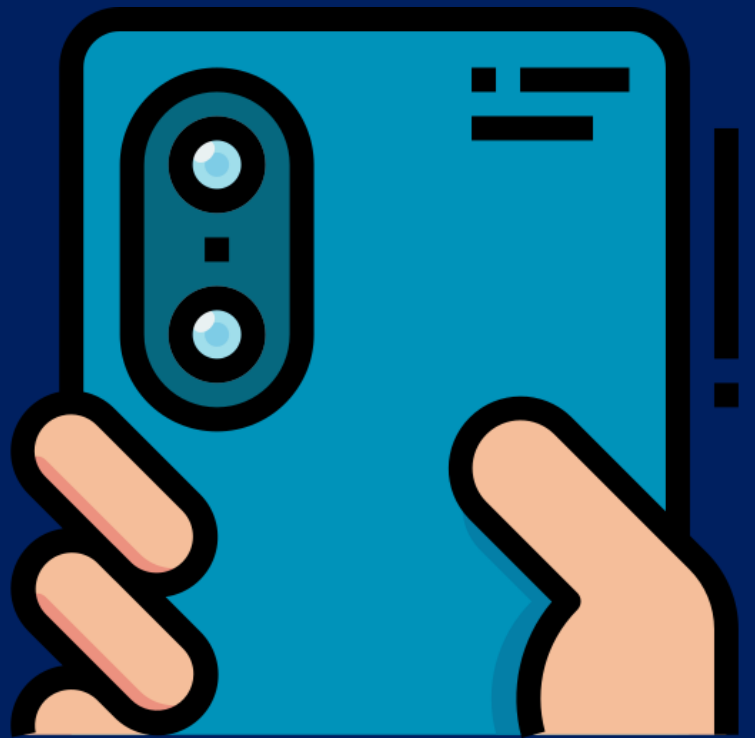
For example:

a 12-megapixel camera can produce images with 12 million total pixels.

1920X1080 Pixels

= 2.073.600 Resolution

= 2 Megapixel Resolution



Multimedia

Graphics

Camera Resolution:

The resolution of digital cameras and camera phones is often measured in Megapixels.

2 megapixels

5 megapixels

12 megapixels

Multimedia

Graphics

Camera Resolution:

The resolution of digital cameras and camera phones is often measured in Megapixels.

For example:

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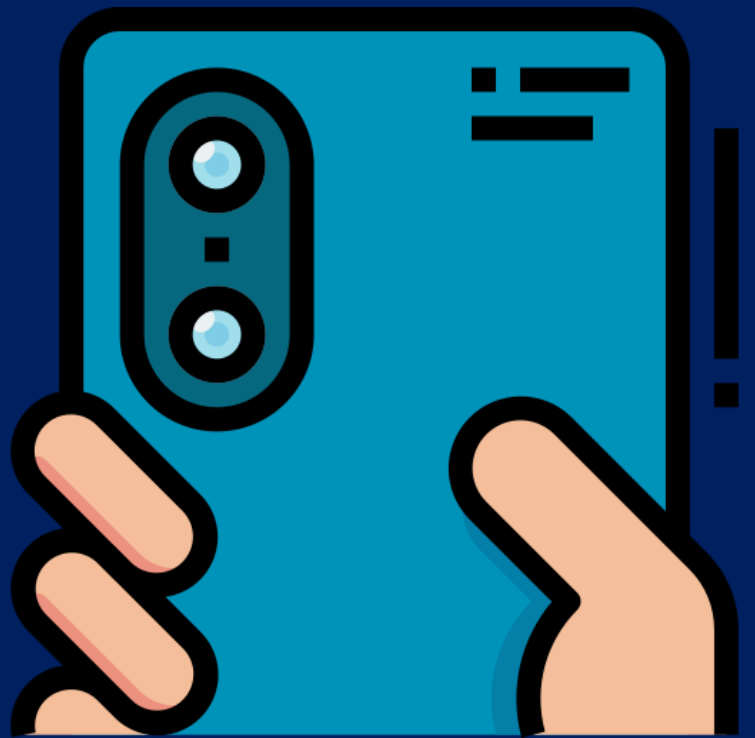
= 12 Megapixels = 12 Million Pixel

= 12.000.000 X 3 Bytes = 36.000.000 Bytes

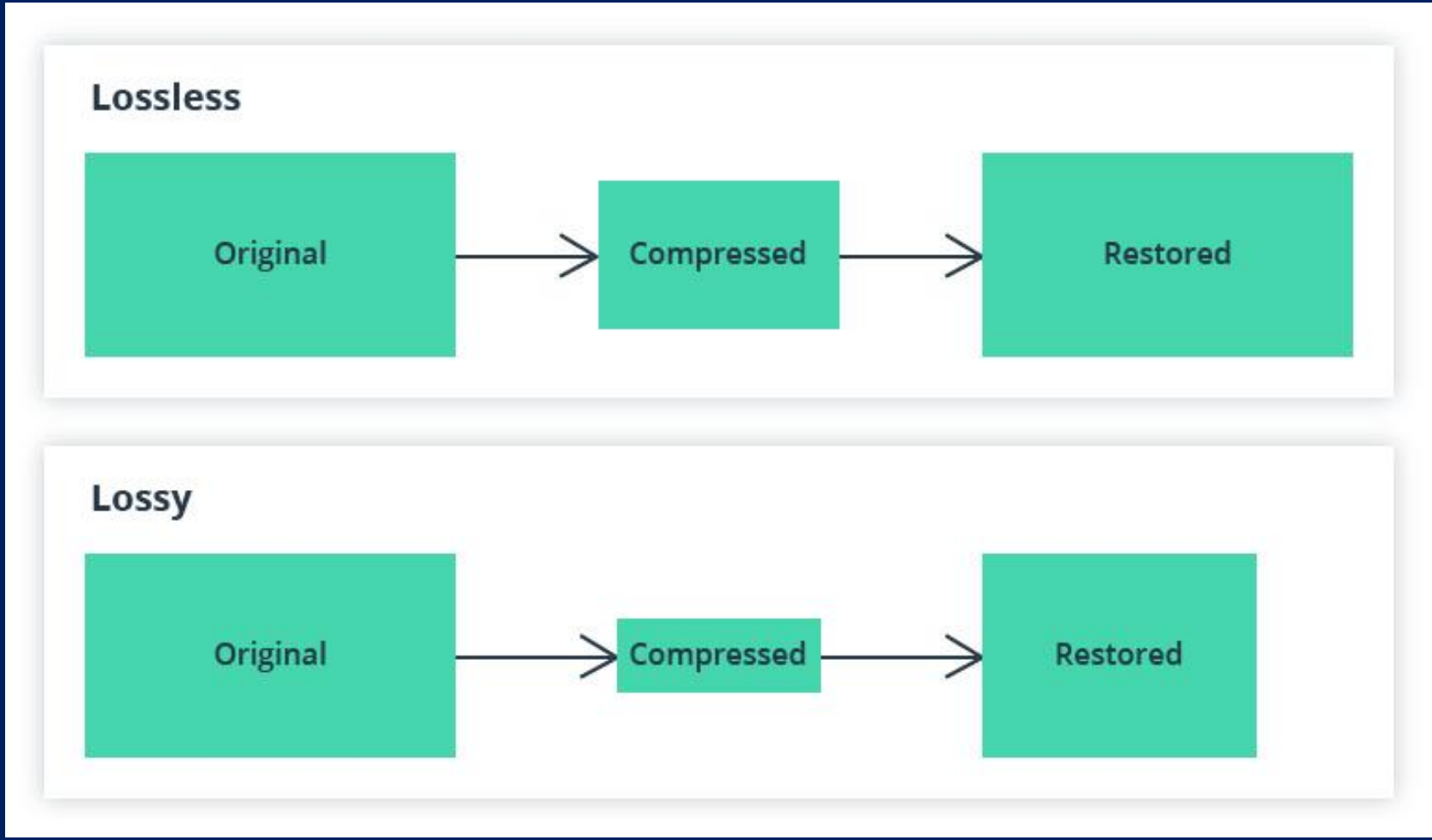
= 36 Megabytes

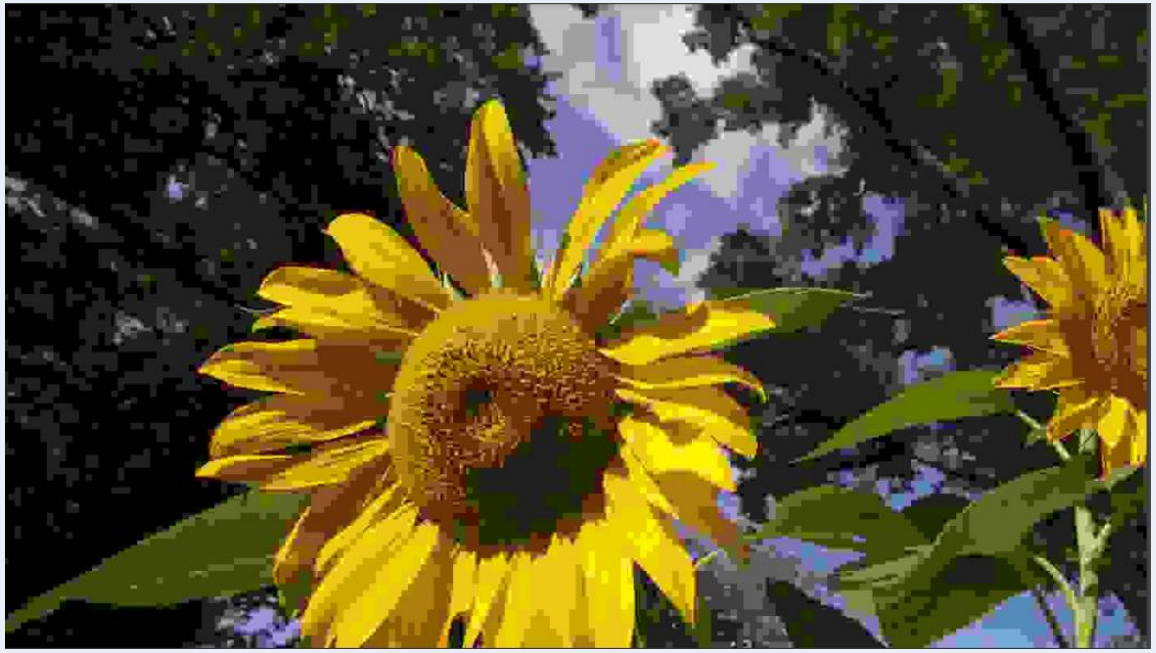
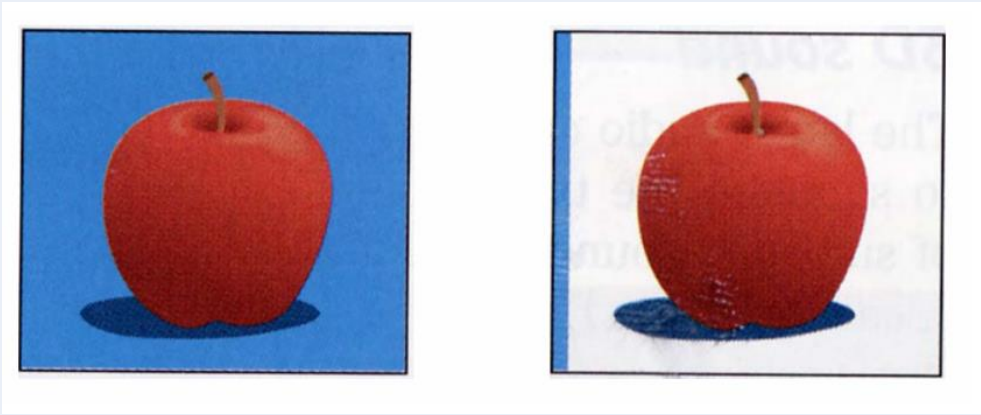


Multimedia

Graphics

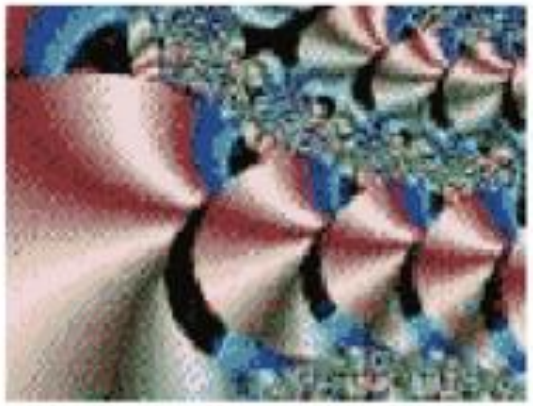
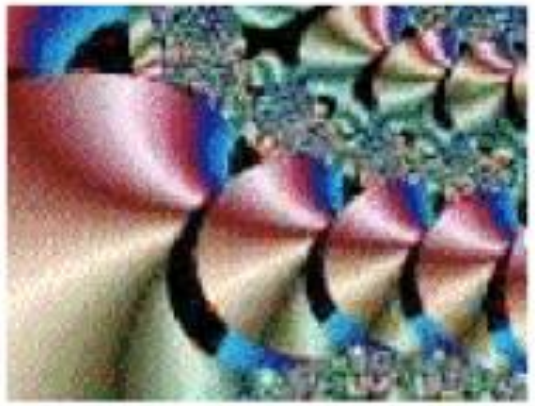
- Image Compression:
  1. Lossy Compression
  2. lossless Compression



lossy compression	Lossless compression
The compression throws away bits of information	Using fewer bits to represent the same information
	
Replaces bits with only a few colors giving an approximation	• The first column contains the color that the rest of the row (scan line) should have • Image contains instructions on how to repeat the color in a particular row
We won’t be able to get that original image back	The original information can be recovered

Multimedia

Color Resolution

Multimedia

Graphics

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= 12 Megapixels = 12 Million Pixel

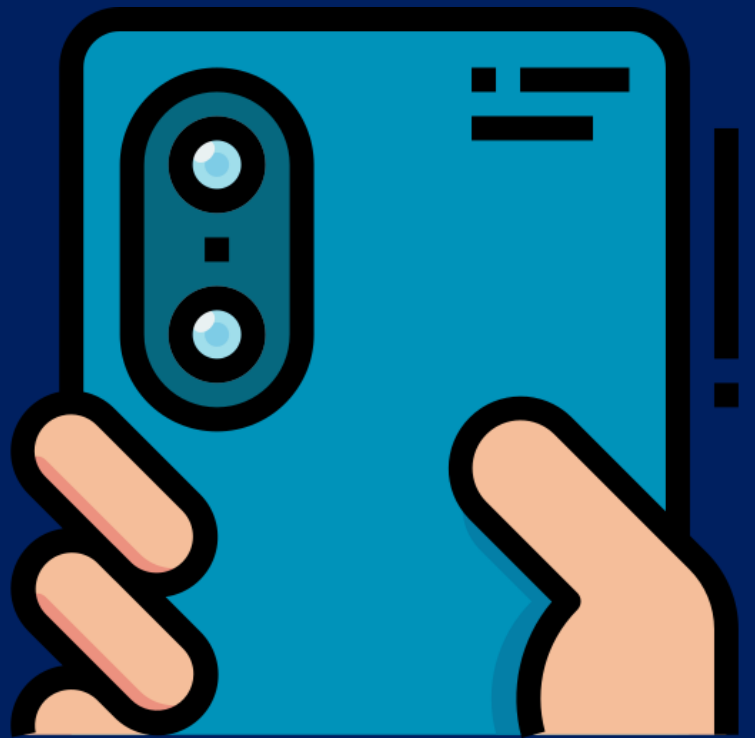
= 12.000.000 X 3 Bytes = 36.000.000 Bytes

= 36 Megabytes

Byte = 8 bits

3 Bytes = 3X8 = 24 bits

(24 - Bit Color)



Multimedia

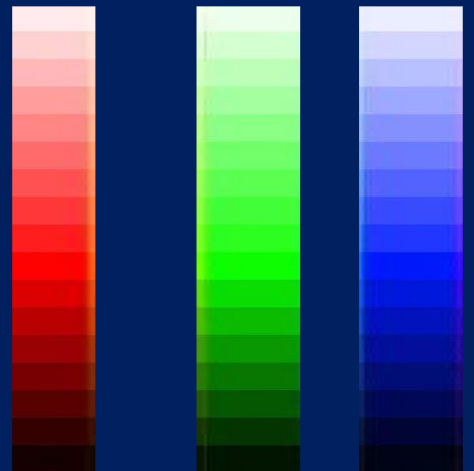
Color depth or bit depth:

The number of bits used to indicate the color of a single pixel

The higher the bit depth of an image, the more colors it can store.

24 – bit Color :

Red 8 bits 256 | Green 8 bits 256 | Blue 8 bits 256



8 – bit Color :

2^8 = 256 color values

00000000 -> black

00000001 -> black with less darkness

00000010

.

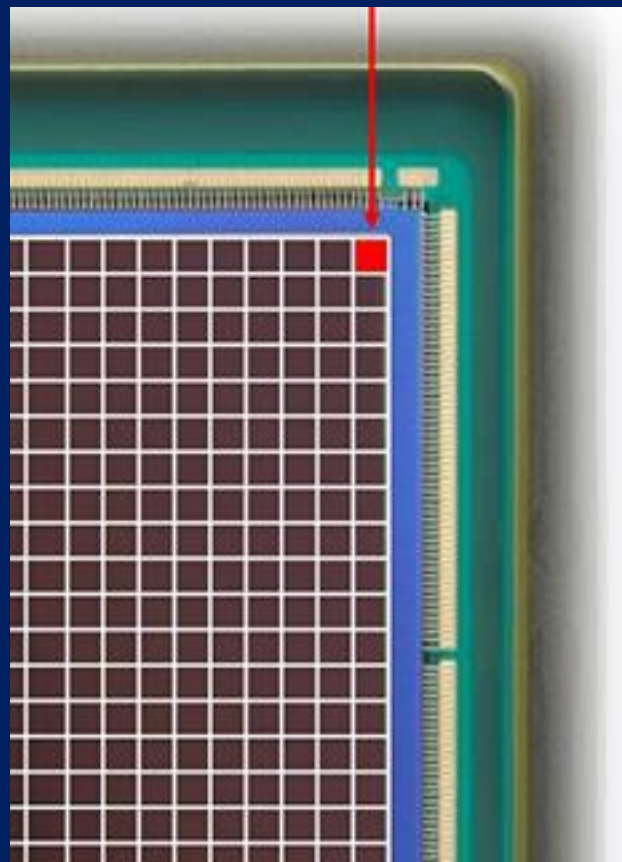
.

.

.

} Other colors between black and white.

11111111 -> white



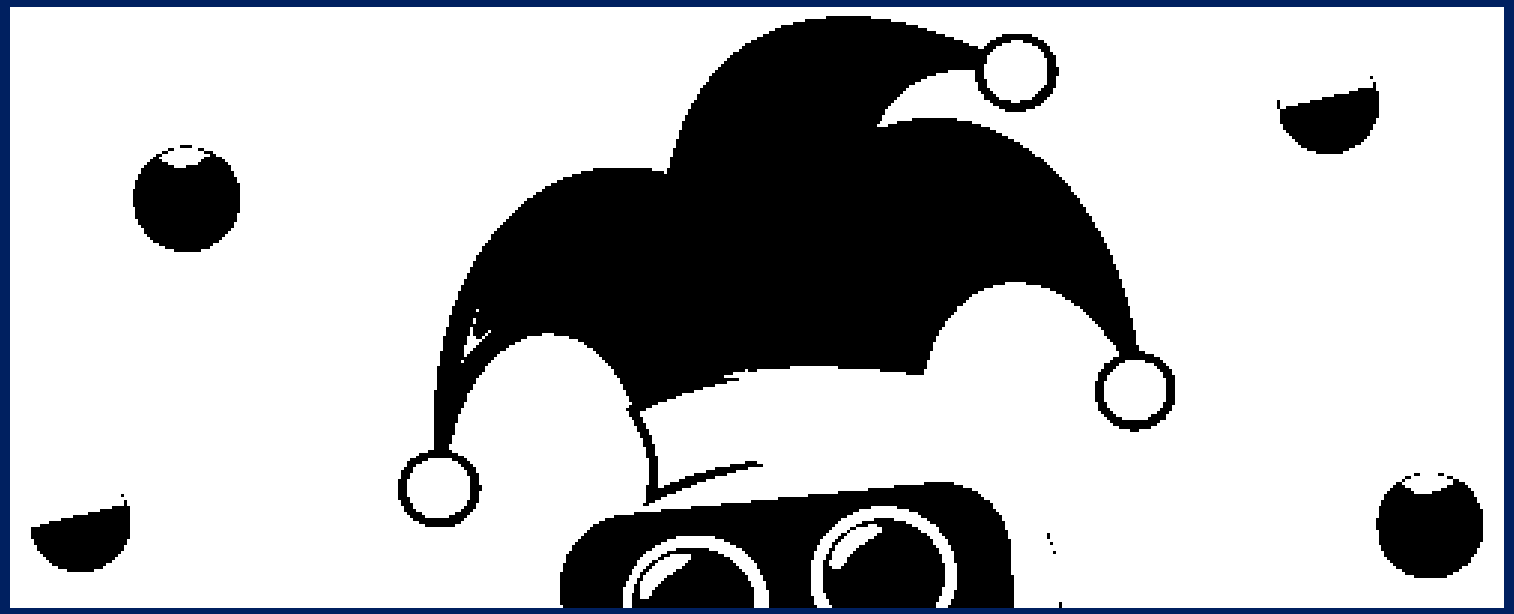
Multimedia

3 Bit
(8 Color)

8 Bit
(256 Color)

24 Bit
(16,77,216 Color)

Multimedia



1-bit color:

2^1 = 2 colors

3 KB

24-bit color:
2^{24} = 16,7 colors
45 KB

5-bit color:
2^{5} = 32 colors
8 KB

8-bit color:
2^{8} = 256 colors
17 KB

4-bit color:
2^{4} = 16 colors
6 KB

7-bit color:
2^{7} = 128 colors
13 KB

3-bit color:
2^{3} = 8 colors
5 KB

6-bit color:
2^{6} = 64 colors
10 KB

2-bit color:
2^{2} = 4 colors
4 KB

Multimedia

Graphics

- Image file formats:
  - BMP
  - GIF
  - JPEG
  - PNG

Multimedia

Graphics

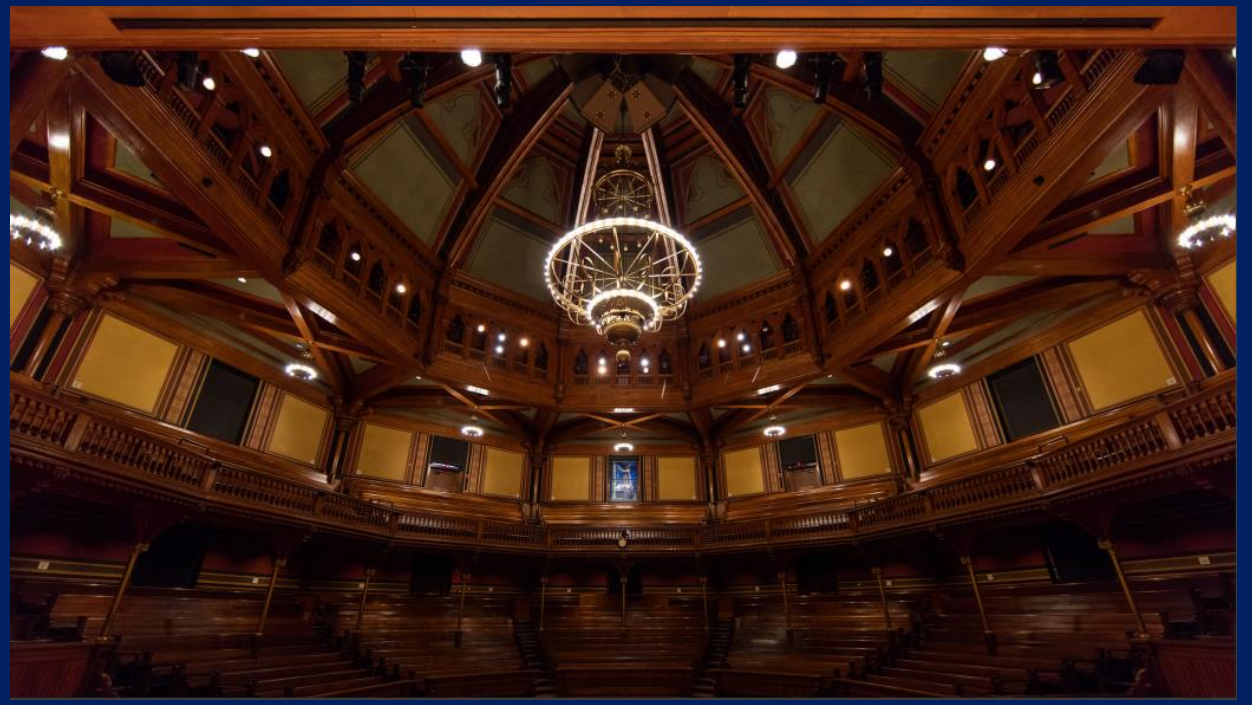
- Image file formats:
  - BMP (Bitmap)
    - Originally used by Windows
    - Not super common these days
    - A mapping or grid of bits much like the smiley face from before
    - BMP files are uncompressed.
      - If you want to compress a BMP file, you must do it manually.
      - You can compress it in a lossless method.
    - The number of bits per pixel (1, 4, 8, 16, 24, 32, or 64) for a given BMP file is specified in a file header.
    - BMP files with 24 bits per pixel are common.
    - BMP files generally have a higher quality than JPEGs.

Multimedia

Graphics

- Image file formats:
  - GIF (Graphics Interchange Format)
    - Low quality images
      - Only supports 8-bit color, So they are limited to 256 colors.
      - GIF files can use only 1, 2, 4, or 8 bits per pixel.
    - GIFs use a lossless compression algorithm
    - Often used for memes, icons, or clip art.
      - A sequence of GIF images can be stored in a single file to form an animated GIF.
      - https://giphy.com/gifs/11xBk5MoWjrYoE

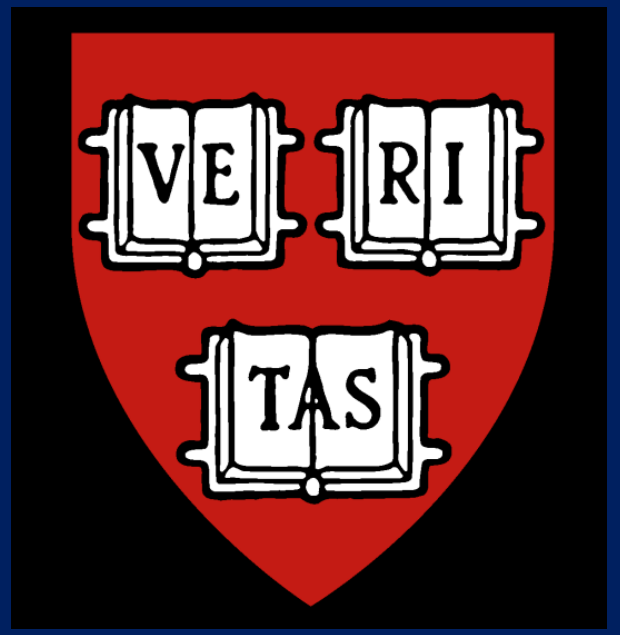
Multimedia



Graphics

- Image file formats:
  - JPEG (Joint Photographic Experts Group)
    - Supports 24-bit color , So they are capable of displaying more than 16 million colors.
    - JPEGs do not support transparency or animation.
    - JPEG's use lossy compression.
      - This may make JPEGs better for everyday use, but it does mean sacrificing some of the original image quality.
      - The smaller size means it'll open faster on most browsers (including mobile) without sacrificing too much quality.
    - Can minimize amount of compression to create high quality photos
    - Often used for Photography display, and Web publishing.

Multimedia



Graphics

- Image file formats:
  - PNG (Portable Network Graphics)
    - High quality graphics created to exceed the performance of GIF files
    - It can handle graphics with transparent or semi-transparent backgrounds.
    - PNG files can store colors with 8, 24, or 48 bits per pixel
    - PNG's use lossless compression.
    - Often used for Logos with transparent backgrounds, and online charts and graphics.
    - PNG file will generally be a lot larger in size than a GIF or JPEG.
      - Their larger file size means slower page loading times and responsiveness.

Multimedia

	BMP	GIF	JPEG (JPG)	PNG
Compression	Uncompressed (Lossless)	lossless compression	lossy compression	lossless compression
Color depth	1, 4, 8, 15, 24, 32, or 64	8 - bit Color	24-bit color	8, 24, or 48
Used for	Not super common these days	memes, icons, or clip art.	Photography display, and Web publishing	Logos with transparent backgrounds, and online charts and graphics.

Multimedia

Graphics

- Enhancement:

  "Enhancing" means to make an image as clear as possible not matter what format it was saved in.
  https://video.cs50.net/cscie1a/2017/fall/lectures/multimedia?t=27m30s

#18:

1. Which file format is ideal for Web photos?
   A. Tiff
   B. Gif
   C. Jpeg
   D. Png

2. What does DPI stand for?
   A. Dots Per Inch
   B. Digits Per Inch
   C. Dotted Pixel Indicator
   D. Dots Paired Inside

3. GIF stands for...
   A. Graphic Independent Files
   B. Graphics Individual Format
   C. Graphics Interchange Format
   D. Great Independent Files

#18:

4. A term used to determine resolution of a printed image. The number of dots used in a linear inch by a printing or imaging device.
   A. Pixel
   B. DPI
   C. Byte
   D. PPI

5. What type of file allows for transparency
   A. JPEG
   B. GIF

6. Which file format is excellent for animation?
   A. Tif
   B. Gif
   C. Jpeg
   D. Png

#18:

7. Lossy files require more memory.
   A. True
   B. False

8. What type of compression permenantly removes data?
   A. Lossy Compression
   B. Lossless Compression

9. Is .JPG lossy or lossless?
   A. Lossy
   B. Lossless

Multimedia

What is Multimedia?

Multimedia is the use of a computer to present and combine text, graphics, audio, and video with links and tools that let the user navigate, interact, create, and communicate.

1. Audio
2. Graphics
3. Video
    1. How Computers Represent Video?
    2. Quality
    3. File formats

Multimedia

Video

Multimedia

Video

Video formats are just a bunch of images shown quickly in succession to create the illusion of motion

- Not necessarily all information stored as png, jpg, gif, or even images
- Algorithms and mathematics can help go from one frame to another

- video frame Rate:
  - The frame is a combination of the image and the time of the image when exposed to the view.
  - In general, one second of a video is comprised of 24 or 30 frames per second also known as FPS.
- Video Quality:
  - Video resolution (the number of pixels contained in each frame)
  - Frame rate

Multimedia

Video :

Resolution: 1920x1080 >>> 2.073.600 Pixels Per Frame

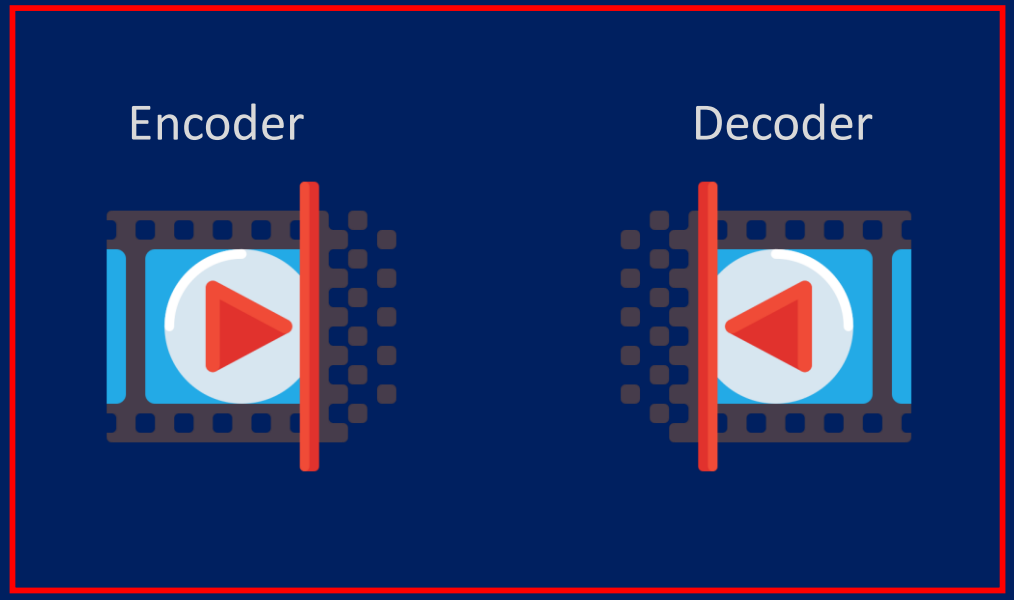
30 FPS: 2.073.600 x 30 = 62.208.000 Pixels Per Second

3 bytes of storage are used for each pixel

62.208.000 x 3 = 186.624.000 Bytes per second

Multimedia

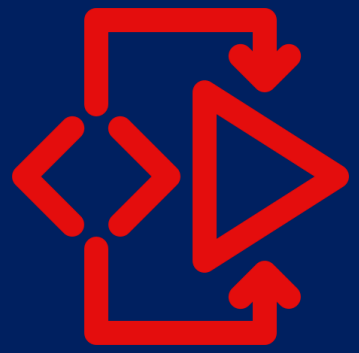
Video :



Multimedia

Video :

Codecs

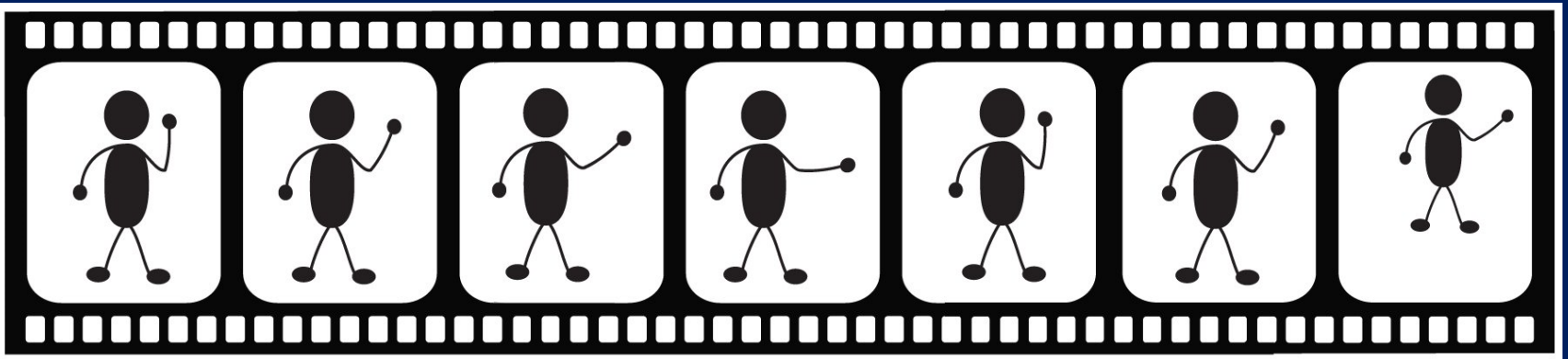


H.264, HEVC, VP9, AV1 ,
and MPEG-4 Part-2 ……..

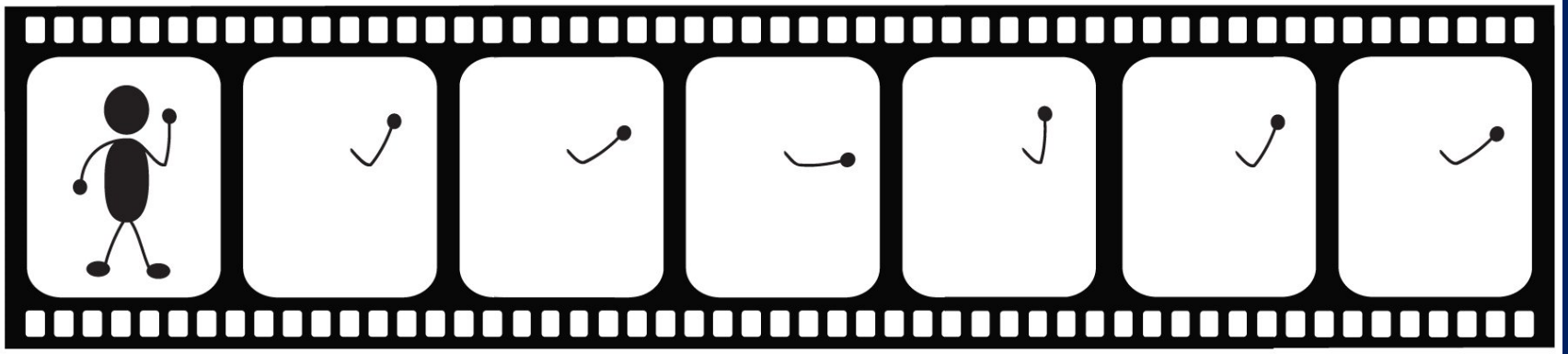
Multimedia

Video Compression:

1. Intra-frame coding
2. Inter-frame coding



Intraframe Compression
Every frame is encoded Individually

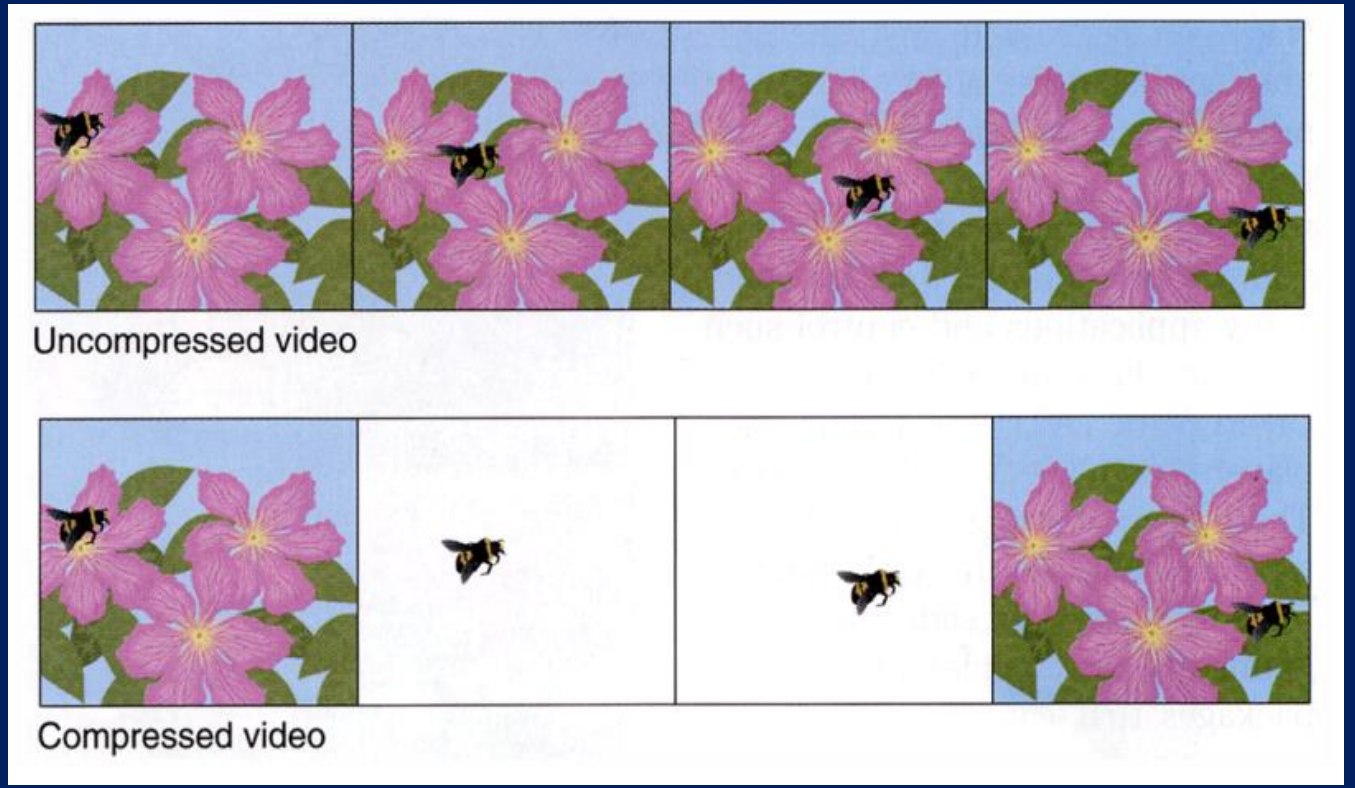


Interframe Compression
Only the differences between frames are encoded for each group of frames

Multimedia

Video Compression:

Inter-frame coding
Background of multiple frames can contain redundant information

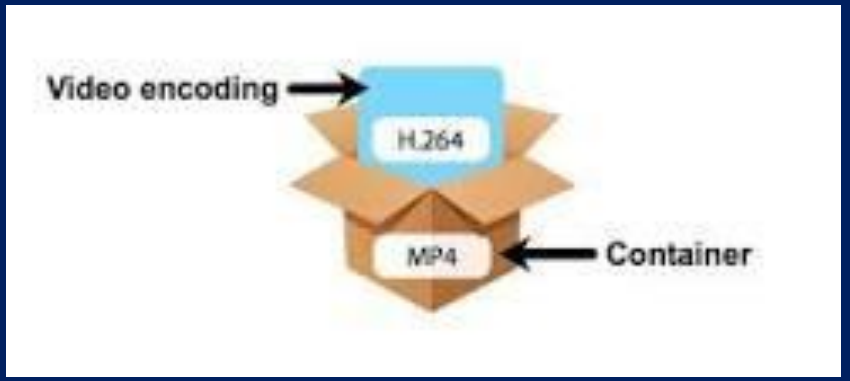


Key frames store a snapshot of time to remember what the video looks like

- In each subsequent frame remember what has changed
  - Using algorithms and math, background is drawn

Key frames are stored multiple times to guarantee that frames can be recovered

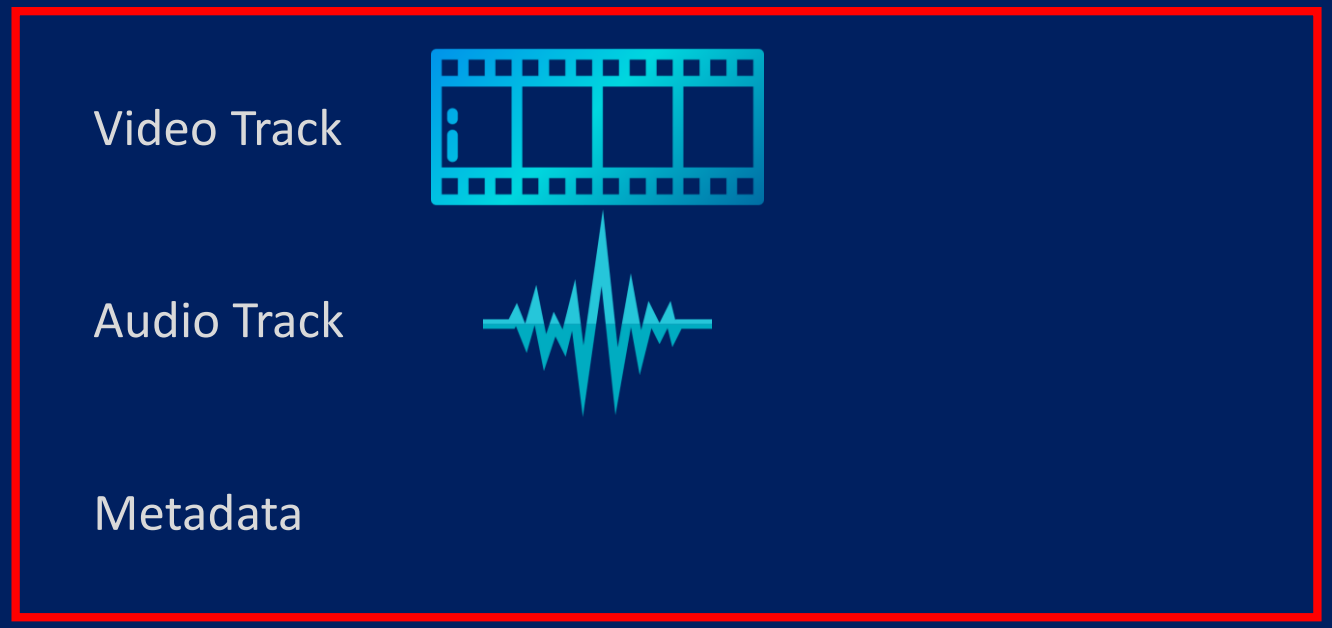
Multimedia



Video File Formats:

Video file formats are containers
Containers are digital container in which you can put multiple types of data
Can include a video track, audio track, a secondary audio track (for different languages), closed captions, …

.mp4



Multimedia

Video File Formats:

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- AVI
- Matroska
- MP4
- QuickTime

Multimedia

Video File Formats:

Video file formats are containers
Containers are digital container in which you can put multiple types of data
Can include a video track, audio track, a secondary audio track (for different languages), closed captions, …

- AVI (Audio Video Interleave):
  - Developed by Microsoft in November 1992.
  - Commonly used in Windows, works with nearly every web browser on Windows, Mac, and Linux machines
  - AVI offers the highest quality but also large file sizes.

Multimedia

Video File Formats:

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- Matroska (Named after the Russian "matroshka" nested dolls):
  - Matroska files are often called "MKV files".
  - Launched in December 2002
  - It supports nearly every codec but it is not itself supported by many programs.
  - MKV is a smart choice if you expect your video to be viewed on a TV or computer using an open-source media player like VLC .

Multimedia

Video File Formats:

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- MP4
  - MP4 (MPEG-4 Part 14)
  - MP4 is the most common and most popular video format.
  - It is the best option for use on Facebook, Instagram, Youtube and twitter.
  - It uses the MPEG-4 encoding algorithm to store video and audio files and text

Multimedia

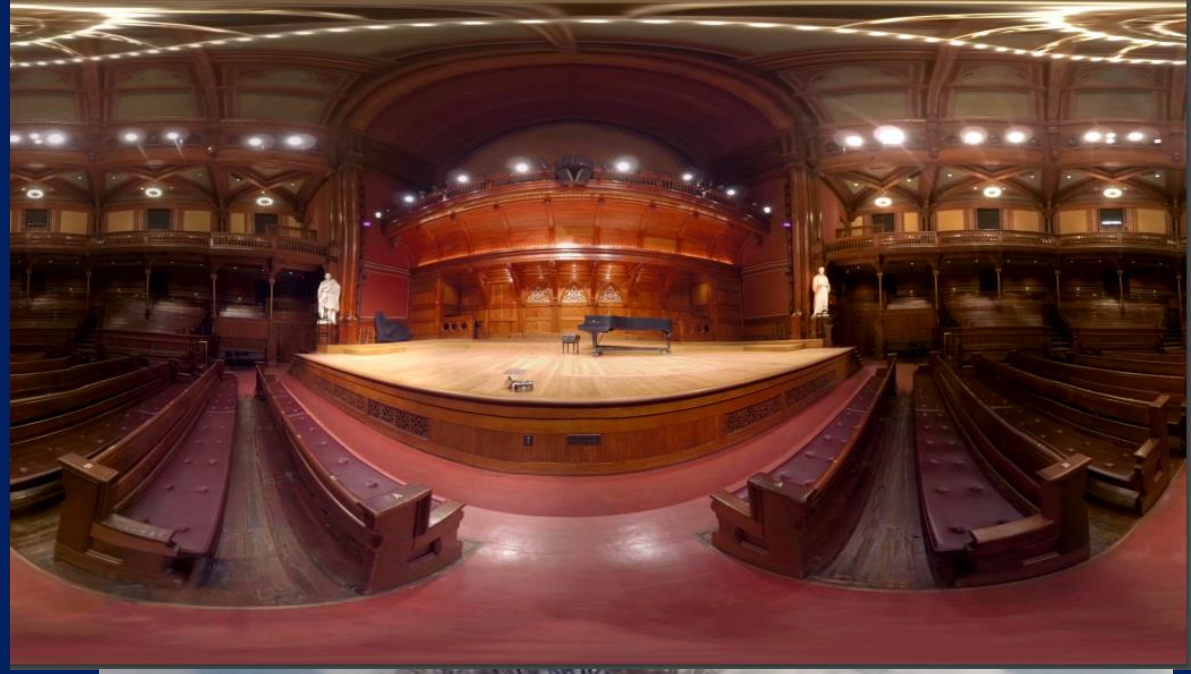
Video File Formats:

Video file formats are containers
Containers are digital container in which you can put multiple types of data
Can include a video track, audio track, a secondary audio track (for different languages), closed captions, …

- QuickTime:
  - Its video files use the file extension . MOV.
  - Is an Apple-designed video format that stores audio and video content for playback.
  - Stores high-quality video, audio, and effects, but these files tend to be quite large.
  - MOV is supported by Facebook and YouTube, and it works well for TV viewing.

Multimedia

3D Video:



- Increasingly, 3D formats are becoming more common
- This is a 360 degree image of Sanders Theatre
  - A spherical image
  - Looks distorted in 2D
  - Like flattening a globe
- Images can contain metadata
  - Information that viewers can't see
  - Tells programs, applications, and browsers how to display the image

Multimedia

3D Video:

- With sensors on a headset, users can experience virtual reality
- Increasingly, 3D formats are becoming more common

THANK YOU
Rasha Abdeen