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Multimedia File Format
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Lecture 1 Multimedia File Format

Multimedia is content that uses a combination of different content forms such as text, audio, images, animations, video and interactive content. Multimedia contrasts with media that use only rudimentary computer displays such as text-only or traditional forms of printed or hand-produced material. It is an integration of many types of media on a single medium in the same information unit.

Definition

" The combination of different types of media in the communication of information between two users and their computers"- Newton

Components of Multimedia

1. **Text:-** basic component of Multimedia. It was originally defined by printed media such as books and newspapers that used various typefaces to display the alphabet, numbers and special characters.
2. **Images:-** An image is a visual representation of something. An image is a picture that has been created or copied and stored in electronic form. An image can be described in terms of vector graphics or raster graphics. An image stored in raster form is sometimes called a bitmap.
3. **Animation:-** consists of still images displayed so quickly that they give the impression of continuous movement.
4. **Sound/Audio:-** It is meaningful speech in any language , from a whisper to a scream.

5. **video:-** The display of recorded real events on a television type screen. The embedding of video in multimedia applications is a powerful way to convey information.

FILE FORMATS

- The file format is the *structure* of a file that tells a program how to display its contents. Even if another program can open the file, it may not have all the features needed to display the document correctly.
- It is a standard way that information is encoded for storage in a computer.
- It may be proprietary or free.

Common file formats

- Text formats
- Image formats
- Video formats
- Audio formats

Text file formats

1. **DOC** general, doc is shorthand for a word document. In computing, .doc is a file extension associated with WordPad and other word processing programs. Microsoft Word is a good example of a word processor that can view .doc files.
2. **DOCX** The DOCX file format is used by Microsoft Word 2007 and later versions. It uses the .docx file extension, and is designed to replace the DOC file format used in previous versions of Word.

3. **RTF** Short for rich text format, RTF is a mix between rich text files and plaintext files. Unlike text files, RTF files offer some formatting features like bold, italic, underline, bullets, different fonts, and text justification. However, it does not provide all of the features found in a full word processor.An example of an RTF editor is Microsoft WordPad.
4. **.txt** is a file extension for a plaintext file.Plaintext is any text, text file, or document that contains only text. Unlike a rich-text document, a plain text file cannot have bold text, fonts, larger font sizes, or any other special text formatting. In the picture is a visual example of plain text vs. formatted text.
5. **WPS** is a file extension used with Microsoft Works versions 6 to Microsoft Works version 9. For users who need to open a Microsoft Works files, you can still use Microsoft Word to open these files.
6. **PDF** (Portable Document Format)It is a file format used to present documents in a manner independent of software , hardware, and operating systems. Developed in 1993. Earlier known as camelot, developed by Adobe corporation . Was a proprietary format controlled by Adobe till 2008

Image file formats

1. **BMP** is often used to describe the extension of the image. If shown, the picture is an example of a BMP image done in MSPaint.

2. **GIF** (The Graphics Interchange Format) is a bitmap image format that was developed by a team at the online services provider CompuServe led by American computer scientist Steve Wilhite on June 15, 1987. It has since come into widespread usage on the World Wide Web due to its wide support and portability between many applications and operating systems.

3. Joint Photographic Experts Group, **JPEG** is a digital image compression format, and one of the most popular image types shown on the Internet and used with digital camera. The JPEG standard uses a lossy sacrificed to achieve greater compression. JPEG is also abbreviated as JPG in the file extension used with IBM compatible computers. The image is an example of a JPEG image.

4. Portable Network Graphics, **PNG** is pronounced as either P-N-G or ping. It is a bitmapped image format featuring lossless compression.PNG was created as a replacement to the GIF after Unisys and CompuServe announced on December 24, 1994, that they expected licensing fees for any software that creates and displays GIF images.

5. tagged image file format, **TIFF** is a common way to store bitmap images that can be viewed and edited on both IBM compatible and Apple Macintosh computers.A TIFF file can have a file extension of .tiff or .tif. Either file extension is acceptable, and they can be opened by most photo viewer and editor software programs.

Video file formats

1. Audio Video Interleave, **AVI** is the standard file format used for video files under Microsoft Windows. The maximum size of an AVI file is 2 GB.

2. **MP4,** MPEG4, or MPEG-4 is an audio and video compression standard. It was introduced in 1998 and agreed upon as a standard by the MPEG (Motion Picture Experts Group) shortly after.Codecs and technologies which use the MPEG-4 standard include DivX, Xvid, QuickTime, DVDs, and Blu-ray discs.

3. **Mov** is a file extension of an Apple QuickTime movie.

4. Windows Media Video, **WMV** is a compressed video file format developed by Microsoft. It supports multiple video codecs for streaming of video on the Internet. The file extension of WMV files is .WMV.

5. **MKV** files are actually multimedia container formats. An MKV container can incorporate audio, video, and subtitles into a single file—even if those elements use different types of encoding.

Audio file formats

1. Musical Instrument Digital Interface, **MIDI** is a standard for digitally representing and transmitting sounds that was first developed in the 1980s. The MIDI sound is played back through the hardware device or computer either through a synthesized audio sound or a waveform stored on the hardware device or computer. The quality of how MIDI sounds when played back by the hardware device or computer depends upon that device's capability.

2. **MP3,** A file extension and compression method that utilizes the MPEG standard to reduce the size, often by a factor of 12, while still maintaining audio quality comparable to a CD. MP3 files are commonly used to store a song or the whole CD and require very little hard drive space. Because of their small file size, a computer can save several hundred or thousands of songs.

3. Windows Media Audio, **WMA** is a file format developed by Microsoft for the encoding of digital audio files. Capable of the same quality as an MP3 with a higher compression rate, WMA achieves acceptable audio quality with bitrates as low as 64 kbps.

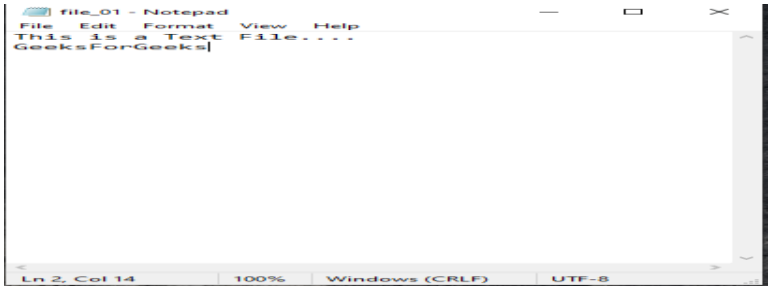
4. **WAV,** Waveform Audio File Format is a file format and file extension ending with .WAV that was created by Microsoft and IBM and was first widely introduced with the release of Microsoft Windows 95. WAV files were an early way of playing audio files on the computer that have been replaced today with MP3 and WMV files.

Chapter two Text file format

What is a Text File?

A text file is a file that contains data in the form of text. This is used to store and share textual data and is useful for human and software systems. A text file generally uses a simple character encoding such as UTF-8 and ASCII. text is a collection of alphanumerical characters.

A text file is non-executable. A text file can be identified by a vivid kind of extension associated with its types such as .txt, .csv, .html, .xml, .py, .log, etc. In some programming issues codes of various software are written in form text files before execution. For example, before making a web page its code needs to be created in the form of a text file of a .html extension.



Types of Text File

There are many types of text file as follows:

1. *Plain Text File*

This is a type where there is no special formatting of text such as italic, bold, heading, subheading etc. In Microsoft OS Notepad is used to create plain text file. In Microsoft OS These files are saved with the .txt extension.

2. *Comma Separated File*

This file remains in .csv extension. This file is used to contain tabular data. Each line represents a record, and fields within each record are separated by commas.

3. HTML File

HTML file is used to create websites and web applications. This is saved with .html extension. In this file all textual data is contained in Hyper Text Markup Language.

4. Doc and Docx file

This type of file is created by MS word in Microsoft OS. In this kind of file Text can be stored in a proper format. Heading, footer can be added. and bold, italic and various types of fonts can be used in writing.

5. Markdown File

In this type of file text is written through Markdown language. This type of file is used to create proper documentation. This file uses .md extension.

6. Programming language Source code File

Text file is also used write programming code of various languages such as python, JavaScript, C etc. This file can be saved in various extension according to the programming language such as .py for python, .js for javascript etc.

How To Open a Text File?

Opening a text file depends on OS. A file which does not contain textual content also can be open as a text file. If you are using windows, you just have to right click on the icon of text file and then select the option to open as text file.

For opening a text file in MacOS you have to right click on the icon and just have to select the text editor. By above methods you can open any file in the form of text file even those which are not contain textual data.

Converting Text File

Converting a text file means to change the file format of a text file. There can many reasons of converting of a text file. A text editor itself provides facility to save a text file in a specific format. for example, you can save a text file in various format such as HTML, XML, YML, CSV etc.

Q.1: What is a text file? A text file is file that contains textual data. Each text file uses a specific charater encoding. It can be created using text editors such Notepad++, vim, text editor etc.

Q.2: What is character encoding? Character encoding is a process which is used to define massage in form of text. UTF-8 and ASCII are example of character encoding.

Q.3: What is the common file extension for text files? A text file can be in many formats. ".txt" for windows OS, ".text" for MacOS are used as a common extension though there are many extensions as .html, .py, .xml, .js, .java etc.

Text File Formats

TXT file format is a format that is developed for storing plain text with no formatting such as graphics, bolding, italicization, font style, alignment, and so on. It is one of the most basic file types and the most widely used file formats on computers. These files are smaller than other file formats even containing the same text data, therefore they take up less space in the system and are very easy to convert and store.

Uses of File Format:

1- Personal documents: Many people utilize text-based documents for personal purposes in their daily lives from CVs and creative writing projects to recipes and lists.
2- Professional documents: They can be utilized for creating reports, memoranda, business plans, process documents, and various other documents.
3- Data storage: Programs utilize text extensions to record activities on a computer or tasks performed by a specific user. So that these can be utilized later on when needed.
4- Format-specific documents: Some programs allow users to store specified items such as an email saved offline as a text file extension. This can be beneficial for sharing with a colleague separately or editing/working with the contents.

Benefits of File Format:

1- Simplicity: Text formats are simple to use and create. This implies that users won't often face complicated or technical challenges or require particular knowledge or skills to utilize them.
2- Data Recovery: It is often easier to recover from data corruption in text file format and proceed with processing the remaining information.
3- Small and easily shareable: Text documents are generally significantly smaller than other forms of files, making them easier to share and store.
4- Highly accessible: Simple text file formats can be accessed by most computers and devices without the need for any specialized software. They have widespread support for several programs.

How to Open a Text File

All text editors should be able to open any text file, especially if there isn't special formatting being used. For example, TXT files can be opened with the built-in Notepad program in Windows by right-clicking the file and choosing Edit.

Rich text files format

The rich text file format extended the range of information carried through from one word processor application or desktop publishing system to another.
The following are the key format information carried out in RTF document files.

1.Character set

The character set determines the characters that are supported in a particular implementation.
Character set groupings include Windows ANSI, IBM PC

2.Font table

A font table lists all fonts used in the document.
These font are then mapped to the fonts available in the receiving application for displaying the text.

3.Color table

The color table lists the color used in the document for highlighting text.

4.Document formatting

Paragraph indents are specified relative to the document margin.

5.Section formatting

Section breaks/page breaks are used to define separation of groups of paragraph.
The formatting information specifies the space above and below the section.

6.Paragraph formatting

The RTF specification defines control characters for specifying paragraph justification, tab position, left, right and first indents relative to document margins, and the spacing between paragraphs.
Paragraph formatting information also includes style sheets.

7.General formatting

General formatting includes items such as footness, annotation, bookmarks and pictures.

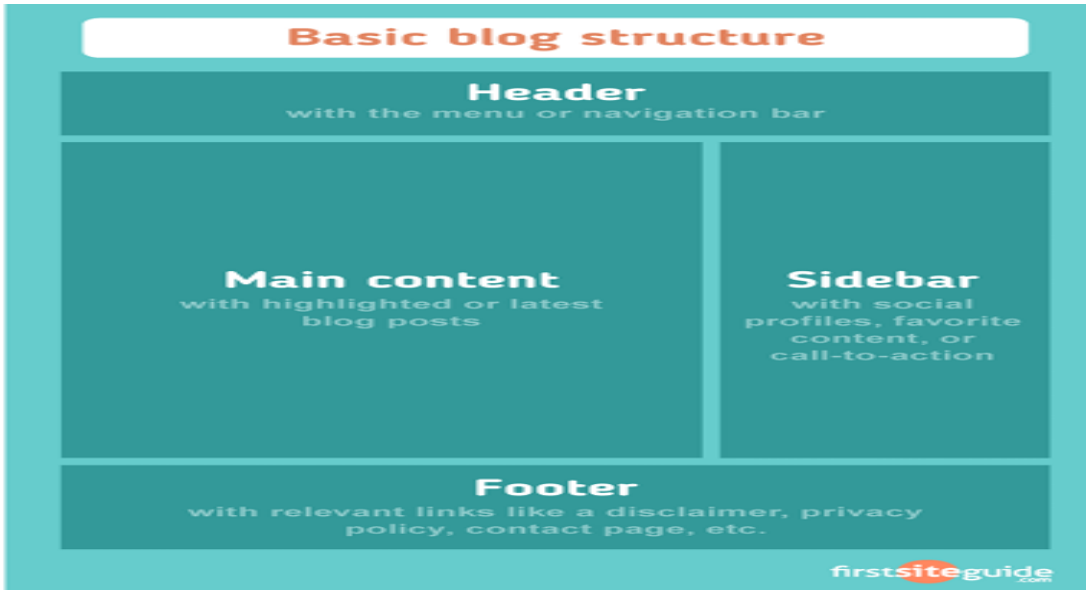
8.Character formatting

Character formatting includes bold, underline, italic, strikethrough, shadow text, outline text and hidden text.

What are the Multimedia Formats in Interpreting Literary Texts?

BLOG A blog (a shortened version of "weblog") is an online journal or informational website displaying information in reverse chronological order, with the latest posts appearing first, at the top. It is a platform where a writer or a group of writers share their views on an individual subject. Blog structure The appearance of blogs has changed over time, and these days blogs include a wide variety of items and widgets. However, most blogs still include some standard features and structures. Here are common features that a typical blog will include:

- Header with the menu or navigation bar.
- Main content area with highlighted or latest blog posts.
- Sidebar with social profiles, favorite content, or call-to-action.
- Footer with relevant links like a disclaimer, privacy policy, contact page, etc.



Chapter Three Image file format

1. Introduction to Image File Formats

Definition: Image file formats are standardized ways of organizing and storing digital images. These formats dictate how data is compressed, represented, and stored in files, affecting image quality, size, and compatibility.

An *image file format* is a file format for a digital image. There are many formats that can be used, such as JPEG, PNG, and GIF. Most formats up until 2022 were for storing 2D images, not 3D ones. The data stored in an image file format may be compressed or uncompressed. If the data is compressed, it may be done so using lossy compression or lossless compression. For graphic design applications, vector formats are often used. Some image file formats support transparency.

Image files are composed of digital data in one of these formats so that the data can be displayed on a digital (computer) display or printed out using a printer. A common method for displaying digital image information has historically been rasterization.

Importance of Multiple Formats:

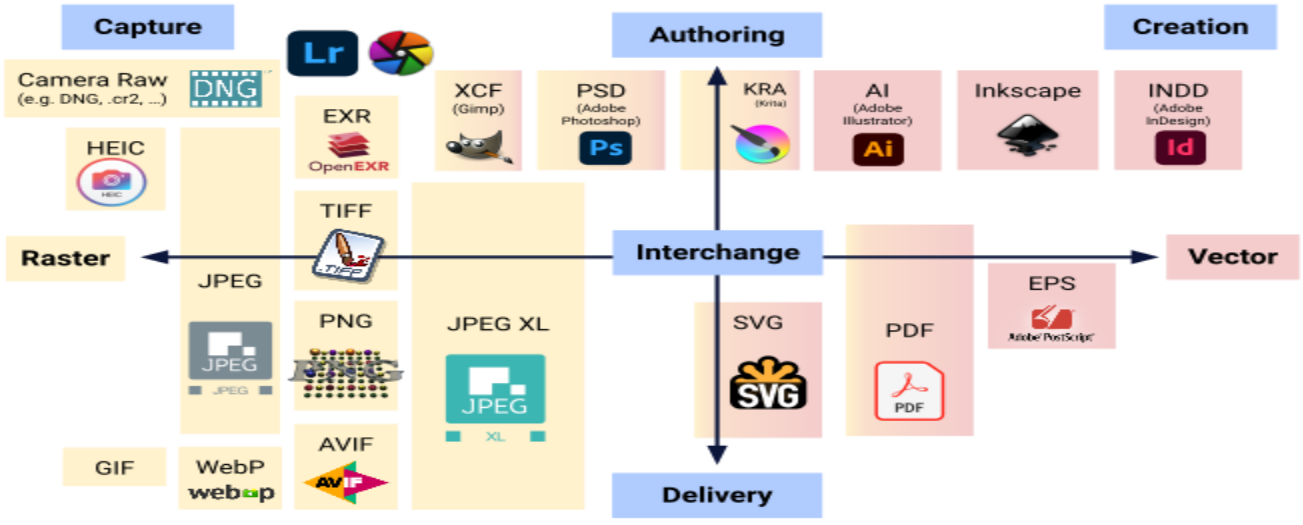
- Different use cases demand different features (e.g., transparency, scalability, small file size).
- Trade-offs between quality, compatibility, and compression drive the choice of formats.

The size of raster image files is positively correlated with *the number of pixels* in the image and the color depth (bits per pixel). Images can be compressed in various ways, however. A compression algorithm stores either an exact representation or an

approximation of the original image in a smaller number of bytes that can be expanded back to its uncompressed form with a corresponding decompression algorithm. Images with the same number of pixels and color depth can have very different compressed file size. Considering exactly the same compression, number of pixels, and color depth for two images, different graphical complexity of the original images may also result in very different file sizes after compression due to the nature of compression algorithms. With some compression formats, images that are less complex may result in smaller compressed file sizes. This characteristic sometimes results in a smaller file size for some lossless formats than lossy formats. For example, graphically simple images (i.e. images with large continuous regions like line art or animation sequences) may be losslessly compressed into a GIF or PNG format and result in a smaller file size than a lossy JPEG format.

Key Characteristics:

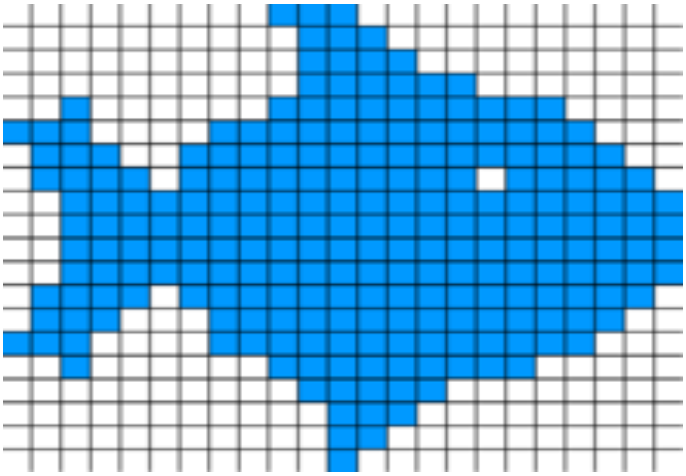
- Compression: Whether the format reduces file size and how.
- Compatibility: Whether the format is supported across platforms.
- Quality: The level of detail and visual fidelity retained.



2. Types of Image Formats

a. Raster Formats

Raster images are made up of a grid of pixels. Each pixel contains color information, resulting in rich detail but limited scalability. Raster graphics are the most common type of image files. They are comprised of a grid of pixels where each pixel represents an individual color within the image. Both Web graphics and digital photos are stored as raster graphics. While some raster image formats are uncompressed, most use some type of image compression. Common raster image file extensions include .BMP, .TIF, .JPG, .GIF, and .PNG. In computer graphics and digital photography, a raster graphic represents a two-dimensional picture as a rectangular matrix or grid of pixels, viewable via a computer display, paper, or other display medium. A raster image is technically characterized by the width and height of the image in pixels and by the number of bits per pixel. Raster images are stored in image files with varying dissemination, production, generation, and acquisition formats.



A single numeric value is then stored for each pixel. For most images, this value is a visible color, but other measurements are possible, even numeric codes for

qualitative categories. Each raster grid has a specified pixel format, the data type for each number. Common pixel formats are binary, gray-scale, palettized, and full-color, where color depth determines the fidelity of the colors represented, and color space determines the range of color coverage (which is often less than the full range of human color vision). Most modern color raster formats represent color using 24 bits (over 16 million distinct colors), with 8 bits (values 0–255) for each color channel (red, green, and blue).

Examples:

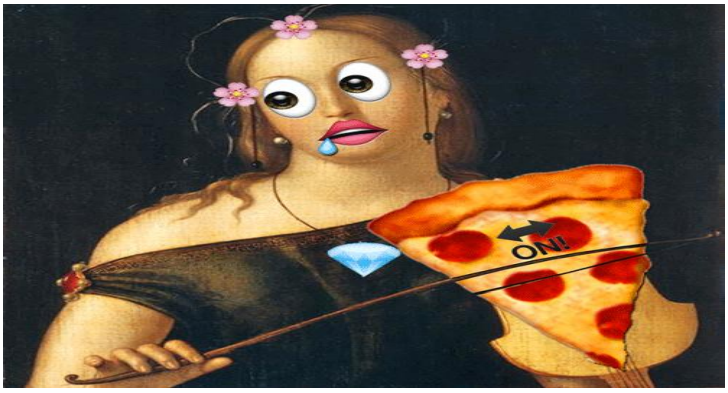
- JPEG (Joint Photographic Experts Group) JPEG has become so popular because of its flexibility; you can easily reduce its file size, making it suitable for sharing images. That's why most social media platforms automatically turn your uploaded image files into JPEGs :
    - Features: Lossy compression, reduced file sizes, commonly used for photographs.
    - Pros: Small file size, widely supported.
    - Cons: Loss of quality with repeated editing.

- PNG (Portable Network Graphics) Many people might consider PNGs as a 2.0 version of GIF. This happens because the patent for the responsible

algorithm for gifs compression was created in 1995 and then Adobe invested in a new improved format to substitute and improve the old GIF :

- Features: Lossless compression, supports transparency.
- Pros: High-quality images, ideal for web graphics.
- Cons: Larger file sizes than JPEG.

- GIF (Graphics Interchange Format) GIF stands for Graphics Interchange Format and, just like JPEG, is also a raster format. It does use lossless compression but constrains the image to 8 bits per pixel and a limited palette of 256 colors, so the quality is not its perk. The GIF format is famous for animated images on the web, as the bit limitation keeps file sizes small and is supported by all major browsers.:
  - Features: Limited to 256 colors, supports simple animations.
  - Pros: Compact and supports motion.
  - Cons: Not suitable for high-quality images.



- BMP (Bitmap) Bitmap appeared at the same time as the Windows operating system and has the capacity of over 16 million color variations (24 bits).The main problem is its low compression capacity; the image files are too heavy, so they are not a good match for the web.The advantage is that BMPs maintain the details of the original file and are free of patents. :
    - Features: Uncompressed format.
    - Pros: Preserves original image quality.
    - Cons: Extremely large file sizes.

b. Vector Formats

Vector images use mathematical equations to represent graphics, making them resolution-independent. Vector graphics are a form of computer graphics in which visual images are created directly from geometric shapes defined on a Cartesian plane, such as points, lines, curves and polygons. The associated mechanisms may include vector display and printing hardware, vector data models and file formats, as well as the software based on these data models (especially graphic design software, computer-aided design, and geographic information systems). Vector graphics are an alternative to raster or bitmap graphics, with each having advantages and disadvantages in specific situations.

Examples:

- SVG (Scalable Vector Graphics) SVG (Scalable Vector Graphics) is a scalable vectorial file format that can be recognized by most browsers and is widely used in websites and blogs. In addition, it's possible to animate SVG images through HTML 5.0 programming. Not suitable for displaying detailed images with high color depth, such as photographs. :
    - Features: XML-based format for web use, scales without losing quality.
    - Use Case: Logos, icons, illustrations.
- EPS (Encapsulated PostScript):
    - Features: High-quality format for print.
    - Use Case: Professional graphic design.

3. Lossy vs. Lossless Compression in image

Lossy Compression:

- Definition: Reduces file size by discarding some data permanently.
- Example: JPEG.
- Advantages: Small file sizes, ideal for web use.
- Disadvantages: Quality degradation, especially after multiple edits.

Lossless Compression:

- Definition: Reduces file size without losing any data.
- Example: PNG, GIF.
- Advantages: High-quality output, retains all details.
- Disadvantages: Larger file sizes compared to lossy formats.

4. Common Use Cases and Selection Criteria

How to Choose the Right Format Each image file format will serve you in a particular way, so you should choose them according to your strategy. If you choose the wrong format for your purpose, it can slow down your website, cause unwanted errors, or provide a bad user experience.:

- Web Graphics:
- Print Media:
- Animations:

Modern Formats:

- WebP:
  - Developed by Google, combines lossy and lossless compression.
  - Smaller file sizes compared to JPEG and PNG.
- HEIF (High Efficiency Image Format):
  - Optimized for modern devices, supports advanced features like live photos.
  -

Metadata in Images:

Image metadata, also known as photo metadata, provides information about a digital image file. It includes details such as:

1- Date and time the photo was taken
2- Camera model and settings used
3- Location where the photo was taken
4- Shutter speed, aperture, and ISO settings Copyright information

Metadata *is, basically, information about other data.*

Homework/Practice Tasks:

1. Identify the formats of three images on your device. Analyze their characteristics and usage.
2. Convert one image into three different formats. Compare their file sizes and quality.
3. Research a modern format (e.g., AVIF) and prepare a brief summary of its features.

Emphasize that understanding these formats is essential for effective digital media management.

1. Introduction to Audio File Formats

Definition: Audio file formats are standardized methods of storing digital audio data. These formats determine how sound is encoded, compressed, and stored, influencing quality, size, and compatibility. An audio file format is a file format for *storing digital* audio data on a computer system. The bit layout of the audio data (excluding metadata) is called the audio coding format and can be uncompressed, or compressed to reduce the file size, often using lossy compression. The data can be a raw bitstream in an audio coding format, but it is usually embedded in a container format or an audio data format with defined storage layer.

Importance of Audio File Formats:

- Compatibility across devices and software.
- Trade-offs between file size and audio quality.
- Different formats optimized for specific use cases (e.g., music streaming, production, archiving).

Key Characteristics:

- Compression: Lossy or lossless.
- Sampling Rate: Number of audio samples per second.
- Bit Depth: Precision of audio samples.
- Channels: Mono, stereo, or surround sound.

2. Types of Audio Formats

a. Lossy Formats

Lossy audio formats reduce file size by discarding some audio data, which may slightly affect quality.

Examples:

- MP3 (MPEG Audio Layer-3):
    - Features: Highly compressed, widely supported.
    - Pros: Small file size, ideal for streaming and downloads.
    - Cons: Loss of audio detail.
- AAC (Advanced Audio Coding):
    - Features: Better quality than MP3 at similar bitrates.
    - Use Case: Apple devices, streaming platforms.
- OGG (Vorbis):
    - Features: Open-source format, high-quality compression.
    - Use Case: Video games, open platforms.

b. Lossless Formats

Lossless audio formats retain all original data, ensuring perfect sound quality.

Examples:

- FLAC (Free Lossless Audio Codec):
    - Features: Open-source, compressed without losing data.
    - Pros: High-quality, smaller file size than uncompressed formats.
    - Cons: Larger file size compared to lossy formats.

- ALAC (Apple Lossless Audio Codec):
  - Features: Proprietary format by Apple.
  - Use Case: iTunes and Apple ecosystem.
- WAV (Waveform Audio File):
  - Features: Uncompressed, used for professional audio editing.
  - Cons: Large file size.

c. Uncompressed Formats

Uncompressed formats store raw audio data with no compression applied.

Examples:

- WAV: Industry standard for audio recording and editing.
- AIFF (Audio Interchange File Format):
  - Developed by Apple, similar to WAV but used in the Apple ecosystem.

3. Key Concepts in Audio Quality

Sampling Rate: The number of samples of audio taken per second, measured in Hz.

Bit Depth: Determines the dynamic range of audio, measured in bits.

Bitrate: Indicates the amount of audio data processed per second, measured in kbps.Comparison: 128 kbps (lower quality) vs. 320 kbps (high quality).

4. Common Use Cases and Selection Criteria

Choosing the Right Format:

- Music Streaming:

    - Use MP3 or AAC for small file sizes and compatibility.
    - Use OGG for open platforms.
- Professional Audio Editing:
    - Use WAV or AIFF for uncompressed, high-quality editing.
    - Use FLAC or ALAC for archiving.
- Podcasts and Audiobooks:
    - Use MP3 for compatibility and smaller size.

Factors to Consider:

- Desired audio quality.
- Storage space.
- Playback device compatibility.

An ***audio file header*** is a metadata block at the beginning of an audio file that stores essential information about the audio format, such as its encoding method, duration, sample rate, bit depth, and number of channels. This information allows media players to interpret and play back audio correctly.

Key Functions of an Audio File Header

1. **Format Identification:**
   Specifies the audio file format (e.g., WAV, MP3, FLAC).
2. **Codec Information:**
   Describes how the audio is compressed or encoded.
3. **Audio Properties:**
   Stores details like sample rate, bit depth, number of channels (mono or stereo).
4. **Data Size:**
   Indicates the total size of the audio data.

Example of WAV Header Structure

```mathematica
52 49 46 46 XX XX XX XX 57 41 56 45 66 6D 74 20
```

Breakdown

- `52 49 46 46 (RIFF)`: Identifies the file as a RIFF format.
- `XX XX XX XX`: File size in bytes.
- `57 41 56 45 (WAVE)`: Specifies the WAV format.
- `66 6D 74 20 (fmt)`: Format chunk for audio properties.

MP3 Header Example

```
FF FB B0 64
```

Breakdown

- `FF FB`: Frame sync bits.
- `B0`: MPEG version and layer information.
- `64`: Bitrate and sampling rate information.

Metadata makes it much easier to browse your music without investing hours of time alphabetising and folder creating in front of your computer screen. Metadata are text-format information attached to an audio file, essentially the sound's dentity card. They can include a variety of details such as :

- Artist
- Album
- Track title
- Genre
- Album artwork
- Track number

ChannelLayout	CatID	Category	CategoryFull	SubCategory	Key	Mood	OpenTier	Library	CDTitle	RecMedium	Microphone	RecType	SampleRate	BitDepth	Location	Scene	Keywords
L/R	AMBMrkt	AMBIENCE	AMBIENCE-MARKET	MARKET	MARKET	BUSY	AMBIENCE-MARKET-Busy	AF_DAY IN KYOTO	AF_DIKT	Sound Devices MixPre-10 II	Sennheiser MKH 8090	ST DOWNMIX	96000	24	JAPAN / Kyoto, Nakagyo-Ku	INT / DAY	KYOTO, CITY, EVERYDAY LIFE, DAY
L/R/C/Ls/Rs	AMBMrkt	AMBIENCE	AMBIENCE-MARKET	MARKET	MARKET	BUSY	AMBIENCE-MARKET-Busy	AF_DAY IN KYOTO	AF_DIKT	Sound Devices MixPre-10 II	Sennheiser MKH 8090	MW SURROUND TREE	96000	24	JAPAN / Kyoto, Nakagyo-Ku	INT / DAY	KYOTO, CITY, EVERYDAY LIFE, DAY
L/R	AMBMrkt	AMBIENCE	AMBIENCE-MARKET	MARKET	MARKET	BUSY	AMBIENCE-MARKET-Busy	AF_DAY IN KYOTO	AF_DIKT	Sound Devices MixPre-10 II	Sennheiser MKH 8090	ST DOWNMIX	96000	24	JAPAN / Kyoto, Nakagyo-Ku	INT / DAY	KYOTO, CITY, EVERYDAY LIFE, DAY
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L/R	AMBPark	AMBIENCE	AMBIENCE-PARK	PARK	RIVERSIDE	BUSY	AMBIENCE-PARK-RIVERSIDE-Busy	AF_DAY IN KYOTO	AF_DIKT	Sound Devices MixPre-10 II	Sennheiser MKH 8090	ST DOWNMIX	96000	24	JAPAN / Kyoto, Nakagyo-Ku	EXT / DAY	KYOTO, CITY, EVERYDAY LIFE, DAY
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Delivering audio over a network

Delivering audio over a network involves transmitting audio data from a source to one or more recipients in real-time or near real-time. This process is used in applications like **voice over IP (VoIP)**, **streaming services**, **online gaming**, and **video conferencing**. Below is a detailed explanation of how audio delivery over a network works, including the key components, protocols, and challenges.

Key Components of Audio Delivery Over a Network

1. **Audio Source**:
   - The origin of the audio data, such as a microphone, pre-recorded audio file, or live audio stream.
2. **Encoder**:
   - Converts raw audio data into a compressed format suitable for transmission (e.g., MP3, AAC, Opus).

3. **Network Protocols**:
    - Define how audio data is packaged, transmitted, and received over the network.
4. **Transmission Medium**:
    - The network infrastructure (e.g., Wi-Fi, Ethernet, cellular) used to deliver the audio data.
5. **Decoder**:
    - Converts the compressed audio data back into a playable format at the receiver's end.
6. **Audio Output**:
    - The destination where the audio is played, such as speakers or headphones.

Steps for Delivering Audio Over a Network

1. **Capture Audio**:
    - Use a microphone or audio interface to capture raw audio data.
2. **Encode Audio**:
    - Compress the audio data to reduce bandwidth usage. Common codecs include:
        - **Opus**: Low latency, high quality, widely used in VoIP.
        - **AAC**: High quality, used in streaming services.
        - **MP3**: Good quality, widely supported.
        - **G.711**: Used in traditional telephony.
3. **Packetize Audio**:
    - Split the encoded audio into small packets for transmission. Each packet includes:

- A header (with sequence numbers, timestamps, etc.).
- Payload (encoded audio data).

4. **Transmit Packets**:
    - Use network protocols to send the packets to the receiver. Common protocols include:
        - **RTP (Real-time Transport Protocol)**: For real-time audio streaming.
        - **RTCP (RTP Control Protocol)**: Monitors quality of service (QoS).
        - **UDP (User Datagram Protocol)**: Low latency, used with RTP.
        - **TCP (Transmission Control Protocol)**: Reliable but higher latency.
        - **WebRTC**: For browser-based real-time communication.
5. **Receive and Reassemble Packets**:
    - The receiver collects the packets, reorders them (if necessary), and decodes the audio.
6. **Play Audio**:

The decoded audio is sent to the speakers or headphones for playback.

Protocols for Audio Delivery

1. **RTP (Real-time Transport Protocol)**:
    - Designed for real-time audio and video streaming.
    - Works with UDP for low-latency transmission.

- Includes timestamps and sequence numbers for synchronization.

2. **RTCP (RTP Control Protocol)**:
   - Works alongside RTP to monitor QoS (e.g., packet loss, jitter).
3. **SIP (Session Initiation Protocol)**:
   - Used in VoIP to establish, manage, and terminate audio sessions.
4. **WebRTC**:
   - Enables real-time audio communication in web browsers without plugins.
   - Uses RTP and UDP for low-latency transmission.
5. **HTTP Live Streaming (HLS)**:
   - Used for adaptive streaming of audio and video over HTTP.
   - Divides audio into small chunks for progressive playback.
6. **RTMP (Real-Time Messaging Protocol)**:
   - Used for live audio and video streaming.
   - Commonly used with Flash-based players (less common now).

Challenges in Delivering Audio Over a Network

1. **Latency**:
   - Delay between audio capture and playback. Low latency is critical for real-time communication.
   - **Solution**: Use UDP instead of TCP, optimize network routing, and use low-latency codecs like Opus.
2. **Packet Loss**:
   - Occurs when audio packets are lost during transmission.
   - **Solution**: Use error correction techniques, retransmission, or adaptive jitter buffers.

3. **Jitter**:
    - Variability in packet arrival times.
    - **Solution**: Use jitter buffers to reorder packets and smooth playback.
4. **Bandwidth Limitations**:
    - Limited network bandwidth can degrade audio quality.
    - **Solution**: Use adaptive bitrate streaming (e.g., HLS) or compress audio with efficient codecs.
5. **Network Congestion**:
    - High traffic can cause delays and packet loss.
    - **Solution**: Implement QoS mechanisms to prioritize audio traffic.
6. **Echo and Noise**:
    - Echo and background noise can degrade audio quality.
    - **Solution**: Use echo cancellation and noise suppression algorithms.

Homework :

1. Analyze the properties (format, bitrate, sampling rate) of three audio files on your device.
2. Convert an audio file into at least two different formats and compare the differences in size and quality.
3. Research a new or emerging audio format (e.g., Opus) and summarize its key features.

Chapter Five Video file format

1. Introduction to Video File Formats

Definition: Video file formats are containers that store video data, audio data, and sometimes metadata. They determine how video and audio are encoded, compressed, and stored. A video file format is an extension that is used at the end of a video file. It takes up more space to store the same data as used by other file formats. It is the most widely used file format for entertainment and educational purposes. Importance of Video File Formats:

- Compatibility with playback devices and software.
- File size optimization for storage and streaming.
- Balancing video quality with compression.

2. Lossy vs. Lossless Compression

Lossy Compression:

- Definition: Reduces file size by removing less noticeable details.
- Examples: H.264, VP9.
- Advantages: Smaller file sizes, ideal for streaming.
- Disadvantages: Slight quality loss.

Lossless Compression:

- Definition: Retains all data, ensuring perfect quality.
- Examples: ProRes, FFV1.
- Advantages: High-quality output, ideal for editing and archiving.
- Disadvantages: Larger file sizes.

Visual Comparison:

- Show a side-by-side example of lossy and lossless video quality.

4. What are the Video File Formats?

Video file is a standard structure for storing data using encoding and compression. The domain has evolved continuously improving the user experience and different other digital services. There are many different video file formats available. But there are mainly five formats which are discussed below.

- **AVI (Audio Video Interleave):** It was introduced in 1992 by Microsoft. It contains both audio and video data. It uses less compression than other video formats. It provides good video quality so the file size is larger. It supports

multiple codecs. It provides good video quality and is compatible with various playback devices. It is the oldest video file format available. It is generally used because of its good video quality. However, it isn't suitable for the web.

- **MP4:** It is the most popular and standard format for video files. It was created by MPEG and introduced in 2001. It uses different compression techniques for audio and video. It is a versatile multimedia container that can store both audio, video, subtitles, and still image. It is the most suitable format for posting video content online. It provides good video quality with a small file size. It is the most widely used format for video files. The most commonly used codec is H.264. It is suitable for social media platforms.
- **MPG:** It contains two video formats MPEG-1 and MPEG-2. MPEG-1 is used for lower bandwidth applications whereas MPEG-2 is more versatile and used for DVDs as well as digital television. It is generally used for video compression and distribution. It is also used for broadcasting with limited resources. It supports interlaced video. It stores audio, video, and metadata interlinked together. Its only downside is that it is a lossy format. Video quality is compromised to achieve a lower file size.
- **MOV:** It was developed by Apple for its own ecosystem. It is commonly used with QuickTime. It supports various codecs and is used for multimedia projects. It is primarily used by video editors because it provides the highest quality for editing. It can store multiple tracks, text files, and effects. It is used for multimedia projects, video editing, and distribution of content for the Apple platform. Its only downside is its poor compatibility with other devices.
- **3GP:** It is the Multimedia container format that is commonly used for mobile phones. It is used where lower video quality is a problem and the only focus is to get a small file size.

- **WMV:** It is a video compression format developed by Microsoft. It is popular for its small file size while maintaining reasonable video quality. It lacks compatibility with certain operating system. It is suitable for online streaming and playback on Windows Media Player. It is compatible with Windows based applications. Its benefit is that files can be sent through e-mail. It is used where lower video quality is not a problem and the only focus is to get a small file size. It isn't compatible with Apple devices.

5. Uses of Video File Formats

It is used by people to create memories in the form of video of a particular event.

a) It is used for entertainment purpose to stream services on various video streaming platforms like Netflix, You Tube and so on.
b) It is used by various video editing softwares like Adobe Premiere Pro, Da Vinci Resolve and so on.
c) People use it to upload memories on social media platforms in different video file formats.
d) It is used to keep surveillance from security cameras.
e) It is used by educational institutions to prepare study material for teaching students.
f) In the modern era of advertising, it is used to create and deliver advertisements in the form of video on different platforms.

6.Benefits of Video File Formats

1. Learning is made easy through video files.
2. It is a major source of entertainment for people all around the world.
3. It makes the information to be conveyed to a larger group of people .

4. It provides flexibility in video editing while maintaining original quality.
5. It is very useful in streaming. Many video formats allow the content to adapt to viewer's internet speed.

7. Key Concepts in Video Quality

Resolution: Number of pixels in a video frame.

Frame Rate: Number of frames displayed per second (fps).

Bitrate: Amount of data processed per second, measured in kbps or Mbps.

Metadata in Videos: Definition: Embedded data such as title, description, codec info.

A ***video file header*** is a structured segment at the beginning of a video file that contains essential metadata about the file. This metadata provides information about the file format, codecs, video and audio properties, and other parameters necessary for proper playback and interpretation by media players.

Video File Header

1. **Format Identification:** Specifies the type of file (e.g., MP4, AVI, MKV).
2. **Codec Information:** Indicates the codecs used for encoding video and audio streams.
3. **File Structure Metadata:** Defines the layout of the file, such as data chunks and synchronization points.
4. **Playback Settings:** Contains details like frame rate, resolution, and duration.
5. **Compatibility:** Ensures the file can be recognized and played by compatible software and devices.

Main Elements of Video File Headers

1. Magic Number
2. File Type (Format Identifier)
3. Codec Information
4. Resolution Information
5. Frame Rate
6. Duration
7. Bitrate

MP4 File Header Example (Hex Representation)

```
mathematica

00 00 00 20 66 74 79 70 69 73 6F 6D 00 00 02 00
69 73 6F 6D 69 73 6F 32 61 76 63 31 6D 70 34 31
```

Breakdown of Important Fields

1. **00 00 00 20:** Size of the atom (32 bytes).
2. **66 74 79 70:** Atom type (`ftyp` stands for "file type").
3. **69 73 6F 6D:** Major brand (`isom`, a common identifier for MP4 files).
4. **00 00 02 00:** Version number or compatibility flags.
5. **61 76 63 31:** Indicates compatibility (`avc1` means H.264 codec).

Video file formats are containers that store video, audio, and metadata (e.g., subtitles, captions) in a single file. These formats determine how the data is encoded, compressed, and organized, affecting compatibility, quality, and file size. Below is a detailed explanation of **video file formats**, including their types, features, and use cases.

1. Common Video File Formats

a. MP4 (MPEG-4 Part 14)

- **Extension**: .mp4
- **Features**:
  - Supports video (H.264, H.265), audio (AAC), and subtitles.
  - High compression with good quality.
  - Widely supported by devices and platforms.
- **Applications**:
  - Streaming, sharing, and storing videos.

b. AVI (Audio Video Interleave)

- **Extension**: .avi
- **Features**:
  - Developed by Microsoft.
  - Supports multiple video and audio codecs.
  - Large file size due to less efficient compression.
- **Applications**:
  - Storing high-quality video, legacy systems.

c. MKV (Matroska Video)

- **Extension**: .mkv
- **Features**:
  - Supports almost any video and audio codec.
  - Can store multiple audio tracks, subtitles, and metadata.
  - Open-source and highly flexible.
- **Applications**:
  - Storing high-quality video, Blu-ray rips.

d. MOV (QuickTime File Format)

- **Extension**: .mov
- **Features**:
  - Developed by Apple.
  - Supports high-quality video and audio.
  - Often used with H.264 or ProRes codecs.
- **Applications**:
  - Video editing, Apple devices.

e. WMV (Windows Media Video)

- **Extension**: .wmv
- **Features**:
  - Developed by Microsoft.
  - High compression with small file size.
  - Limited compatibility outside Windows.
- **Applications**:
  - Streaming, Windows-based systems.

f. FLV (Flash Video)

- **Extension**: .flv
- **Features**:
  - Developed for Adobe Flash.
  - High compression with decent quality.
  - Declining usage due to Flash deprecation.
- **Applications**:

- Web streaming, legacy Flash content.

g. WebM

- **Extension**: .webm
- **Features**:
  - Open-source format developed for the web.
  - Uses VP8/VP9 video codec and Opus/Vorbis audio codec.
  - High compression with good quality.
- **Applications**:
  - Web streaming, HTML5 video.

h. MPEG (Moving Picture Experts Group)

- **Extensions**: .mpeg, .mpg
- **Features**:
  - Developed for DVDs and digital television.
  - Uses MPEG-1 or MPEG-2 compression.
- **Applications**:
  - DVDs, digital broadcasting.

i. 3GP (3GPP)

- **Extension**: .3gp
- **Features**:
  - Designed for mobile devices.
  - Uses H.263 or MPEG-4 video codec.
  - Small file size, low quality.
- **Applications**:

- Mobile video recording and playback.

j. HEVC (High Efficiency Video Coding) / H.265

- **Extension**: .hevc, .mp4
- **Features**:
  - Successor to H.264, offering better compression and quality.
  - Supports 4K and 8K video.
- **Applications**:
  - High-resolution video, streaming.

2. Key Components of Video File Formats

a. Codec (Coder-Decoder)

- **Description**:
  - Software or hardware that compresses (encodes) and decompresses (decodes) video and audio data.
- **Common Video Codecs**:
  - H.264, H.265 (HEVC), VP9, AV1.
- **Common Audio Codecs**:
  - AAC, MP3, Opus.

b. Container

- **Description**:
  - A file format that stores video, audio, and metadata.

- **Examples**:
    - MP4, MKV, AVI.

c. Bitrate

- **Description**:
    - The amount of data processed per second (measured in Mbps or Kbps).
- **Impact**:
    - Higher bitrate = better quality = larger file size.

d. Resolution

- **Description**:
    - The number of pixels in each dimension (e.g., 1920x1080 for Full HD).
- **Impact**:
    - Higher resolution = better quality = larger file size.

e. Frame Rate

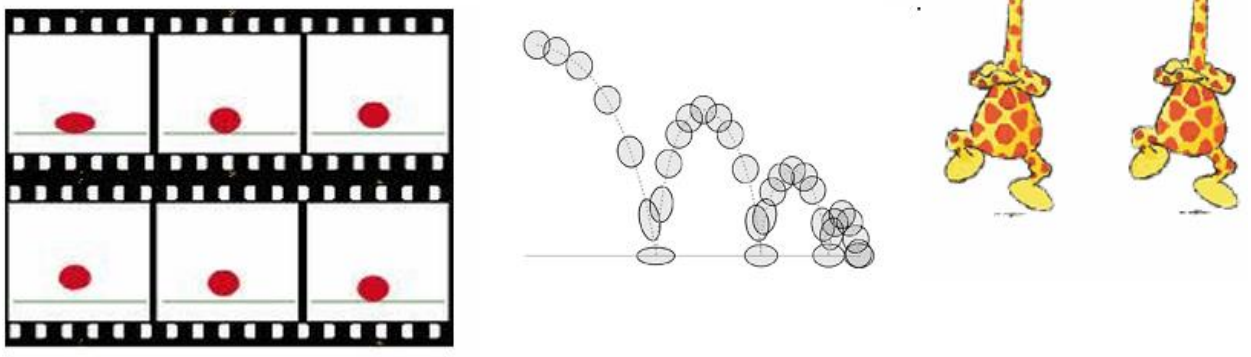
- **Description**:
    - The number of frames displayed per second (e.g., 24fps, 30fps, 60fps).
- **Impact**:
    - Higher frame rate = smoother motion = larger file size.

Homework :

1. Identify the formats of three video files on your device. Analyze their containers and codecs.
2. Convert a video file into two different formats (e.g., MP4 to MKV) and compare the differences in size and quality.
3. Research AV1 and summarize its key advantages for modern video streaming.

Introduction to Animation File Formats

Definition: Animation file formats are specialized digital formats designed to store sequences of images, audio, and sometimes metadata, enabling the playback of animated content. Animation is defined as the act of making something come alive. Animation is an object moving across or into or out of the screen. When you rapidly flipped the pages, it appeared as if the still images were actually moving. This is a kind of optical illusion of sorts, and it's a good example of the phi phenomenon, a psychological term that describes the optical illusion of seeing a series of still images as moving.



Importance of Animation File Formats:

- Compatibility with software, platforms, and devices.
- Efficient storage of animated sequences.
- Optimization of quality, size, and playback speed.

Key Components of Animation Files:

- **Frames:** Individual images in the animation sequence.
- **Frame Rate:** Number of frames displayed per second (fps).
- **Metadata:** Additional information like frame timing, audio sync, and compression details.

2. Types of Animation File Formats

a. Raster-Based Animation Formats

- Store animations as a series of raster (pixel-based) images.
    - **GIF (Graphics Interchange Format):**
        - Supports short, looping animations.
        - Limited to 256 colors.
        - Commonly used for web and social media.
    - **APNG (Animated PNG):**
        - High-quality alternative to GIF.
        - Supports full-color range and transparency.

b. Vector-Based Animation Formats

- Use mathematical equations to define shapes and movements, ensuring scalability.
    - **SWF (Shockwave Flash):**
        - Legacy format for web animations.
        - Requires Adobe Flash Player (now deprecated).
    - **SVG (Scalable Vector Graphics) with Animation:**
        - Open standard, supports lightweight vector animations.

c. 3D Animation Formats

- Store 3D models, textures, and animations.
    - **FBX (Filmbox):**
        - Widely used for 3D animation and game development.
        - Supports complex animations and rigging.
    - **GLTF (GL Transmission Format):**
        - Optimized for 3D web and AR/VR applications.
    - **OBJ with MDD (Motion Design Data):**
        - Combines 3D models (OBJ) with animation data (MDD).

d. Specialized Formats for Software

- **FLA:**
    - Used in Adobe Animate for creating vector animations.
    - Editable but requires export to formats like SWF or MP4.
- **ANME:**
    - Format for Moho (Anime Studio), used for 2D animation.

3. Key Concepts in Animation

Frame Rate: Determines the smoothness of animation.

Resolution: Number of pixels in each frame. Higher resolutions yield sharper images but require more storage.

Compression: Reduces file size by eliminating redundant data.

- **Lossy Compression:** Reduces quality to save space (e.g., GIF).
- **Lossless Compression:** Retains full quality (e.g., APNG).

4. Popular Animation File Formats and Their Use Cases

GIF:

- **Features:**
  - Looping capability.
  - Limited to 256 colors.
- **Use Case:** Web memes, short animations, banners.

APNG:

- **Features:**
  - Supports full-color and alpha transparency.
  - Higher quality than GIF.
- **Use Case:** Web animations, high-quality banners.

SWF:

- **Features:**
  - Used for interactive and vector-based animations.
  - Obsolete due to Flash Player deprecation.
- **Use Case:** Legacy projects, older websites.

FBX:

- **Features:**
  - Supports rigging, textures, and animations.
  - Compatible with most 3D software.
- **Use Case:** Game development, 3D rendering.

GLTF:

- **Features:**
  - Lightweight, supports real-time rendering.
  - Open-source and optimized for web.
- **Use Case:** AR/VR applications, web-based 3D models.

Interactive Animations:

- **HTML5 Canvas and SVG:**
  - Support for interactive animations on web browsers.
  - Examples: Web banners, interactive infographics.

Metadata in Animation Files: Stores information such as:

  - Frame timing and duration.
  - Audio synchronization.
  - Author and copyright details.

An ***animation file header*** is a structured block of metadata located at the beginning of an animation file. It stores essential information about the animation, such as its format, frame rate, resolution, color depth, duration, and compression method. This metadata helps playback software interpret and render the animation correctly.

Key Functions of an Animation File Header

1. **Format Identification:** Specifies the animation file type (e.g., GIF, SWF, APNG).
2. **Frame Properties:** Includes information about the number of frames, frame rate, and playback duration.
3. **Color Information:** Defines the color palette, bit depth, and transparency properties.
4. **Resolution Details:** Stores the width and height of the animation canvas.
5. **Compression Information:** Indicates the method used for compression, if any.

Example: GIF File Header

```
47 49 46 38 39 61
```

Breakdown

- `47 49 46` : ASCII characters "GIF" (indicating GIF format).
- `38 39 61` : Version identifier (`89a` for the GIF89a standard).

APNG File Header (Extension of PNG)

```mathematica
89 50 4E 47 0D 0A 1A 0A
```

Breakdown

- `89 50 4E 47` : PNG signature bytes.
- Additional animation-specific chunks (`acTL` , `fcTL`) for frame control in APNG.

Homework :

1. Create a short animation using a tool of your choice and export it in at least two different formats (e.g., GIF and MP4).
2. Research GLTF and USDZ and summarize their applications in modern animation.
3. Compare a GIF and APNG file in terms of size, quality, and playback.

Graphics file formats

Graphics file formats are used to store and transmit images in digital form. They vary in terms of compression, quality, and use cases. Below is an overview of the most common **graphics file formats**, categorized into **raster** and **vector** formats, along with their key features and applications.

Raster Graphics File Formats

Raster images are composed of pixels, making them resolution-dependent. They are ideal for photographs and complex images.

1. JPEG (Joint Photographic Experts Group)

- **Extension**: .jpg, .jpeg
- **Features**:
  - Lossy compression (reduces file size but loses some quality).
  - Supports 24-bit color (16.7 million colors).
  - Small file size, suitable for web use.
- **Applications**:
  - Photographs, web images, digital cameras.

2. PNG (Portable Network Graphics)

- **Extension**: .png
- **Features**:
  - Lossless compression (no quality loss).
  - Supports transparency (alpha channel).
  - Supports 24-bit color and grayscale.
- **Applications**:
  - Web graphics, logos, images requiring transparency.

3. GIF (Graphics Interchange Format)

- **Extension**: .gif
- **Features**:
  - Lossless compression.
  - Supports animation.

- Limited to 256 colors (8-bit).
- **Applications**:
  - Simple animations, web graphics, low-color images.

4. BMP (Bitmap)

- **Extension**: .bmp
- **Features**:
  - Uncompressed or minimally compressed.
  - Large file size.
  - Supports 24-bit color.
- **Applications**:
  - Storing high-quality images, Windows applications.

5. TIFF (Tagged Image File Format)

- **Extension**: .tiff, .tif
- **Features**:
  - Lossless or lossy compression.
  - Supports high color depth (up to 48-bit).
  - Can store multiple layers and metadata.
- **Applications**:
  - Professional photography, printing, archiving.

6. WebP

- **Extension**: .webp
- **Features**:
  - Lossless and lossy compression.
  - Smaller file size than JPEG and PNG.
  - Supports transparency and animation.
- **Applications**:
  - Web images, modern browsers.

Vector Graphics File Formats

Vector images are composed of paths, shapes, and curves, making them resolution-independent. They are ideal for logos, icons, and illustrations.

1. SVG (Scalable Vector Graphics)

- **Extension**: .svg
- **Features**:
  - XML-based format.
  - Scalable without loss of quality.
  - Supports interactivity and animation.
- **Applications**:
  - Web graphics, logos, icons.

2. AI (Adobe Illustrator)

- **Extension**: .ai
- **Features**:
  - Proprietary format for Adobe Illustrator.
  - Supports layers, text, and complex vector graphics.
- **Applications**:
  - Professional graphic design, illustrations.

3. EPS (Encapsulated PostScript)

- **Extension**: .eps
- **Features**:
  - Can contain both vector and raster graphics.
  - Widely supported by graphic design software.
- **Applications**:
  - Printing, professional design.

4. PDF (Portable Document Format)

- **Extension**: .pdf
- **Features**:
  - Can contain vector graphics, raster images, and text.
  - Preserves layout and formatting.
- **Applications**:
  - Document sharing, printing, vector graphics.

5. CDR (CorelDRAW)

- **Extension**: .cdr

- **Features**:
  - Proprietary format for CorelDRAW.
  - Supports vector graphics, text, and effects.
- **Applications**:
  - Professional graphic design.

Comparison of Raster and Vector Formats

Feature	Raster Formats (e.g., JPEG, PNG)	Vector Formats (e.g., SVG, AI)
Composition	Pixels	Paths, shapes, curves
Resolution	Resolution-dependent	Resolution-independent
Scalability	Loses quality when scaled up	No quality loss when scaled
File Size	Larger (depends on resolution)	Smaller
Best Use Cases	Photographs, complex images	Logos, icons, illustrations

Choosing the Right Format

1. **Photographs**:
   - Use **JPEG** for small file sizes.
   - Use **TIFF** or **PNG** for high quality.
2. **Web Graphics**:
   - Use **JPEG** for photographs.
   - Use **PNG** for images with transparency.
   - Use **SVG** for logos and icons.
3. **Printing**:
   - Use **TIFF** or **PDF** for high-quality prints.
   - Use **EPS** for vector-based designs.
4. **Animations**:
   - Use **GIF** for simple animations.

- Use **WebP** for modern, high-quality animations.

5. **Professional Design**:
   - Use **AI** or **CDR** for vector graphics.
   - Use **PSD** (Photoshop) for raster graphics.

Tools for Working with Graphics Formats

1. **Raster Graphics Editors**:
   - Adobe Photoshop, GIMP, Paint.NET.
2. **Vector Graphics Editors**:
   - Adobe Illustrator, CorelDRAW, Inkscape.
3. **Viewers and Converters**:
   - IrfanView, XnView, online tools like CloudConvert.

Chapter Eight Interactive multi media

Interactive multimedia file formats

Interactive multimedia file formats are designed to combine various types of media (text, audio, video, images, animations) with interactivity, allowing users to engage with the content. These formats are widely used in applications like **e-learning**, **gaming**, **presentations**, and **web applications**. Below is an overview of the most common **interactive multimedia file formats**, their features, and use cases.

Common Interactive Multimedia File Formats

1. Adobe Flash (SWF)

- **Extension**: .swf
- **Features**:
  - Supports animations, audio, video, and interactivity.
  - Uses ActionScript for programming interactivity.
  - Widely used in the past for web games and animations.
- **Applications**:
  - Web-based games, interactive ads, e-learning modules.
- **Note**: Adobe Flash is now deprecated and no longer supported by most browsers.

2. HTML5 (Canvas, WebGL, Video, Audio)

- **Extensions**: .html, .js
- **Features**:

- Combines HTML, CSS, and JavaScript for interactivity.
- Supports audio, video, animations, and 2D/3D graphics.
- Works natively in modern web browsers.

- **Applications**:
  - Interactive websites, web games, multimedia presentations.

3. PDF (Portable Document Format)

- **Extension**: .pdf
- **Features**:
  - Supports embedded multimedia (audio, video, animations).
  - Can include interactive elements like forms, buttons, and hyperlinks.
- **Applications**:
  - Interactive documents, e-books, forms.

4. Microsoft PowerPoint (PPTX)

- **Extension**: .pptx
- **Features**:
  - Supports animations, audio, video, and hyperlinks.
  - Allows interactive presentations with clickable elements.
- **Applications**:
  - Interactive presentations, e-learning modules.

5. Unity (WebGL, EXE, etc.)

- **Extensions**: .unity, .webgl, .exe
- **Features**:
  - A game engine that supports 2D/3D graphics, audio, and interactivity.
  - Exports to multiple platforms (web, desktop, mobile).
- **Applications**:
  - Interactive games, simulations, virtual reality.

6. SCORM (Sharable Content Object Reference Model)

- **Extensions**: .zip, .xml
- **Features**:
  - A standard for e-learning content.
  - Combines multimedia (text, audio, video) with interactivity and tracking.

- **Applications**:
    - E-learning courses, training modules.

7. MPEG-4 (Interactive Multimedia)

- **Extension**: .mp4
- **Features**:
    - Supports interactive video with clickable elements.
    - Combines audio, video, and graphics.
- **Applications**:
    - Interactive videos, advertisements.

8. Java Applets (Deprecated)

- **Extension**: .jar
- **Features**:
    - Allows interactive applications to run in web browsers.
    - Uses Java programming language.
- **Applications**:
    - Web-based games, interactive tools.
- **Note**: Java applets are deprecated and no longer supported.

9. Director (Shockwave)

- **Extension**: .dir, .dcr
- **Features**:
    - Supports animations, audio, video, and interactivity.
    - Uses Lingo scripting language.
- **Applications**:
    - Interactive multimedia projects, e-learning.
- **Note**: Adobe Director is no longer actively developed.

10. EXE (Executable Files)

- **Extension**: .exe
- **Features**:
    - Standalone interactive applications.
    - Combines multimedia and interactivity.
- **Applications**:
    - Interactive kiosks, desktop applications.

Key Features of Interactive Multimedia Formats

1. **Interactivity**:
    - Allows users to interact with the content (e.g., clickable buttons, forms, games).
2. **Multimedia Support**:
    - Combines text, audio, video, images, and animations.
3. **Cross-Platform Compatibility**:
    - Works on multiple devices and operating systems (e.g., web, desktop, mobile).
4. **Scalability**:
    - Can be used for small projects (e.g., interactive ads) or large projects (e.g., e-learning courses).
5. **Tracking and Analytics**:
    - Some formats (e.g., SCORM) support tracking user interactions and progress.

Applications of Interactive Multimedia Formats

1. **E-Learning**:
    - Interactive courses, quizzes, and simulations (e.g., SCORM, HTML5).
2. **Gaming**:
    - Web-based and desktop games (e.g., Unity, HTML5).
3. **Advertising**:
    - Interactive ads and banners (e.g., HTML5, MPEG-4).
4. **Presentations**:
    - Interactive slideshows (e.g., PowerPoint, PDF).
5. **Web Applications**:
    - Interactive websites and tools (e.g., HTML5, JavaScript).

6. **Virtual Reality (VR) and Augmented Reality (AR)**:
    - Immersive experiences (e.g., Unity).

Example: Creating Interactive Multimedia with HTML5

Here's a simple example of an interactive multimedia webpage using HTML5:

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Interactive Multimedia Example</title>
  <style>
    #canvas {
      border: 1px solid black;
    }
  </style>
</head>
<body>
  <h1>Interactive Multimedia Example</h1>
  <canvas id="canvas" width="400" height="300"></canvas>
  <button id="playButton">Play Audio</button>
  <video id="video" width="400" controls>
    <source src="example.mp4" type="video/mp4">
    Your browser does not support the video tag.
  </video>

  <script>
    const canvas = document.getElementById("canvas");
    const ctx = canvas.getContext("2d");

    // Draw a rectangle
    ctx.fillStyle = "blue";
```

```
    ctx.fillRect(50, 50, 100, 100);

    // Add interactivity
    canvas.addEventListener("click", (event) => {
      const x = event.offsetX;
      const y = event.offsetY;
      ctx.fillStyle = "red";
      ctx.fillRect(x, y, 50, 50);
    });

    // Play audio on button click
    const audio = new Audio("example.mp3");
    document.getElementById("playButton").addEventListener("click", () =>
 {
      audio.play();
    });
  </script>
</body>
</html>
```

Tools for Creating Interactive Multimedia

1. **Adobe Animate**:
    - For creating interactive animations and games.
2. **Unity**:
    - For developing interactive 2D/3D games and simulations.
3. **Articulate Storyline**:
    - For creating interactive e-learning courses.
4. **HTML5 Editors**:
    - Visual Studio Code, Adobe Dreamweaver.

5. **PowerPoint**:
    - For creating interactive presentations.

Chapter Nine Color in video image

Color in video and images

Color in video and images is a fundamental aspect of digital media, influencing visual quality, mood, and communication. Understanding how color is represented, processed, and displayed is essential for working with video and image data. Below is a detailed explanation of **color in video and images**, including color models, color spaces, and practical considerations.

1. Color Models

Color models are mathematical representations of colors. The most common models used in video and images are:

a. RGB (Red, Green, Blue)

- **Description**:
    - Represents colors as combinations of red, green, and blue light.
    - Additive color model: Combining all three colors at full intensity produces white.
- **Usage**:
    - Used in displays (e.g., monitors, TVs) and digital cameras.
- **Example**:
    - (255, 0, 0) represents pure red.
    - (0, 255, 0) represents pure green.
    - (0, 0, 255) represents pure blue.

b. CMYK (Cyan, Magenta, Yellow, Key/Black)

- **Description**:
  - Represents colors as combinations of cyan, magenta, yellow, and black ink.
  - Subtractive color model: Combining all four colors at full intensity produces black.
- **Usage**:
  - Used in printing.

c. HSV/HSL (Hue, Saturation, Value/Lightness)

- **Description**:
  - Represents colors in terms of hue (color type), saturation (intensity), and value/lightness (brightness).
- **Usage**:
  - Useful for color manipulation and editing.

d. YUV/YCbCr

- **Description**:
  - Separates luminance (Y) from chrominance (UV or CbCr).
  - Used in video compression and broadcasting.
- **Usage**:
  - Reduces bandwidth by storing more luminance detail than chrominance.

2. Color Spaces

A color space defines the range of colors (gamut) that can be represented. Common color spaces include:

a. sRGB

- **Description**:
  - Standard color space for web and most consumer devices.
- **Usage**:
  - Default for images and videos on the internet.

b. Adobe RGB

- **Description**:
  - Wider gamut than sRGB, suitable for professional photography and printing.
- **Usage**:
  - Used in high-end cameras and monitors.

c. DCI-P3

- **Description**:
  - Wider gamut than sRGB, used in digital cinema.
- **Usage**:
  - Common in high-end displays and HDR content.

d. Rec. 709

- **Description**:
  - Standard color space for HD television.
- **Usage**:
  - Used in HD video production.

e. Rec. 2020

- **Description**:
  - Ultra-wide gamut for UHD (4K/8K) and HDR content.
- **Usage**:
  - Used in UHD and HDR video production.

3. Color Depth

Color depth refers to the number of bits used to represent the color of a single pixel. Common color depths include:

a. 8-bit

- **Description**:
  - Represents 256 levels per channel (16.7 million colors total).
- **Usage**:
  - Standard for most images and videos.

b. 10-bit

- **Description**:

- Represents 1,024 levels per channel (1.07 billion colors total).
- **Usage**:
  - Used in professional video and HDR content.

c. 12-bit and Higher

- **Description**:
  - Represents even more color levels for high-end applications.
- **Usage**:
  - Used in advanced video production and medical imaging.

4. Color in Video

In video, color is represented frame by frame. Key considerations include:

a. Chroma Subsampling

- **Description**:
  - Reduces the resolution of chrominance (color) information while preserving luminance (brightness).
- **Common Schemes**:
  - **4:4:4**: No subsampling (full color resolution).
  - **4:2:2**: Horizontal chroma subsampling (used in professional video).
  - **4:2:0**: Horizontal and vertical chroma subsampling (used in consumer video).

b. Bitrate and Compression

- Higher bitrates and advanced codecs (e.g., H.265) preserve color quality better.

c. HDR (High Dynamic Range)

- **Description**:
  - Expands the range of colors and brightness levels.
- **Standards**:
  - HDR10, Dolby Vision, HLG (Hybrid Log-Gamma).

5. Color in Images

In images, color is represented pixel by pixel. Key considerations include:

a. Color Profiles

- **Description**:
  - Embedded metadata that defines the color space (e.g., sRGB, Adobe RGB).
- **Usage**:
  - Ensures consistent color representation across devices.

b. Gamma Correction

- **Description**:
  - Adjusts the brightness of an image to match human perception.
- **Usage**:
  - Standard gamma value is 2.2 for most displays.

c. Dithering

- **Description**:
  - Simulates colors not available in the palette by mixing available colors.
- **Usage**:
  - Used in images with limited color depth (e.g., GIF).

6. Practical Considerations

1. **Color Accuracy**:
   - Use calibrated monitors and color profiles for accurate color representation.
2. **Consistency Across Devices**:
   - Convert images and videos to a standard color space (e.g., sRGB) for web use.
3. **HDR Workflow**:
   - Use HDR-compatible tools and displays for HDR content creation.
4. **Compression Artifacts**:
   - Avoid excessive compression to prevent color banding and loss of detail.

Example: Working with Color in Python

Here's how to manipulate color in an image using the Pillow library in Python:

```
from PIL import Image

# Open an image
image = Image.open("example.jpg")

# Convert to grayscale
grayscale_image = image.convert("L")
grayscale_image.save("grayscale.jpg")

# Adjust brightness
from PIL import ImageEnhance
enhancer = ImageEnhance.Brightness(image)
bright_image = enhancer.enhance(1.5)  # Increase brightness by 50%
bright_image.save("bright.jpg")

# Convert color space (e.g., sRGB to Adobe RGB)
# Note: Pillow does not support advanced color space conversions directly.
```