



Program : **B.Tech**

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Semester: **6<sup>th</sup>**



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**Unit V Syllabus:**

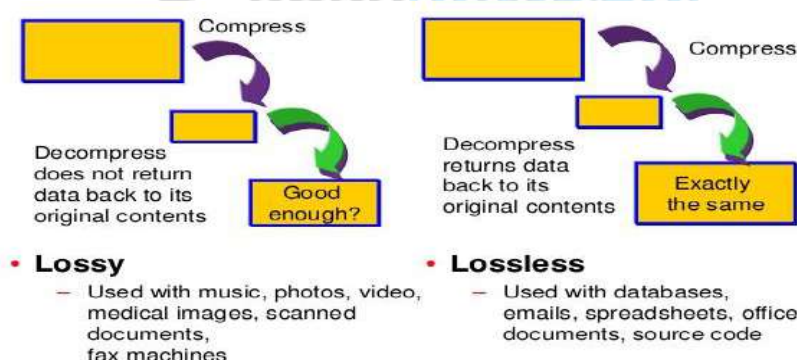
**Compression & Decompression, Multimedia Data & File Format standards, TIFF, MIDI, JPEG, DIB, MPEG, RTF, Multimedia I/O technologies, Digital voice and audio, Video image and animation, Full motion video, Storage and retrieval technologies.**

**Compression & Decompression****Compression Techniques**

There are two categories of compression techniques used with digital graphics, lossy and lossless.

Lossless and lossy compression are terms that describe whether or not, in the compression of a file, all original data can be recovered when the file is uncompressed. With lossless compression, every single bit of data that was originally in the file remains after the file is uncompressed. All of the information is completely restored. This is generally the technique of choice for text or spreadsheet files, where losing words or financial data could pose a problem. The Graphics Interchange File (GIF) is an image format used on the Web that provides lossless compression.

On the other hand, lossy compression reduces a file by permanently eliminating certain information, especially redundant information. When the file is uncompressed, only a part of the original information is still there (although the user may not notice it). Lossy compression is generally used for video and sound, where a certain amount of information loss will not be detected by most users. The JPEG image file, commonly used for photographs and other complex still images on the Web, is an image that has lossy compression. Using JPEG compression, the creator can decide how much loss to introduce and make a trade-off between file size and image quality.



**Figure 5.1: Difference between Lossless VS. Lossy Compression Technique**

**Image Compression**

Image compression is a type of data compression applied to digital images, to reduce their cost for storage or transmission. Algorithms may take advantage of visual perception and the statistical properties of image data to provide superior results compared with generic compression methods.

**Methods for lossless image compression are:**

- Run-length encoding – used in default method in PCX and as one of possible in BMP, TGA, TIFF
- Area image compression
- DPCM and Predictive Coding
- Entropy encoding
- Adaptive dictionary algorithms such as LZW – used in GIF and TIFF
- Deflation – used in PNG, MNG, and TIFF
- Chain codes

**Methods for lossy compression:**

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- Reducing the color space to the most common colors in the image. The selected colors are specified in the color palette in the header of the compressed image. Each pixel just references the index of a color in the colour palette; this method can be combined with dithering to avoid posterization.
- Chroma subsampling. This takes advantage of the fact that the human eye perceives spatial changes of brightness more sharply than those of color, by averaging or dropping some of the chrominance information in the image.
- Transform coding. This is the most commonly used method. In particular, a Fourier-related transform such as the Discrete Cosine Transform (DCT) is widely used: N. Ahmed, T. Natarajan and K.R. Rao, "Discrete Cosine Transform," IEEE Trans. Computers, 90-93, Jan. 1974. The DCT is sometimes referred to as "DCT-II" in the context of a family of discrete cosine transforms; e.g., see discrete cosine transform. The more recently developed wavelet transform is also used extensively, followed by quantization and entropy coding.
- Fractal compression.



**Figure 5.2: Lossless VS. Lossy Compression**

Decompression is the process of restoring compressed data to its original form. Data decompression is required in almost all cases of compressed data, including lossy and lossless compression. Similar to compression of data, decompression of data is also based on different algorithms. Decompression is considered important, as compressed data needs to be restored back to standard state for usage. Decompression is widely used in data communications, multimedia, audio, video and file transmissions.

## Multimedia Data & File Format standards

### Text File Formats

#### ASCII

The ASCII standard allows ASCII-only text files (unlike most other file types) to be freely interchanged and readable on Unix, Macintosh, Microsoft Windows, DOS, and other systems. These differ in their preferred line ending convention and their interpretation of values outside the ASCII range (their character encoding).

#### UTF-8

In English context text files can be uniquely ASCII, when in some files are usually 8 bits permissive allowing storage of native texts. In that international context, a Byte Order Mark can appear in start of file to differentiate UTF-8 encoding from legacy regional encoding.

#### MIME

Text files usually have the MIME type "text/plain", usually with additional information indicating an encoding. Prior to the advent of Mac OS X, the Mac OS system regarded the content of a file (the data fork) to be a text file when its resource fork indicated that the type of the file was "TEXT". Under the Microsoft Windows operating system, a file is regarded as a text file if the suffix of the name of the file (the "extension") is ".txt". However, many other suffixes are used for text files with specific purposes. For example, source code for computer programs is usually kept in text files that have file name suffixes indicating the programming language in which the source is written.

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**.TXT** is a file format for files consisting of text usually containing very little formatting (e.g., no bolding or italics). The precise definition of the .txt format is not specified, but typically matches the format accepted by the system terminal or simple text editor. Files with the .txt extension can easily be read or opened by any program that reads text and, for that reason, are considered universal (or platform independent).

The ASCII character set is the most common format for English-language text files, and is generally assumed to be the default file format in many situations. For accented and other non-ASCII characters, it is necessary to choose a character encoding. In many systems, this is chosen on the basis of the default locale setting on the computer it is read on. Common character encodings include ISO 8859-1 for many European languages.

Because many encodings have only a limited repertoire of characters, they are often only usable to represent text in a limited subset of human languages.

Unicode is an attempt to create a common standard for representing all known languages, and most known character sets are subsets of the very large Unicode character set. Although there are multiple character encodings available for Unicode, the most common is UTF-8, which has the advantage of being, backwards-compatible with ASCII: that is, every ASCII text file is also a UTF-8 text file with identical meaning.

**Unicode** is a computing industry standard for the consistent encoding, representation and handling of text expressed in most of the world's writing systems. Developed in conjunction with the Universal Character Set standard and published in book form as The Unicode Standard, the latest version of Unicode contains a repertoire of more than 110,000 characters covering 100 scripts. The standard consists of a set of code charts for visual reference, an encoding method and set of standard character encodings, a set of reference data computer files, and a number of related items, such as character properties, rules for normalization, decomposition, collation, rendering, and bidirectional display order (for the correct display of text containing both right-to-left scripts, such as Arabic and Hebrew, and left-to-right scripts). As of September 2013, the most recent version is Unicode 6.3. The standard is maintained by the Unicode Consortium.

Unicode can be implemented by different character encodings. The most commonly used encodings are UTF-8, UTF-16 and the now-obsolete UCS-2. UTF-8 uses one byte for any ASCII characters, which have the same code values in both UTF-8 and ASCII encoding, and up to four bytes for other characters. UCS-2 uses a 16-bit code unit (two 8-bit bytes) for each character but cannot encode every character in the current Unicode standard. UTF-16 extends UCS-2, using two 16-bit units (4 × 8 bit) to handle each of the additional characters.

### Unicode Transformation Format and Universal Character Set

Unicode defines two mapping methods: the Unicode Transformation Format (UTF) encodings, and the Universal Character Set (UCS) encodings. An encoding maps (possibly a subset of) the range of Unicode code points to sequences of values in some fixed-size range, termed code values. The numbers in the names of the encodings indicate the number of bits in one code value (for UTF encodings) or the number of bytes per code value (for UCS) encodings. UTF-8 and UTF-16 are probably the most commonly used encodings. UCS-2 is an obsolete subset of UTF-16; UCS-4 and UTF-32 are functionally equivalent.

UTF encodings include:

1. UTF-1 – a retired predecessor of UTF-8, maximizes compatibility with ISO 2022, no longer part of The Unicode Standard
2. UTF-7 – a 7-bit encoding sometimes used in e-mail, often considered obsolete (not part of The Unicode Standard, but only documented as an informational RFC, i.e. not on the Internet Standards Track either)
3. UTF-8 – an 8-bit variable-width encoding which maximizes compatibility with ASCII.

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4. UTF-EBCDIC – an 8-bit variable-width encoding similar to UTF-8, but designed for compatibility with EBCDIC. (Not part of The Unicode Standard)
5. UTF-16 – a 16-bit, variable-width encoding
6. UTF-32 – a 32-bit, fixed-width encoding
7. There are basically four ways to encode Unicode characters in bytes:

#### UTF-8

128 characters are encoded using 1 byte (the ASCII characters). 1920 characters are encoded using 2 bytes (Roman, Greek, Cyrillic, Coptic, Armenian, Hebrew, Arabic characters). 63488 characters are encoded using 3 bytes (Chinese and Japanese among others). The other 2147418112 characters (not assigned yet) can be encoded using 4, 5 or 6 characters. For more info about UTF-8, do 'man 7 utf-8' (manpage contained in the man-pages-1.20 package).

#### UCS-2

Every character is represented as two bytes. This encoding can only represent the first 65536 Unicode characters.

#### UTF-16

This is an extension of UCS-2 which can represent 1112064 Unicode characters. The first 65536 Unicode characters are represented as two bytes, the other ones as four bytes.

#### UCS-4

Every character is represented as four bytes. The space requirements for encoding a text, compared to encodings currently in use (8 bit per character for European languages, more for Chinese / Japanese / Korean), is as follows. This has an influence on disk storage space and network download speed (when no form of compression is used).

#### UTF-8

No change for US ASCII, just a few percent more for ISO-8859-1, 50% more for Chinese / Japanese / Korean, 100% more for Greek and Cyrillic.

Text Files Format	Description / Properties	Usage and Archival Recommendations
<b>.txt</b>	Text file Simple plain text document Compatible across software packages Supports very little formatting	Good for extremely simple files Commonly used for introductory “Read me” files containing basic information on project archives
<b>.doc</b>	Microsoft Word document (- 2003) Proprietary binary format Can be read by OpenOffice Easily converted into PDF format	Accepted for archiving because it is so widely used However, will become obsolete
<b>.docx</b>	Microsoft Word document (2007 ) Human readable XML format Stored along with embedded content as zipped file	Good for dissemination and preservation Conversion to .doc file to open with earlier versions of MS Word
<b>.rtf</b>	Rich Text Format (Microsoft) Tagged plain text format	Formatting issues when using opened in different software Large file sizes mean that .docx or. odt file

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		formats are preferred
<b>.odt</b>	Open Document Text (OpenOffice) ISO standard, human readable XML format	Open source format good for use, dissemination and archiving Archive files in uncompressed form Can open .doc files Might not open correctly in other word processing programs
<b>.pdf</b>	Portable Document Format (Adobe) Proprietary binary format Aims to retain document formatting Can store embedded data: raster and vector images (e.g. Adobe Illustrator files)	Highly suitable for dissemination PDF creators and readers freely and widely available Retain original text document and embedded objects (e.g. images, tabular data, etc)
<b>PDF/A</b>	Portable Document Format / Archive (Adobe) Open ISO standard format for long-term archiving Formatting data self-contained in file	Widely accepted as viable format for long-term archiving Retain original text file and embedded objects separately (e.g. images, tabular data, etc)

**RTF**

An RTF file is a common text file format that supports "rich text." It includes several types of text formatting, such as bold type, italics, different fonts and font sizes, and custom tab settings. RTF files also support objects and images, such as .JPG and .PNG files, saved within the text file.

RTF files are usually 7-bit ASCII plain text. RTF consists of control words, control symbols, and groups. RTF files can be easily transmitted between PC based operating systems because they are encoded as a text file with 7-bit graphic ASCII characters. Converters that communicate with Microsoft Word for MS Windows or Macintosh should expect data transfer as 8-bit characters and binary data can contain any 8-bit values.

**Image File Format****TIFF**

Tagged Image File Format (TIFF) is a variable-resolution bitmapped image format developed by Aldus (now part of Adobe) in 1986. TIFF is very common for transporting color or gray-scale images into page layout applications, but is less suited to delivering web content.

following about TIFF:

- TIFF files are large and of very high quality. Baseline TIFF images are highly portable; most graphics, desktop publishing, and word processing applications understand them.
- The TIFF specification is readily extensible, though this comes at the price of some of its portability. Many applications incorporate their own extensions, but a number of application-independent extensions are recognized by most programs.
- Four types of baseline TIFF images are available: bilevel (black and white), gray scale, palette (i.e., indexed), and RGB (i.e., true color). RGB images may store up to 16.7 million colors. Palette and gray-scale images are limited to 256 colors or shades. A common extension of TIFF also allows for CMYK images.



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- TIFF files may or may not be compressed. A number of methods may be used to compress TIFF files, including the Huffman and LZW algorithms. Even compressed, TIFF files are usually much larger than similar GIF or JPEG files.
- Because the files are so large and because there are so many possible variations of each TIFF file type, few web browsers can display them without plug-ins.

### JPEG

JPEG is a standardized image compression mechanism. JPEG stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard. JPEG compresses either full-color or grayscale images, and works best with photographs and artwork. For geometric line drawings, lettering, cartoons, computer screenshots, and other images with flat color and sharp borders, the PNG and GIF image formats are usually preferable.

JPEG uses a lossy compression method, meaning that the decompressed image isn't quite the same as the original. (There are lossless image compression algorithms, but JPEG achieves much greater compression than is possible with lossless methods.) This method fools the eye by using the fact that people perceive small changes in color less accurately than small changes in brightness.

JPEG was developed for two reasons: it makes image files smaller and it stores 24-bit per pixel color data (full color) instead of 8-bit per pixel data. Making image files smaller is important for storing and transmitting files. Being able to compress a 2MB full-color file down to, for example, 100KB makes a big difference in disk space and transmission time. JPEG can easily provide 20:1 compression of full-color data. (With GIF images, the size ratio is usually more like 4:1.) The file name for a JPEG image is .jpg or .jpeg. There is actually no difference between JPG and JPEG, except for the number of characters used.

JPEG is the most commonly used format for photographs. It is specifically good for color photographs or for images with many blends or gradients. However, it is not the best with sharp edges and might lead to a little blurring. This is mainly because JPEG is a method of lossy compression for digital photography. An advantage to using the JPEG format is that due to compression, a JPEG image will take up a few MB of data. This means that while saving the image in a JPEG format, there is a slight loss of quality due to compression. Hence, JPEG is not the greatest format in case one needs to keep making numerous edits and re-saves to the image.

The JPEG is quite popular for web hosting of images, for amateur and average photographers, digital cameras, etc. This is mainly due to the fact that high quality images can be saved using less space. JPEG is one of the most common image formats proposed by the Joint Photographic Experts Group to save and store digital images. Almost all high-definition digital cameras including modern-day Smartphone cameras use JPEG file extension to store image files.

### DIB

DIB is a graphics file format used by Windows. DIB stands for "Device-Independent Bitmap." DIB files are bitmapped graphics that represent color formats. Similar to .BMP format, except they have a different header. DIB files can be opened and edited in most image editing programs.

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A device-independent bitmap (DIB) contains a color table. A color table describes how pixel values correspond to RGB color values, which describe colors that are produced by emitting light. Thus, a DIB can achieve the proper color scheme on any device. A DIB contains the following color and dimension information:

- The color format of the device on which the rectangular image was created.
- The resolution of the device on which the rectangular image was created.
- The palette for the device on which the image was created.
- An array of bits that maps red, green, blue ( RGB ) triplets to pixels in the rectangular image.
- A data-compression identifier that indicates the data compression scheme (if any) used to reduce the size of the array of bits.

### Audio file formats

Audio files come in all types and sizes. We are familiar with MP3, but what about AAC, FLAC, OGG, or WMA? Why do so many standards exist? Which ones should you care about and which ones can you ignore?

It's actually quite simple once you realize that all audio formats fall into three major categories. Once you know which category you want, all you have to do is pick the format within that category that best suits your needs.

File extension	Format	Codec	Note
.mp3	MPEG	MPEG1 Audio Layer 3	
.m4a .mpa .aac	MPEG 4	AAC	
.flac	FLAC	FLAC	Supports up to 2 channels
.ogg	OGG	Vorbis	Supports up to 2 channels
.wma	WMA	WMA	Supports up to 10 Pro 5.1 channels. WMA lossless audio is not supported. Supports up to the M2 profile.
.wav	Wav	wav	
.mid .midi	Midi	midi	Supports type 0 and type 1. Seek is not supported. Supports USB device only.
.ape	Ape	ape	
.aif .aiff	AIFF	AIFF	
.m4a	ALAC	ALAC	

### Uncompressed Audio Formats

Uncompressed audio is exactly what it sounds like: real sound waves that have been captured and converted to digital format without any further processing. As a result, uncompressed audio files tend to be the most accurate but take up a LOT of disk space — about 34 MB per minute for 24-bit 96 KHz stereo.

### PCM

PCM stands for Pulse-Code Modulation, a digital representation of raw analog audio signals. Analog sounds exist as waveforms, and in order to convert a waveform into digital bits, the sound must be sampled and recorded at certain intervals (or pulses).



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As such, this digital audio format has a “sampling rate” (how often a sample is made) and a “bit depth” (how many bits are used to represent each sample). There is no compression involved. The digital recording is a close-to-exact representation of the analog sound.

PCM is the most common audio format used in CDs and DVDs. There is a subtype of PCM called Linear Pulse-Code Modulation, where samples are taken at linear intervals. LPCM is the most common form of PCM, which is why the two terms are almost interchangeable at this point.

#### WAV

WAV stands for Waveform Audio File Format (also called Audio for Windows at some point but not anymore). It's a standard that was developed by Microsoft and IBM back in 1991.

A lot of people assume that all WAV files are uncompressed audio files, but that's not exactly true. WAV is actually just a Windows container for audio formats. This means that a WAV file can contain compressed audio, but it's rarely used for that.

Most WAV files contain uncompressed audio in PCM format. The WAV file is just a wrapper for the PCM encoding, making it more suitable for use on Windows systems. However, Mac systems can usually open WAV files without any issues.

#### AIFF

AIFF stands for Audio Interchange File Format. Similar to how Microsoft and IBM developed WAV for Windows, AIFF is a format that was developed by Apple for Mac systems back in 1988.

Also similar to WAV files, AIFF files can contain multiple kinds of audio. For example, there is a compressed version called AIFF-C and another version called Apple Loops which is used by GarageBand and Logic Audio — and they all use the same AIFF extension.

Most AIFF files contain uncompressed audio in PCM format. The AIFF file is just a wrapper for the PCM encoding, making it more suitable for use on Mac systems. However, Windows systems can usually open AIFF files without any issues.

#### Lossy Compressed Audio Formats

Lossy compression is a form of compression that loses data during the compression process. In the context of audio, that means sacrificing quality and fidelity for file size. The good news is that, in most cases, you won't be able to hear the difference. However, if the audio gets compressed too much or too often, you'll start hearing artifacts and other weirdness's that become more and more noticeable.

#### MP3

MP3 stands for MPEG-1 Audio Layer 3. It was released back in 1993 and quickly exploded in popularity, eventually becoming the most popular audio format in the world for music files. There's a reason why we have “MP3 players” but not “OGG players”...

The main pursuit of MP3 is to cut out all of the sound data that exists beyond the hearing range of most normal people and to reduce the quality of sounds that aren't as easy to hear, and then to compress all other audio data as efficiently as possible.

Nearly every digital device in the world with audio playback can read and play MP3 files, whether we're talking about PCs, Macs, Androids, iPhones, Smart TVs, or whatever else. When you need universal, MP3 will never let you down.

#### AAC

AAC stands for Advanced Audio Coding. It was developed in 1997 as the successor to MP3, and while it did catch on as a popular format to use, it never really overtook MP3 as the most popular for everyday music and recording. The compression algorithm used by AAC is much more advanced and technical than MP3, so when

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you compare a particular recording in MP3 and AAC formats at the same bitrate, the AAC one will generally have better sound quality.

Again, even though MP3 is more of a household format, AAC is widely used today. In fact, it's the standard audio compression method used by YouTube, Android, iOS, iTunes, later Nintendo portables, and later PlayStations.

### OGG (Vorbis)

OGG doesn't stand for anything. Actually, it's not even a compression format. OGG is a multimedia container that can hold all kinds of compression formats, but is most commonly used to hold Vorbis files — hence why these audio files are called Ogg Vorbis files.

Vorbis was first released in 2000 and grew in popularity due to two reasons: first, it adheres to the principles of open source software, and second, it performs significantly better than most other lossy compression formats (i.e. produces a smaller file size for equivalent audio quality).

MP3 and AAC have such strong footholds that OGG has had a hard time breaking into the spotlight — not many devices support it natively— but it's getting better with time. For now, it's mostly used by hardcore proponents of open software.

### WMA

WMA stands for Windows Media Audio. It was first released in 1999 and has gone through several evolutions since then, all while keeping the same WMA name and extension. As you might expect, it's a proprietary format created by Microsoft.

Not unlike AAC and OGG, WMA was meant to address some of the flaws in the MP3 compression method — and as such, WMA's approach to compression is pretty similar to AAC and OGG. In other words, in terms of objective quality, WMA is better than MP3.

But since WMA is proprietary, not many devices and platforms support it. It also doesn't offer any real benefits over AAC or OGG, so in most cases when MP3 isn't good enough, it's simply more practical to go with one of those two instead.

### Lossless Compressed Audio Formats

On the other side of the coin is lossless compression, which is a method that reduces file size without any loss in quality between the original source file and the resulting file. The downside is that lossless compression isn't as efficient as lossy compression, meaning equivalent files can be 2x to 5x larger.

This is obviously much harder to do well, but there are a few good formats for this. And don't confuse lossless compression with high-resolution audio (which is most likely a scam anyway).

### FLAC

FLAC stands for Free Lossless Audio Codec. A bit on the nose maybe, but it has quickly become one of the most popular lossless formats available since its introduction in 2001.

What's nice is that FLAC can compress an original source file by up to 60% without losing a single bit of data. What's even nicer is that FLAC is an open source and royalty-free format rather than a proprietary one, so it doesn't impose any intellectual property constraints.

FLAC is supported by most major programs and devices and is the main alternative to MP3 for CD audio. With it, you basically get the full quality of raw uncompressed audio in half the file size.

### ALAC

ALAC stands for Apple Lossless Audio Codec. It was developed and launched in 2004 as a proprietary format but eventually became open source and royalty-free in 2011. ALAC is sometimes referred to as Apple Lossless.

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While ALAC is good, it's slightly less efficient than FLAC when it comes to compression. However, Apple users don't really have a choice between the two because iTunes and iOS both provide native support for ALAC and no support at all for FLAC.

### WMA

WMA stands for Windows Media Audio. We covered it above in the lossy compression section, but we mention it here because there's a lossless alternative called WMA Lossless that uses the same extension. Confusing, I know.

Compared to FLAC and ALAC, WMA Lossless is the worst in terms of compression efficiency but only slightly. It's a proprietary format so it's no good for fans of open source software, but it is supported natively on both Windows and Mac systems.

The biggest issue with WMA Lossless is the limited hardware support. If you want lossless audio across multiple devices, you should stick with FLAC unless all of your devices are of the Windows variety.

### So Which Format Should You Use?

For most people, the decision is actually pretty easy:

If you're capturing and editing raw audio, use an uncompressed format. This way you're working with the truest quality of audio possible. When you're done, you can export to a compressed format.

If you're listening to music and want faithful audio representation, use lossless audio compression. This is why audiophiles always scramble for FLAC albums over MP3 albums. Note that you'll need more storage space for these.

If you're okay with "good enough" music quality, if your audio file doesn't have any music, or if you need to conserve disk space, use lossy audio compression. Most people actually can't hear the difference between lossy and lossless compression.

For those who want utmost quality in their music playback, note that high-quality audio files won't matter if your playback device can't faithfully recreate those sounds. Meaning, you need to have good quality speakers or good quality headphones.

Video and Audio Files Format	Notes
<b>.wav</b>	Waveform Audio (Microsoft) Uncompressed file Recommended for long term preservation
<b>.aif</b>	Audio Interchange File (Apple) Uncompressed file Recommended for long term preservation
<b>.mp3</b>	MPEG1, 2 Audio Layer 3 (Moving Picture Expert Group: Audio group) Patented ISO standard compressed format
<b>.rm / .ram</b>	Real Audio file format used for streaming radio over the internet
<b>.wma</b>	Windows Media Audio Compressed file used by Windows
<b>.ogg</b>	Open standard format for compressed audio files
<b>.avi</b>	Audio Video Interleave (Microsoft)
<b>.wmv</b>	Windows Media Video (Microsoft) Proprietary compression format for hard media delivery (DVD, Blu-Ray)
<b>.mov</b>	QuickTime File Format (Apple)

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<b>.mp4</b>	MPEG4 – Digital Video File Format ISO standard Recommended by DSpace for long term storage
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## MIDI

MIDI, or Musical Instrument Digital Interface, is a standard protocol for the interchange of musical information between musical instruments, synthesizers, keyboard controllers, sound cards, computers and all other electronic instruments from all manufacturers. In other words, a MIDI file (with file extension '.mid' or '.midi') translates music – like what notes are to be played, when they are to be played, how long each note is to be held, with what loudness, pitch and so on – and then reproduces it on another instrument, much like a human reading a music sheet.

A MIDI file is very small, often as small as 10 KB for a 1-minute playback (a .wav file of the same duration requires 5 to 10 MB of disk space). This is because it doesn't contain audio waves like audio file formats do, but instructions on how to recreate the music. Another advantage of the file containing instructions is that it is quite easy to change the performance by changing, adding or removing one or more of the instructions – like note, pitch, tempo, and so on – thus creating a completely new performance. This is the main reason for the file to be extremely popular in creating, learning, and playing music.

MIDI actually consists of three distinctly different parts – the physical connector, the message format, and the storage format. The physical connector connects and transports data between devices; the message format (considered to be the most important part of MIDI) controls the stored data and the connected devices; and the storage format stores all the data and information.

## Video File Formats

### MPEG

The MPEG standards consist of different Parts. Each part covers a certain aspect of the whole specification. The standard also specifies Profiles and Levels. Profiles are intended to define a set of tools that are available, and Levels define the range of appropriate values for the properties associated with them.

MPEG-4 (.mp4)	Also MPEG-4 part 14 or mp4, a digital multimedia format used to store video and audio, but also store subtitles and still images. It will be the best video format for iMovie, in case you want a smaller video file size.
Quick Time Movie (.mov)	This file format specifies a multimedia container file containing one or more tracks, each of which stores a particular type of data: audio, video, effects, or text.
MPEG-2	aka H.222/H.262 as defined by the ITU. It is the core of most digital television and DVD formats.
AVCHD	Short for Advanced Video Coding High Definition, it is a file based format for the digital recording and playback of high definition video.
DV & HDV	The format for storing digital video recorded by camcorder. If you want video for better quality, believe it will be the best video format for iMovie as it is uncompressed.

MPEG has standardized the following compression formats and ancillary standards:

**MPEG-1:** is the first compression standard for audio and video. It was basically designed to allow moving pictures and sound to be encoded into the bitrate of a Compact Disc. To meet the low bit requirement, MPEG-1 downsamples the images, as well as using picture rates of only 24-30 Hz, resulting in a moderate quality. It includes the popular Layer 3 (MP3) audio compression format.

**MPEG-2:** Transport, video and audio standards for broadcast-quality television. MPEG-2 standard was considerably broader in scope and of wider appeal--supporting interlacing and high definition. MPEG-2 is

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considered important because it has been chosen as the compression scheme for over-the-air digital television ATSC, DVB and ISDB, digital satellite TV services like Dish Network, digital cable television signals, SVCD, and DVD.

**MPEG-3:** Developments in standardizing scalable and multi-resolution compression which would have become MPEG-3 were ready by the time MPEG-2 was to be standardized; hence, these were incorporated into MPEG-2 and as a result there is no MPEG-3 standard. MPEG-3 is not to be confused with MP3, which is MPEG-1 Audio Layer 3.

**MPEG-4:** MPEG-4 uses further coding tools with additional complexity to achieve higher compression factors than MPEG-2. In addition to more efficient coding of video, MPEG-4 moves closer to computer graphics applications. In more complex profiles, the MPEG-4 decoder effectively becomes a rendering processor and the compressed bitstream describes three-dimensional shapes and surface texture. MPEG-4 also provides Intellectual Property Management and Protection (IPMP) which provides the facility to use proprietary technologies to manage and protect content like digital rights management.

Several new higher-efficiency video standards (newer than MPEG-2 Video) are included (an alternative to MPEG-2 Video), notably:

- MPEG-4 Part 2 (or Advanced Simple Profile) and
- MPEG-4 Part 10 (or Advanced Video Coding or H.264). MPEG-4 Part 10 may be used on HD DVD and Blu-ray discs, along with VC-1 and MPEG-2.

In addition, the following standards, while not sequential advances to the video encoding standard as with MPEG-1 through MPEG-4, are referred to by similar notation:

- MPEG-7: A multimedia content description standard.
- MPEG-21: MPEG describes this standard as a multimedia framework.

### Multimedia I/O technologies

An input device is any peripheral (piece of computer hardware equipment) used to provide data and control signals to an information processing system such as a computer or other information appliance. Input and output devices make up the hardware interface between a computer and a scanner. Many input devices can be classified according to:

- Modality of input (e.g. mechanical motion, audio, visual, etc.)
- The input is discrete (e.g. key presses) or continuous (e.g. a mouse's position, though digitized into a discrete quantity, is fast enough to be considered continuous)
- The number of degrees of freedom involved (e.g. two-dimensional traditional mice, or three-dimensional navigators designed for CAD applications)
- Pointing devices, which are input devices used to specify a position in space, can further be classified according to:
  - Whether the input is direct or indirect. With direct input, the input space coincides with the display space, i.e. pointing is done in the space where visual feedback or the cursor appears. Touch screens and light pens involve direct input. Examples involving indirect input include the mouse and trackball. Direct input is almost necessarily absolute, but indirect input may be either absolute or relative. For example, digitizing graphics tablets that do not have an embedded screen involve indirect input and sense absolute positions and are often run in an absolute input mode, but they may also be set up to simulate a relative input mode where the stylus or puck can be lifted and repositioned.
  - Whether the positional information is absolute (e.g. on a touch screen) or relative (e.g. with a mouse that can be lifted and repositioned).

### Output Devices



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An output device is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system (such as a computer) to the outside world.

In computing, input/output, or I/O, refers to the communication between an information processing system (such as a computer), and the outside world. Inputs are the signals or data sent to the system, and outputs are the signals or data sent by the system to the outside. Examples of output devices: Speakers, Headphones, Screen (Monitor), Printer.

#### Digital voice and audio

Audio signal processing or audio processing is the intentional alteration of audio signals often through an audio effect or effects unit. As audio signals may be electronically represented in either digital or analog format, signal processing may occur in either domain. Analog processors operate directly on the electrical signal, while digital processors operate mathematically on the digital representation of that signal.

The five general steps in digital audio signal processing are as follows:

**Step 1 Signal Generation:** Signal generation is the conversion of the sound waves from the source into electrical energy which corresponds to the frequency of the original source. The audio signal may be generated mechanically using a microphone or turntable to create an analog of the original sound signal such as a phonograph record or audio cassette. Microphones are used to transduce the physical energy of music and voice into electrical energy. The audio signal may be generated electromagnetically using tape recorders. The audio signal may also be generated digitally by using laser optics to create a binary or digital equivalent of the original sound. Television signal generation requires electronic line-by-line scanning of an image using an electron beam to scan each element of the picture. The image is subsequently retraced by the television receiver.

**Step 2 Signal Amplification and Processing:** Audio signals are amplified and mixed using audio consoles. After the audio signal has been converted from a physical sound wave into an electrical or digital facsimile, the audio signal must be amplified to boost the signal and processed including the mixing, combining and routing for broadcast transmission and/or recording. Sound sources are combined at the mixing board. The amplified sound may be fine tuned using equalizers and special effects. The switcher is used to mix TV signals and put the desired picture on the air. A special effect generator is used to add transitions, split screen and keying. Digital video editing and effects can also be produced using computer software such as Adobe Premiere Pro and After Effects.

**Step 3 Signal Transmission:** The electronic signal is superimposed by a modulation process on a carrier wave generated or propagated by the radio station on its assigned frequency. The generated sound wave may travel by ground, sky and direct waves. Radio waves occupy a segment of the electromagnetic spectrum. AM radio channel frequencies are divided into three main types: clear channels, regional channels and local channels. FM channel frequencies are classified by antenna height and power. Stereo broadcasting and other non broadcast services are accomplished with the wide bandwidth of the FM channel. Digital radio is satellite-based or in-band on channel. Television signal transmission includes over-the-air broadcasting using the electromagnetic radiation on the VHF and UHF portions of the spectrum or by wire through a cable system using coaxial cable that can carry programming on more than 100 channels. New transmission technologies used for transmission and distribution include satellite and fiber optics for digital signals.

**Step 4 Signal Reception:** After the radio signal has been transduced, modulated and transmitted, the radio waves are picked up on a radio receiver where they are transduced or converted by the speaker system back into sound waves. The characteristics of the electromagnetic spectrum and modulation method used in transmission determine the type of radio receiver needed to convert the signal back into sound waves. There are several types of radio receivers including AM, AM stereo, FM, shortwave, and multiband. These receivers can be equipped with either analog tuners or a digital system. For moving images both large and small-screen TVs are now receiving high-definition television vision signals.



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**Step 5 Signal Storage:** Audio technology is used in the storage and retrieval of sounds. Audio signals are transduced or converted for storage and eventual playback or rebroadcast. The storage medium have included glass discs, wire, vinyl, magnetic type, compact disc, video tapes, digital storage media such as digital versatile discs (DVDs) and computer hard drives including high-capacity disc drives.

### Sound cards

A sound card (also known as an audio card) is an internal expansion card that provides input and output of audio signals to and from a computer under control of computer programs. The term sound card is also applied to external audio interfaces used for professional audio applications. Typical uses of sound cards include providing the audio component for multimedia applications such as music composition, editing video or audio, presentation, education and entertainment (games) and video projection.

Sound functionality can also be integrated onto the motherboard, using components similar to those found on plug-in cards. The integrated sound system is often still referred to as a sound card. Sound processing hardware is also present on modern video cards with HDMI to output sound along with the video using that connector; previously they used a SPDIF connection to the motherboard or sound card.

Image Creation and Capture Image	Format options	Archive Recommendations
Digital Cameras	Dependent on model of camera	1. Raw DNG (or TIFF) file if possible 2. Original JPEG: save archive copy on download and for presentation images always work on a copy of the file
Scanners	Wide range once scanned	Save uncompressed/lossless format (TIFF) as archive copy regardless of intended format
Graphics Images	Wide choice of formats under 'Save As...' command	Alongside software package files (e.g Photoshop [.psd], Corel Draw [.cpt]), save draft images in uncompressed TIFF format if possible, and replace with archive TIFF of end product image

### Video image and animation

#### Animation

**Animation** means giving life to any object in computer graphics. It has the power of injecting energy and emotions into the most seemingly inanimate objects. Computer-assisted animation and computer-generated animation are two categories of computer animation. It can be presented via film or video.

The basic idea behind animation is to play back the recorded images at the rates fast enough to fool the human eye into interpreting them as continuous motion. Animation can make a series of dead images come alive. Animation can be used in many areas like entertainment, computer aided-design, scientific visualization, training, education, e-commerce, and computer art.

#### Animation Techniques

Animators have invented and used a variety of different animation techniques. Basically there are six animation techniques which we would discuss one by one in this section.

#### Traditional Animation (frame by frame)

Traditionally most of the animation was done by hand. All the frames in an animation had to be drawn by hand. Since each second of animation requires 24 frames (film), the amount of efforts required to create even the shortest of movies can be tremendous.

#### Key framing

In this technique, a storyboard is laid out and then the artists draw the major frames of the animation. Major frames are the ones in which prominent changes take place. They are the key points of animation. Key framing

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requires that the animator specifies critical or key positions for the objects. The computer then automatically fills in the missing frames by smoothly interpolating between those positions.

#### **Procedural**

In a procedural animation, the objects are animated by a procedure – a set of rules – not by key framing. The animator specifies rules and initial conditions and runs simulation. Rules are often based on physical rules of the real world expressed by mathematical equations.

#### **Behavioral**

In behavioural animation, an autonomous character determines its own actions, at least to a certain extent. This gives the character some ability to improvise, and frees the animator from the need to specify each detail of every character's motion.

#### **Performance Based (Motion Capture)**

Another technique is Motion Capture, in which magnetic or vision-based sensors record the actions of a human or animal object in three dimensions. A computer then uses these data to animate the object.

This technology has enabled a number of famous athletes to supply the actions for characters in sports video games. Motion capture is pretty popular with the animators mainly because some of the commonplace human actions can be captured with relative ease. However, there can be serious discrepancies between the shapes or dimensions of the subject and the graphical character and this may lead to problems of exact execution.

#### **Physically Based (Dynamics)**

Unlike key framing and motion picture, simulation uses the laws of physics to generate motion of pictures and other objects. Simulations can be easily used to produce slightly different sequences while maintaining physical realism. Secondly, real-time simulations allow a higher degree of interactivity where the real person can manoeuvre the actions of the simulated character.

In contrast, the applications based on key-framing and motion select and modify motions from a pre-computed library of motions. One drawback that simulation suffers from is the expertise and time required to handcraft the appropriate controls systems.

#### **Key Framing**

A key frame is a frame where we define changes in animation. Every frame is a key frame when we create frame by frame animation. When someone creates a 3D animation on a computer, they usually don't specify the exact position of any given object on every single frame. They create key frames.

Key frames are important frames during which an object changes its size, direction, shape or other properties. The computer then figures out all the in-between frames and saves an extreme amount of time for the animator. The following illustrations depict the frames drawn by user and the frames generated by computer.

#### **Uses of Animation**

- **Cartoons** - One of the most exciting applications of multimedia is games. Nowadays the live internet is used to play gaming with multiple players has become popular. In fact, the first application of multimedia system was in the field of entertainment and that too in the video game industry. The integrated audio and video effects make various types of games more entertaining.
- **Simulations** - Computer simulation and animation are well known for their uses in visualizing and explaining complex and dynamic events. They are also useful in the analysis and understanding of these same types of events. That is why they are becoming increasingly used in litigation. While simulation and animation are different, they both involve the application of 3D computer graphics and are presented in that form with motion on a video screen. Simulation produces motion, which is consistent with the laws of physics and relies on the inputs by the user to be consistent with the events portrayed. The motion in an animation can be derived from a reconstruction of the event or can be taken from a simulation. Currently available animation software is more advanced in the ability to build objects and scenes to achieve photos-

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realism. Current simulation software is able to produce a dynamic visualization in a fraction of the time required by an animation.

- **Scientific Visualisation** - Multimedia had a wide application in the field of science and technology. It is capable of transferring audio, sending message and formatted multimedia documents. At the same time it also helps in live interaction through audio messages and it is only possible with the multimedia. It reduces the time and cost can be arranged at any moment even in emergencies. At the same time, the multimedia is enough useful services based on images. Similarly, it is useful for surgeons as they can use images created from imaging scans of human body to practice complicated procedures such as brain removal and reconstructive surgery. The plans can be made in a better way to reduce the costs and complications.
- **Analysis and Understanding** - Another successful use of the animated information graphic is for explaining a process or procedure. Although technical animations have been around for a long time, modern versions use the visual language of videos, such as overlaying windows, novel transitions between segments, a popping soundtrack, lively pace and surprising sound effects. Often the concepts and ideas are pared down to the basics, as they should be when intended for the general public.
- **Teaching and Communicating** - In the area of education also, the multimedia has a great importance. Talking particularly about the schools, the usage of multimedia is very important for children also. It is extensively used in the field of education and training. Even in traditional method we used audio for imparting education, where charts, models etc. were used. Nowadays the classroom need is not limited to that traditional method rather it needs audio and visual media. The multimedia integrates all of them in one system. As an education aid the PC contains a high-quality display with mic option. This all has promoted the development of a wide range of computer based training.
- **Architecture Visualization** - Architectural Animation is a short digital architectural movie which includes the concerned project or construction, the site, animated people and vehicles, all of which are digitally generated through 2D or 3D animation techniques. Unlike an architectural rendering, which is a single image from a single point of view, an architectural animation is a series of such still images. When this series of images are put together in a sequence and played, they produce the effect of a movie, much like a real movie except, all images in an architectural animation are digitally created by computer. It is appropriate to add a computer-generated digital landscape around the central construction to enhance its visual effect and to better convey its relationship to the surrounding area. Architectural animation is thus an effective and attractive way to provide designers and stakeholders with a realistic view of what the project will look like on completion.

### Principles of Animation

Disney's Twelve Basic Principles of Animation were introduced by the Disney animators Ollie Johnston and Frank Thomas in their 1981 book *The Illusion of Life: Disney Animation*. Johnston and Thomas in turn based their book on the work of the leading Disney animators from the 1930s onwards, and their effort to produce more realistic animations. The main purpose of the principles was to produce an illusion of characters adhering to the basic laws of physics, but they also dealt with more abstract issues, such as emotional timing and character appeal.

#### Squash and Stretch

The most important principle is "squash and stretch" the purpose of which is to give a sense of weight and flexibility to drawn objects. It can be applied to simple objects, like a bouncing ball, or more complex constructions, like the musculature of a human face. Taken to an extreme point, a figure stretched or squashed to an exaggerated degree can have a comical effect in realistic animation, however, the most important aspect of this principle is the fact that an object's volume does not change when squashed or stretched. If the length of a ball is stretched vertically, its width (in three dimensions, also its depth) needs to contract correspondingly horizontally

#### Anticipation

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Anticipation is used to prepare the audience for an action, and to make the action appear more realistic. A dancer jumping off the floor has to bend his knees first; a golfer making a swing has to swing the club back first. The technique can also be used for less physical actions, such as a character looking off-screen to anticipate someone's arrival, or attention focusing on an object that a character is about to pick up.

### Staging

This principle is akin to staging in theatre, as it is known in theatre and film. Its purpose is to direct the audience's attention, and make it clear what is of greatest importance in a scene; Johnston and Thomas defined it as "the presentation of any idea so that it is completely and unmistakably clear", whether that idea is an action, a personality, an expression, or a mood. This can be done by various means, such as the placement of a character in the frame, the use of light and shadow, or the angle and position of the camera. The essence of this principle is keeping focus on what is relevant, and avoiding unnecessary detail.

### Straight Ahead Action and Pose to Pose

These are two different approaches to the actual drawing process. "Straight ahead action" means drawing out a scene frame by frame from beginning to end, while "pose to pose" involves starting with drawing a few key frames, and then filling in the intervals later. "Straight ahead action" creates a more fluid, dynamic illusion of movement, and is better for producing realistic action sequences. On the other hand, it is hard to maintain proportions, and to create exact, convincing poses along the way. "Pose to pose" works better for dramatic or emotional scenes, where composition and relation to the surroundings are of greater importance. A combination of the two techniques is often used.

Computer animation removes the problems of proportion related to "straight ahead action" drawing; however, "pose to pose" is still used for computer animation, because of the advantages it brings in composition. The use of computers facilitates this method, and can fill in the missing sequences in between poses automatically. It is, however, still important to oversee this process and apply the other principles discussed.

### Follow Through and Overlapping Action

Follow through and overlapping action is a general heading for two closely related techniques which help to render movement more realistically, and help to give the impression that characters follow the laws of physics, including the principle of inertia. "Follow through" means that loosely tied parts of a body should continue moving after the character has stopped and the parts should keep moving beyond the point where the character stopped to be "pulled back" only subsequently towards the center of mass and/or exhibiting various degrees of oscillation damping. "Overlapping action" is the tendency for parts of the body to move at different rates (an arm will move on different timing of the head and so on). A third, related technique is "drag", where a character starts to move and parts of him take a few frames to catch up. These parts can be inanimate objects like clothing or the antenna on a car, or parts of the body, such as arms or hair. On the human body, the torso is the core, with arms, legs, head and hair appendices that normally follow the torso's movement. Body parts with much tissue, such as large stomachs and breasts, or the loose skin on a dog, are more prone to independent movement than bonier body parts. Again, exaggerated use of the technique can produce a comical effect, while more realistic animation must time the actions exactly, to produce a convincing result. The "moving hold" animates between similar key frames, even characters sitting still can display some sort of movement, such as the torso moving in and out with breathing.

### Slow In and Slow Out

The movement of the human body, and most other objects, needs time to accelerate and slow down. For this reason, animation looks more realistic if it has more drawings near the beginning and end of an action, emphasizing the extreme poses, and fewer in the middle. This principle goes for characters moving between two extreme poses, such as sitting down and standing up, but also for inanimate, moving objects, like the bouncing ball in the above illustration.

### Arc

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Most natural action tends to follow an arched trajectory, and animation should adhere to this principle by following implied "arcs" for greater realism. This technique can be applied to a moving limb by rotating a joint, or a thrown object moving along a parabolic trajectory. The exception is mechanical movement, which typically moves in straight lines.

As an object's speed or momentum increases, arcs tend to flatten out in moving ahead and broaden in turns. In baseball, a fastball would tend to move in a straighter line than other pitches; while a figure skater moving at top speed would be unable to turn as sharply as a slower skater, and would need to cover more ground to complete the turn.

An object in motion that moves out of its natural arc for no apparent reason will appear erratic rather than fluid. For example, when animating a pointing finger, the animator should be certain that in all drawings in between the two extreme poses, the fingertip follows a logical arc from one extreme to the next. Traditional animators tend to draw the arc in lightly on the paper for reference, to be erased later.

### Secondary Action

Adding secondary actions to the main action gives a scene more life, and can help to support the main action. A person walking can simultaneously swing his arms or keep them in his pockets, speak or whistle, or express emotions through facial expressions. The important thing about secondary actions is that they emphasize, rather than take attention away from the main action. If the latter is the case, those actions are better left out. For example, during a dramatic movement, facial expressions will often go unnoticed. In these cases it is better to include them at the beginning and the end of the movement, rather than during.

### Timing

Timing refers to the number of drawings or frames for a given action, which translates to the speed of the action on film. On a purely physical level, correct timing makes objects appear to obey the laws of physics; for instance, an object's weight determines how it reacts to an impetus, like a push. Timing is critical for establishing a character's mood, emotion, and reaction. It can also be a device to communicate aspects of a character's personality.

### Exaggeration

Exaggeration is an effect especially useful for animation, as perfect imitation of reality can look static and dull in cartoons the level of exaggeration depends on whether one seeks realism or a particular style, like a caricature or the style of a specific artist. The classical definition of exaggeration, employed by Disney, was to remain true to reality, just presenting it in a wilder, more extreme form. Other forms of exaggeration can involve the supernatural or surreal, alterations in the physical features of a character; or elements in the storyline itself. It is important to employ a certain level of restraint when using exaggeration. If a scene contains several elements, there should be a balance in how those elements are exaggerated in relation to each other, to avoid confusing or overawing the viewer.

### Solid drawing

The principle of solid drawing means taking into account forms in three-dimensional space, or giving them volume and weight. The animator needs to be a skilled artist and has to understand the basics of three-dimensional shapes, anatomy, weight, balance, light and shadow, etc. For the classical animator, this involved taking art classes and doing sketches from life. One thing in particular that Johnston and Thomas warned against was creating "twins": characters whose left and right sides mirrored each other, and looked lifeless. Modern-day computer animators draw less because of the facilities computers give them, yet their work benefits greatly from a basic understanding of animation principles and their additions to basic computer animation.

### Animation file formats

There are a number of different types of animation file formats. Each type stores graphics data in a different way. Bitmap, vector, and metafile formats are by far the most commonly used formats, and we focus on



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these. However, there are other types of formats as well - scene, animation, multimedia, hybrid, hypertext, hypermedia, 3D, virtual modeling reality language (VRML), audio, font, and page description language (PDL). The increasing popularity of the World Wide Web has made some of these formats more popular.

File Name	Description
JPEG/JPG (Joint Photographers Expert Group)	Most popular lossy image format. Allows users to specify what level of compression they desire.
PNG (Portable Network Graphic)	Best of lossless image formats. Widely supported across web. Allows you to include an alpha channel within file.
BMP (BitMaP)	Would avoid if possible. They offer little to no compression which results in unnecessarily large files.
TIFF/TIF (Tagged Image File Format)	Offers both compressed and uncompressed versions. Compressed are similar to PNG and uncompressed are similar to BMP.
PDF (Portable Document Format)	Most widely used document format. Great vector image format. Created by Adobe.
EPS (Encapsulated PostScript)	Most common vector image format. Standard format for print industry.
GIF (Graphic Interchange Format)	Lossless format that supports both animated and static images. Great for webpage banner ads.

### Full motion video

Full motion video, usually abbreviated as FMV, is a popular term for pre-recorded TV-quality movie or animation in a video game. FMV differs from real-time cut scenes in that real-time cut scenes render the surrounding environment as it appears in the actual game, whereas FMV is simply a playback of something that was previously recorded, usually rendered by a much more powerful machine. Thus, FMV was traditionally much higher quality than real-time cut scenes, and the two can usually be differentiated by this. With computer games running on more modern hardware, however, the use of FMV for cut scenes has been drastically reduced as similar quality graphics can be produced in the game engine with much less disc space required for the source data.

### Storage and retrieval technologies

A data storage device is a device for recording (storing) information (data). Recording can be done using virtually any form of energy, spanning from manual muscle power in handwriting, to acoustic vibrations in phonographic recording, to electromagnetic energy modulating magnetic tape and optical discs. Data retrieval means obtaining data from a database management system such as ODBMS. In this case, it is considered that data is represented in a structured way, and there is no ambiguity in data. In order to retrieve the desired data the user present a set of criteria by a query.

### Multimedia Storage

Multimedia can be stored in mediums such as Optical Disks, Hard Drives, Magnetic Storage Media and such.

### Multimedia Retrieval

Multimedia retrieval depends on the type of multimedia file it is which may be continuous or discrete. Continuous media is data where there is a timing relationship between source and destination. Video, animation and audio are examples of continuous media. Some media is time independent or static or discrete media: normal data, text, single images, graphics are examples.

### Magnetic Media

- Magnetic storage or magnetic recording is the storage of data on a magnetized medium.



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- Magnetic storage uses different patterns of magnetization in a magnetisable material to store data and is a form of non-volatile memory.

#### **Optical Media**

Optical media-such as the compact disk (CD) -are storage media that hold content in digital form and that are written and read by a laser; these media include all the various CD and DVD variations, as well as optical jukeboxes and auto changers.

#### **Disk Spanning**

Disc spanning is a feature of CD and DVD burning software that automatically spreads a large amount of data across many data discs if the data set's size exceeds the storage capacity of an individual blank disc.

#### **RAID Storage**

RAID is a technology that is used to increase the performance and/or reliability of data storage. The abbreviation stands for Redundant Array of Inexpensive Disks. A RAID system consists of two or more disks working in parallel.





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