

Multimedia Systems and Applications

An Open Elective

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Course Objectives: Multimedia has become an indispensable part of modern computer technology. In this course, students will be introduced to principles and current technologies of multimedia systems. Issues in effectively representing, processing, and retrieving multimedia data such as signal, graphics, image and video will be addressed. The students will gain hands-on experience in those areas by implementing some components of multimedia streaming system in laboratories. Latest Web technologies and some advanced topics in current multimedia research will also be discussed.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	0	0	3	40/14	60/21	-	-	100/35



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Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction and Multimedia Data Representations: Introduction to Multimedia, Multimedia: Past, Present and Future, Multimedia Software Tools, Multimedia Presentation, Multimedia Sharing and Distribution, Signal, Image, Graphics and Video Data Representations.	8
2	Multimedia Data Compression: Storage Space; Coding Requirements; Source, Entropy, and Hybrid Coding; Lossless Compression Algorithms, Lossy Compression Algorithms, Image Compression Standards, Video Compression Techniques, MPEG Video/Audio coding, Fractal Compression.	10
3	Multimedia Communications and Networking: Network Services and Protocols for Multimedia Communications, Internet Multimedia Content Distribution, Multimedia Over Wireless and Mobile Networks.	10
4	Cloud Computing for Multimedia Services: Cloud Computing Overview, Multimedia Cloud Computing, Computation Offloading for Multimedia Services, Interactive Cloud Gaming.	9
5	Multimedia Application Design: Multimedia Application Classes; Types of Multimedia Systems; Virtual Reality Design; Components of Multimedia Systems; Organizing Multimedia Databases; Application Workflow Design Issues; Distributed Application Design Issues.	8
		45



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Reference Books:

1	Ze-Nian Li, and Mark S. Drew, Fundamentals of Multimedia , 2 nd Edition, Pearson Prentice Hall, 2014
2	K. Rammohanarao, Z. S. Bolzkovic, D. A. Milanovic, Multimedia Communication Systems , 1 st edition, Prentice Hall, May 2002.
3	Fred Halsall, Addison-Wesley, Multimedia Communications: Applications, Networks, Protocols and Standards , 2001.
4	Yao Wang, Joern Ostermann, and Ya-Qin Zhang, Video Processing and Communications , Prentice Hall, 2002.
5	Stephen McGloughlin, Multimedia: Concepts and Practice , Prentice Hall, 2000.

What is Multimedia?

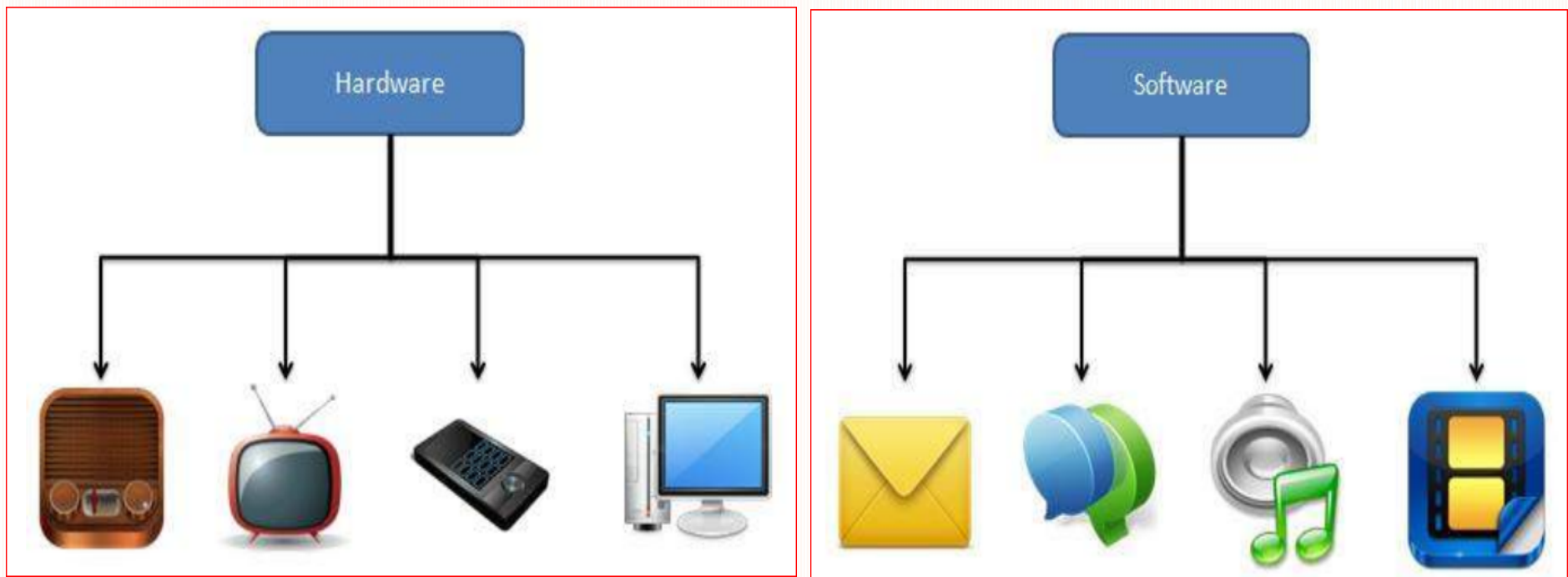
Multimedia is a medium through which the information can be easily transmitted from one place to another.

The word '**Multimedia**' is a combination of two words, '**Multi**' and '**Media**'. Multi means many and media means material through which something can be transmitted or send. Multimedia combined all the media elements like text and graphics to make the information more effective and attractive.

Multimedia is a representation of information in an attractive and interactive manner with the use of a combination of text, audio, video, graphics and animation. In other words we can say that Multimedia is a computerized method of presenting information combining textual data, audio, visuals (video), graphics and animations.

For examples: E-Mail, Yahoo Messenger, Video Conferencing, and Multimedia Message Service (MMS).

Multimedia as name suggests is the combination of Multi and Media that is many types of media (hardware/software) used for communication of information.



In 1945, as part of MIT's postwar deliberations on what to do with all those scientists employed on the war effort, Vannevar Bush wrote a landmark article [9] describing what amounts to a hypermedia system, called “c.”

Memex was meant to be a universally useful and personalized memory device that even included the concept of associative links—it really is the forerunner of the World Wide Web.

What is Hypermedia?

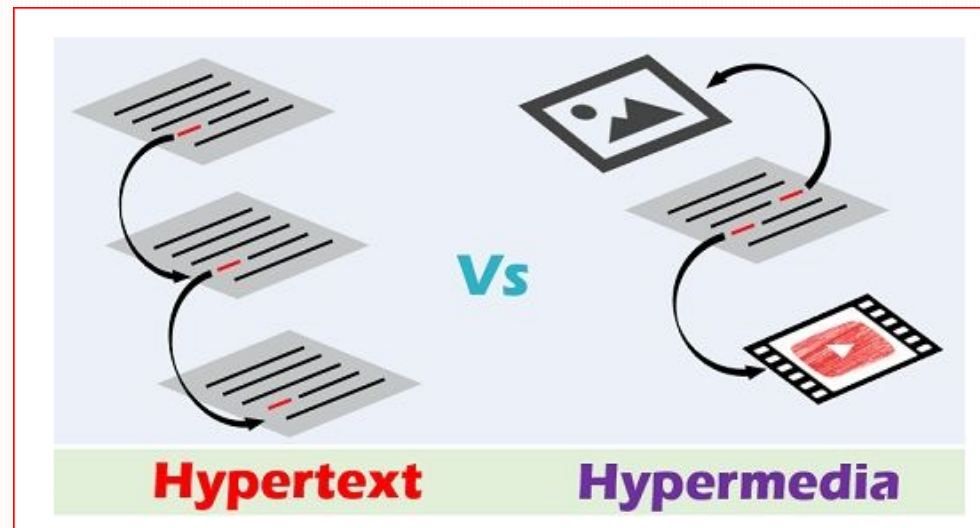
First introduced by Ted Nelson, went beyond text-only. Hypermedia is the next generation of hypertext, containing a variety of media such as images, text, audio, video, and moving visuals. Both hypermedia and hypertext have a structure that is comparable.

Hypermedia includes much more sophisticated capabilities such as webpage clickable connections. The most frequent hypermedia link is an image link that leads to another website. CERN (European Center for Nuclear Research) team invented the Hypertext Markup Language (HTML) and the Hypertext Transfer Protocol (HTTP) for this purpose.

The network of interconnected media forms that are linked together in a non-linear fashion we call the World Wide Web are called hypermedia. It's a cross-linguistic exchange of nonlinearly distributed data or information based on a shared structure. It is an extension of the term hypertext – text with links to other text – that refers to the presentation of non-linear data which makes it easy for the users to explore the world of internet via clickable links of web browsers.

The need for a more sophisticated form of media and non-linear association of digital content have brought the concept of hypermedia from the past to the forefront of the World Wide Web.

Hypertext and hypermedia, are the techniques for **linking non-linear information**. The two terms are distinct in a manner that the hypertext allows only text to be hyperlinked while hypermedia could use various multimedia elements such as images, audio and video, in order to link the text and media over the World Wide Web. However, hypertext is a part of the hypermedia as hypermedia includes text, image, audio, video, etcetera.





BASIS FOR COMPARISON	HYPERTEXT	HYPERMEDIA
Basic	It is a text that links to the other chunks of the text under the same or separate document.	It can be considered as the enhanced version of hypertext where other graphics is also the part of the link.
Involves	Text	Graphics, image, audio, video, etc.
Relation	Is a part of hypermedia.	Comes in the superior level entity.
Represents	Multimedia content present in the electronic text format.	It can contain various multimedia elements which are linked with each other non-linearly.



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S.No.	Comparison	Multimedia	Hypermedia
1	Basic	It represents the various forms of representing the information.	It is an extension of hypertext and not considered as text-based.
2	Types available	Both linear and non-linear available.	Only non-linear available.
3	Relation	It combines with hypertext to form a hypermedia.	It combines both hypertext as well as multimedia to represent information.
4	Based on	It basically works on interaction and interactivity.	It is used for inter-connectivity among elements and also for the cross referencing.
5	Requirements of hardware	It requires its own delivery system called as multimedia delivery system.	It provides the clickable links to increase capability.
6	Information present	It is the combination of the media and content which stores the information in some form across the devices.	It is more contrasting in nature and used in non-linear data representation.



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Components of Multimedia

The various components of multimedia are Text, Audio, Graphics, Video and Animation. All these components work together to represent information in an effective and easy manner.

1)Text: Text is the most common medium of representing the information. In multimedia, text is mostly use for titles, headlines, menu etc. The most commonly used software for viewing text files are Microsoft Word, Notepad, Word pad etc. Mostly the text files are formatted with ,DOC, TXT etc extension.

2)Audio: In multimedia audio means related with recording, playing etc. Audio is an important components of multimedia because this component increase the understandability and improves the clarity of the concept. audio includes speech, music etc. The commonly used software for playing audio files are:

- i) Quick Time
- ii) Real player
- iii) Windows Media Player



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3)Graphics: Every multimedia presentation is based on graphics. The used of graphics in multimedia makes the concept more effective and presentable. The commonly used software for viewing graphics are *windows Picture, Internet Explorer etc.* The commonly used graphics editing software is Adobe Photoshop through which graphics can be edited easily and can be make effective and attractive.

4)Video: Video means moving pictures with sound. It is the best way to communicate with each other. In multimedia it is used to makes the information more presentable and it saves a large amount of time. The commonly used software for viewing videos are:

- i) Quick Time
- ii) Window Media Player
- iii) Real Player

5)Animation: In computer animation is used to make changes to the images so that the sequence of the images appears to be moving pictures. An animated sequence shows a number of frames per second to produce an effect of motion in the user's eye. Some of the commonly used software for viewing animation are:

- i) Internet Explorer
- ii) Windows Pictures
- iii) Fax Viewer

Components of a Multimedia System :

Now let us consider the Components (Hardware and Software) required for a multimedia system:

Capture devices : Video Camera, Video Recorder, Audio Microphone, Keyboards, mice, graphics tablets, 3D input devices, tactile sensors, VR devices.

Digitizing Hardware Storage Devices : Hard disks, CD-ROMs, DVD-ROM, etc

Communication Networks : Local Networks, Intranets, Internet, Multimedia or other special high speed networks.

Computer Systems : Multimedia Desktop machines, Workstations, MPEG/VIDEO/DSP Hardware

Display Devices : CD-quality speakers, HDTV, SVGA, Hi-Res monitors, Colour printers etc.

Applications Examples of Multimedia Applications include:

1. World Wide Web
2. Hypermedia courseware
3. Video conferencing
4. Video-on-demand
5. Interactive TV
6. Groupware
7. Home shopping
8. Games
9. Virtual reality
10. Digital video editing and production systems

Multimedia Software Tools: A Quick Scan

The categories of software tools we examine here are

- Music sequencing and notation
- Digital audio
- Graphics and image editing
- Video editing
- Animation
- Multimedia authoring

Link:-> <https://users.cs.cf.ac.uk/dave/Multimedia/node40.html>

Music Sequencing and Notation

Cakewalk is a well known older name for what is now called Pro Audio. The firm producing this sequencing and editing software, Twelve Tone Systems, also sells an introductory version of their software, "Cakewalk Express", over the Internet for a low price.

Cubase is another sequencing/editing program, with capabilities similar to those of Cakewalk. It includes some digital audio editing tools.

Macromedia Sound edit is a mature program for creating audio for multimedia projects and the web that integrates well with other Macromedia products such as Flash and Director.

Digital Audio

Digital Audio tools deal with accessing and editing the actual sampled sounds that makeup audio.

Cool Edit is a powerful, popular digital audio toolkit with capabilities (for PC users, at least) that emulate a professional audio studio, including multitrack productions and sound file editing, along with digital signal processing effects.

Sound Forge is a sophisticated PC - based program for editing WAV files. Sound can be captured from a CD - ROM drive or from tape or microphone through the sound card, then mixed and edited. It also permits adding complex special effects.

Pro Tools is a high-end integrated audio production and editing environment that MNS on Macintosh computers as well as Windows. Pro Tools offers easy MIDI creation and manipulation as well as powerful audio mixing, recording, and editing software.

Graphics and Image Editing

Adobe Illustrator is a powerful publishing tool for creating and editing vector graphics, which can easily be exported to use on the web.

Adobe Photoshop is the standard tool for graphics, image processing, and image manipulation. Layers of images, graphics, and text can be separately manipulated for maximum flexibility, and its "filter factory" permits the creation of sophisticated lighting effects.

Macromedia Fireworks is software for making graphics specifically for the web. It includes a bitmap editor, a vector graphics editor, and a JavaScript generator for buttons and rollovers.

Macromedia Freehand is a text and web graphics editing tool that supports many bitmap formats, such as GIF, PNG, and JPEG. These are pixel-based formats, in that each pixel is specified.

Video Editing:

Adobe Premiere is a simple, intuitive video editing tool for nonlinear editing — putting video clips into any order. Video and audio are arranged in tracks, like a musical score. It provides a large number of video and audio tracks, superimpositions, and virtual clips.

Adobe After Effects is a powerful video editing tool that enables users to add and change existing movies with effects such as lighting, shadows, and motion blurring. It also allows layers, as in Photoshop, to permit manipulating objects independently.

Final Cut Pro is a video editing tool offered by Apple for the Macintosh platform. It allows the capture of video and audio from numerous sources, such as film and DV. It provides a complete environment, from capturing the video to editing and color correction and finally output to a video file or broadcast from the computer.

Animation

Multimedia APIs

Java3D is an API used by Java to construct and render 3D graphics, similar to the way Java Media Framework handles media files.

DirectX, a Windows API that supports video, images, audio, and 3D animation, is the most common API used to develop modern multimedia Windows applications, such as computer games.

OpenGL was created in 1992 and has become the most popular 3D API in use today. OpenGL is highly portable and will run on all popular modern operating systems, such as UNIX, Linux, Windows, and Macintosh.

Rendering:

Rendering is the process involved in the generation of a two-dimensional or three-dimensional image from a model by means of application programs. Rendering is mostly used in architectural designs, video games, and animated movies, simulators, TV special effects and design visualization. The techniques and features used vary according to the project. Rendering helps increase efficiency and reduce cost in design.



Rendering Tools

3D Studio Max includes a number of high-end professional tools for character animation, game development, and visual effects production.

Softimage XSI (previously called Softimage 3D) is powerful modeling, animation, and rendering package for animation and special effects in films and games.

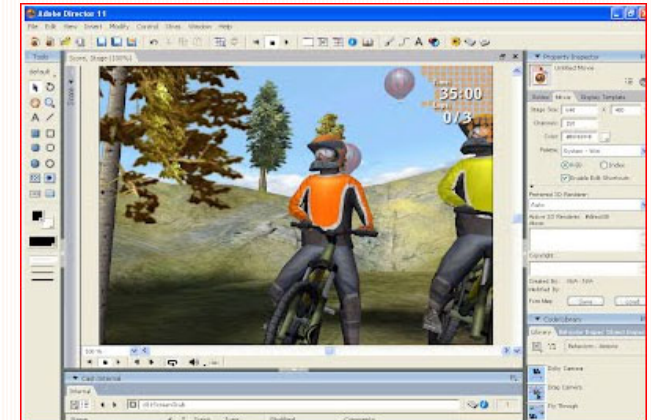
Maya, a competing product to Softimage, is a complete modeling package. It features a wide variety of modeling and animation tools, such as creating realistic clothes and fur.

RenderMan is a rendering package created by Pixar. It excels in creating complex surface appearances and images and has been used in numerous movies, such as Monsters Inc. and Final Fantasy: The Spirits Within. It is also capable of importing models from Maya.

GIF Animation Packages For a simpler approach to animation that also allows quick development of effective small animations for the web, many shareware and other programs permit creating animated GIF images. GIFs can contain several images, and looping through them creates a simple animation. Gifcon and GifBuilder are two of these. Linux also provides some simple animation tools, such as animate.

Multimedia Authoring:

Multimedia authoring is a process of assembling different types of media contents like text, audio, image, animations and video as a single stream of information with the help of various software tools available in the market. Multimedia authoring tools give an integrated environment for joining together the different elements of a multimedia production. It gives the framework for organizing and editing the components of a multimedia project. It enables the developer to create interactive presentation by combining text, audio, video, graphics and animation.





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Tools that provide the capability for creating a complete multimedia presentation, including interactive user control, are called authoring programs.

Author ware was an interpreted, flowchart-based, graphical programming language. Authorware is used for creating interactive programs that can integrate a range of multimedia content, particularly e-learning applications. The flowchart model differentiates Authorware from other authoring tools, such as Adobe Flash and Adobe Director, which rely on a visual stage, timeline, and script structure.

Quest which uses a type of flowcharting metaphor, is similar to Authorware in many ways. However, the flowchart nodes can encapsulate information in a more abstract way (called "frames") than simply subroutine levels. As a result, connections between icons are more conceptual and do not always represent the flow of control in the program.

Camera-based object tracking technology

Face detection

Shot detection

Google Glass: which, equipped with an optical head-mounted display, enable interactive, smartphone-like information display for its users. Wirelessly connected the Internet, it can also communicate using natural language voice commands. All these make a good step toward *wearable computing* of great potentials.

Social Event Detection for Social Multimedia

Search and Hyperlinking of Television Content

Executable academic papers In science and engineering, one traditional way to communicate findings is by publication of papers in academic journals. A new idea that exploits the completely digital pathway for broadcast of information is called “Executable papers.” The idea here is that results discussed in a published paper are often difficult to reproduce. The reason is that datasets being used and programming code working on that data are typically not supplied as part of the publication. The executable papers approach allows the “reader” to interact with and interactively manipulate the data and code, to further understand the findings being presented. Moreover, the concept includes allowing the reader to rerun the code, change parameters, or upload different data .

Animated Lifelike Virtual Agents e.g. virtual educators, in particular as social partners for special needs children; and various other roles that are designed to demonstrate emotion and personality and with a variety of embodiments. The objective is flexibility as opposed to a fixed script.

A new educational paradigm is emerging: face-to-face interaction with intelligent pedagogical animated agents in interactive learning environments that are capable of performing tasks and achieving goals individually and in collaboration with human and non-human agents. Currently, significant work has been undertaken on incorporating conversational behaviours of emotion, personality, conversational performatives and functions into such agents

Behavioral science models can be brought into play to model interaction between people, which can then be extended to enable natural interaction by virtual characters. Such “augmented interaction” applications can be used to develop interfaces between real and virtual humans for tasks such as augmented storytelling.

Geo-coordinate Prediction for Social Multimedia, Preserving Privacy in Surveillance Videos, Spoken Term Web Search, Question Answering for the Spoken Web, Soundtrack Selection for Commercials





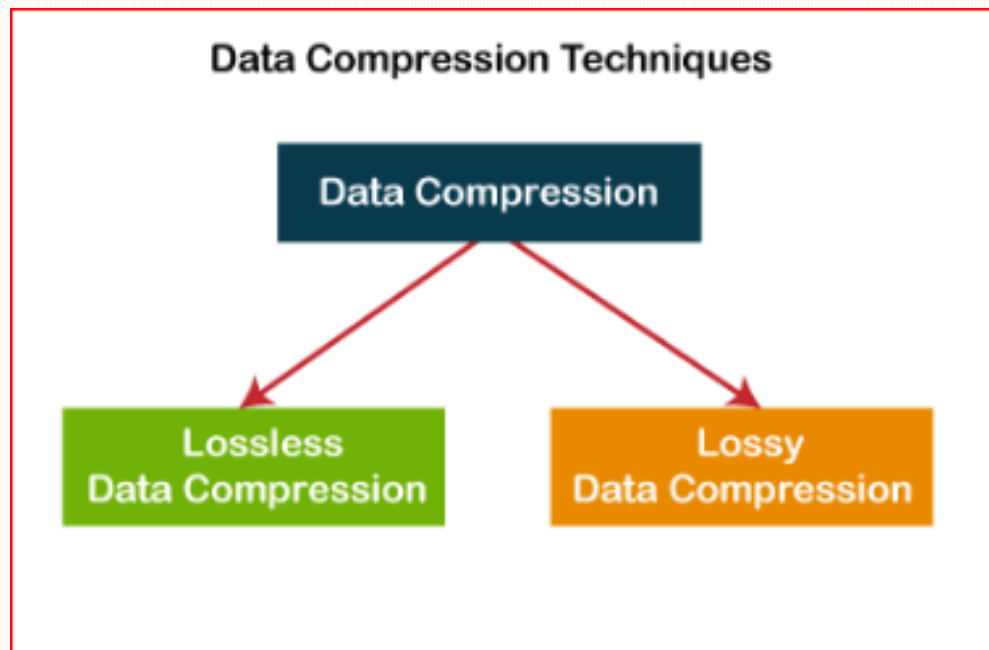
What is Data Compression

Data Compression is also referred to as **bit-rate reduction** or **source coding**. This technique is used to reduce the size of large files.

The advantage of data compression is that it helps us save our disk space and time in the data transmission.

There are mainly two types of data compression techniques -

1. Lossless Data Compression
2. Lossy Data Compression

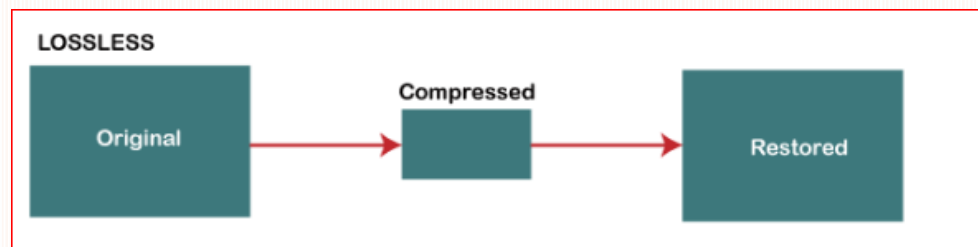


What is Lossless data compression?

Lossless data compression is used to compress the files **without losing an original file's quality and data**. Simply, we can say that in lossless data compression, **file size is reduced, but the quality of data remains the same.**

The main advantage of lossless data compression is that we **can restore the original data in its original form after the decompression.**

Lossless data compression mainly used in the **sensitive documents, confidential information, and PNG, RAW, GIF, BMP file formats.**



Some most important Lossless data compression techniques are -

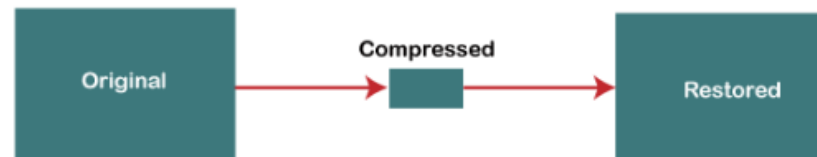
1. Run Length Encoding (RLE)
2. Lempel Ziv - Welch (LZW)
3. Huffman Coding
4. Arithmetic Coding

What is Lossy data compression

Lossy data compression is used to compress larger files into smaller files. In this compression technique, some specific amount of **data and quality are removed (loss) from the original file**. It takes less memory space from the original file due to the loss of original data and quality. This technique is generally useful for us when the quality of data is not our first priority.

Lossy data compression is most widely used in JPEG images, MPEG video, and MP3 audio formats.

LOSSY



Some important Lossy data compression techniques are -

1. Transform coding
2. Discrete Cosine Transform (DCT)
3. Discrete Wavelet Transform (DWT)



Lossy and Lossless Compression:

S.No	Lossless data compression	Lossy data compression
1.	In Lossless data compression, there is no loss of any data and quality.	In Lossy data compression, there is a loss of quality and data, which is not measurable.
2.	In lossless, the file is restored in its original form.	In Lossy, the file does not restore in its original form.
3.	Lossless data compression algorithms are Run Length Encoding, Huffman encoding, Shannon fano encoding, Arithmetic encoding, Lempel Ziv Welch encoding, etc.	Lossy data compression algorithms are: Transform coding, Discrete Cosine Transform, Discrete Wavelet Transform, fractal compression, etc.
4.	Lossless compression is mainly used to compress text-sound and images.	Lossy compression is mainly used to compress audio, video, and images.
5.	As compare to lossy data compression, lossless data compression holds more data.	As compare to lossless data compression, lossy data compression holds less data.
6.	File quality is high in the lossless data compression.	File quality is low in the lossy data compression.
7.	Lossless data compression mainly supports RAW, BMP, PNG, WAV, FLAC, and ALAC file types.	Lossy data compression mainly supports JPEG, GIF, MP3, MP4, MKV, and OGG file types.

Dithering

Dithering is the process by which we create illusions of the color that are not present actually. It is done by the random arrangement of pixels.

For example. Consider this image.



This is an image with only black and white pixels in it. Its pixels are arranged in an order to form another image that is shown below. Note at the arrangement of pixels has been changed, but not the quantity of pixels.

