ក្រសួងអប់រំ យុវជន និងកីឡា

Ministry of Education, Youth and Sport

Educational Multimedia

KOICA
Korea International Cooperation Agency

Korea National University of Education

PREFACE

Cambodian has taken steps toward developing a digital-based economy in accordance with the ever-changing world in the digital era wherein society is rich in information and technological competitiveness, which influence on daily living, work and society. Likewise, Information and Communication Technology is playing a crucial role in responding to the above trend.

In this regard, the Ministry of Education, Youth and Sport has a vision of developing well-rounded human resources with knowledge, skills, especially strengthening ICT skills with a goal to promote creation, innovation, research and sustainable daily problem-solving skill. Strengthening 21st-century skills, science and technology education, digital education, and teacher education institution reform are fundamental priorities in Education sector.

Ministry of Education, Youth and Sport, together with KOICA, has developed nine textbooks for providing pre-service training to ICT-subject trainees at Teacher Education Institutions such as (1) Introduction to Computers, (2) Data Communication and Computer Network, (3) Educational Multimedia, (4) Artificial Intelligence Programming, (5) Database, (6) Python Programming, (7) Informatics Education, (8) Digital Literacy Foundation and (9) STEAM Education based on ICT. These training materials will contribute to the support and implementation of teacher education institution reform throughout strengthening the ICT knowledge and skills of trainers to provide the training to the trainees who will be teachers in the future.

The Ministry of Education, Youth and Sport would like to express a profound gratitude to all stakeholders who have contributed to the compilation and development of textbooks for RTTCs and other Teacher Edcuation Institutions for the benefit of teacher educators, pre-service teachers, learners, and the Cambodian people.

The Ministry of Education, Youth and Sport hopes that these textbooks will be essential learning tools to support the digital economy transformation and teacher educators, pre-service teachers, and learners at all levels for capacity development on technological skills to solve problems in daily life.

Phnom Penh, 07th August 2023

Dr. HANG CHUON NARON
Minister
Ministry of Education, Youth and Sport

Project Management Committee

H.E. Dr. Nath Bunroeun
H.E Put Samith
Mr. Rho Hyunjun
Mr. Kim Junsu

Faculty Advisors
Korea National
University of Education

Dr. Ki-Sang Song (PM)
Dr. Taeyoung Kim
Dr. Youngsik Kim
Dr. KwiHoon Kim
Dr.Hyung-Jong Choe
Dr. Seung-Hyun Kim
Dr. Sang-Mok Jung
Dr. Kwan-Hee Yoo
Dr. In-Seong Jeon (PMO)

Project Technical Committee

H.E Put Samith
Mr. Kim Junsu
Dr. Ki-Sang Song (PM)
Ms. Pen Vuthyda
Mr. Ngor Penglong
Mr. Sun Bunna
Mr. Sok Tha
Mr. Pring Morokoath
Dr. Chhouk Chanchhaya
Mr. Seng Sim
Mr. Oeur Sokmeng
Mr. Bouy Vuthy
Mr. Nget Soda

Author Committee

Dr. Chhouk Chan Chhaya
Mr. Sopheap Vannpheakdey
Mr. Chhom Leang
Mr. Hout Panharith
Mr. Miech Thuy
Mr. Phel Phearoun
Ms. Pok Pisey
Mr. Samang Mengheng
Mr. San Phun
Mr. Sok Chea
Mr. Sorn Rithy
Mr. Toy Kompheak
Mr. Ty Puthy
Mr. Uk Borath
Mr. Uk Samphors
Mr. Lay Sokchea
Mr. Phin Phal

Preface for Educational Multimedia

Information and Communication Technology (ICT) are very important parts of today's development. In fact, in the field of education, the use of ICT has made a significant contribution to the development of highly effective human resources. Therefore, as a teacher in this digital age, you must have a basic knowledge of the use of ICT.

Under the Project of ICT Capacity Building for Lower Secondary Education in Cambodia, supported by the Korea International Cooperation Agency with the cooperation of the Ministry of Education, Youth, and Sports (MoEYS) of Cambodia, the development of ICT textbooks is also a part of this project.

The Educational Multimedia Book was developed with the aim of providing basic knowledge of ICT to general learners, especially teacher trainees who are training at the Regional Teacher Training Centre (RTTC) in Cambodia. In this book, there are 13 chapters divided into three sections. The first section discusses multimedia, which is covered in chapters 1 through 3. In this section, we provide a basic understanding of multimedia and how to use multimedia applications. In the second section, we look at computer graphics from chapters 4 to 8. The emphasis in computer graphics is on how to use Adobe Photoshop. And in the last section, from chapters 9 to 13, we consider web programming. The basics of HTML, CSS, and JavaScript are included in this section.

In addition, qualified instructors can access the following supplements, which provide access to the following resources: syllabus, lesson plan, PowerPoint lecture slides, electronic guidelines, and instructor's guide with chapter review problem solutions.

Due to the limited time required to develop this book, it still has some shortcomings in terms of continuous improvement. We hope that through this book, all learners, especially teacher trainees, will gain basic knowledge related to ICT subjects and be able to fully teach students about ICT subjects in lower secondary schools in Cambodia.

Contents

Chapter 01

Introduction to Multimedia

Learning Objective:

The objective of this chapter is to introduce you to the fundamental principles of multimedia. It will provide a basic understanding of multimedia elements. The emphasis will be on studying multimedia representations, perceptions, and applications. Software abilities and hands-on experience with digital media will be stressed as well. After completing the chapter, students will grasp the technologies behind multimedia applications and be able to design multimedia projects.

After completing this chapter, students should be able to:

- Understand what multimedia is
- Explain the term multimedia in computing
- Classify the elements of multimedia
- Use multimedia in daily life.

In this chapter, you will learn about:

1.1. What is Multimedia?

1.1.1. The Term "Multimedia."

The word multimedia comprises two parts: the prefix multi and the root media. The prefix multi does not pose any difficulty; it comes from the Latin word multus, which means "numerous." The use of multi as a prefix is not recent, and many Latin words employ it. The root media has a more complicated story. Media is the plural form of the Latin word medium. Medium is a noun and means "middle, center."

Today, multimedia is often used as an attribute for many systems, components, products, and concepts that do not meet the key properties we will introduce later.

1.1.2. The Term "Media"

As with most generic words, the meaning of the word media varies with the context in which it is used. Our definition of medium is "a means to distribute and represent information." Media are, for example, *text*, *graphics*, *pictures*, *voice*, *sound*, and *music*. In this sense, we could add water and the atmosphere to this definition. A subtle differentiation of diverse aspects of this term uses various criteria to distinguish between perception, representation, presentation, storage, transmission, and information exchange media. The following sections describe these attributes.

1) Perception Media

Perception media refers to the nature of information perceived by humans, which is not strictly identical to the sense stimulated. For example, a still image and a movie conveys information of a different nature, though stimulating the same sense. The question to ask here is: *How do humans perceive information?*

In this context, we primarily distinguish between what we see and hear. Auditory media include music, sound, and voice. Visual media include text, graphics, and still and moving pictures. This differentiation can be further refined. For example, a visual medium can consist of moving pictures, animation, and text. In turn, moving pictures typically consist of a series of scenes that, in turn, are composed of single pictures.

2) System Requirements

The term representation media refers to how information is represented internally to the computer. The encoding used is of essential importance. The question to ask here is: *How is information encoded in the computer?*

There are several options:

- Each character of a piece of text is encoded in **ASCII**.
- A picture is encoded by the **CEPT** or **CAPTAIN** standard, or the **GKS** graphics standard can serve as a basis.
- An audio data stream is available in simple **PCM** encoding and a linear quantization of 16 bits per sampling value.
- A single image is encoded as a Group-3 facsimile or in **JPEG** format.
- A combined audio-video sequence is stored in the computer in various TV standards (*e.g., PAL, SECAM, or NTSC*), in the **CCIR-601** standard, or **MPEG** format.

3) Presentation Media

The term presentation media refers to the physical means used by systems to reproduce information for people. For example, a TV set uses a cathode-ray tube and loudspeaker. The question here is: *Which medium is used to output information from the computer or input in the computer?*

We distinguish primarily between output and input. Media such as paper, computer monitors, and loudspeakers are output media, while keyboards, cameras, and microphones are input media.

4) Storage Media

Storage media is often used in computing to refer to various physical means for storing computer data, such as magnetic tapes, magnetic disks, USB, SSD, or digital optical disks. However, data storage is not limited to the components available in a computer, which means that paper is also considered a storage medium. The question to ask here is: *Where is information stored?*

5) Transmission Media

The term transmission media refers to the physical means: cables of various types, radio towers, satellites, or ether (the medium that transmits radio waves): that allow the transmission of telecommunication signals. The question here is: *Which medium is used to transmit data?*

6) Information Exchange Media

Information exchange media includes all data media used to transport information, e.g., all storage and transmission media. The question is: *Which data medium is used to exchange information between different locations?*

For example, information can be exchanged by storing it on a removable medium and transporting the medium from one location to another. These storage media include microfilms, paper, and floppy disks. Likewise, information can also be exchanged directly if transmission media such as coaxial cables, optical fibers, or radio waves are used.

7) Presentation Spaces and Presentation Values

The terms described above serve as a basis to characterize the term medium in the information processing context. The description of perception media is closest to our definition of media: those media concerned mainly with the human senses. Each medium defines presentation values in presentation spaces, which address our five senses.

Paper or computer monitors are examples of visual presentation spaces. A computer-controlled slide shows that projects a screen's content over the entire projection screen is a visual presentation space. Stereophony and quadrophonic define acoustic presentation spaces. Presentation spaces are part of the above-described presentation media used to output information.

Presentation values determine how information from various media is represented. While text is a medium that represents a sentence visually as a sequence of characters, voice is a medium that represents information acoustically in the form of pressure waves. In some media, humans cannot interpret the presentation values correctly. Examples include temperature, taste, and smell. Other media require a predefined set of symbols we have

to learn to be able to understand this information. This class includes text, voice, and gestures.

Presentation values can be available as a continuous sequence or a sequence of single values. Fluctuations in pressure waves do not occur as single values; they define acoustic signals. Electromagnetic waves in the range perceived by the human eye are not scanned with regard to time, which means that they form a continuum. The characters of a piece of text and the sampling values of an audio signal are sequences composed of single values.

8) Presentation Dimensions

Each presentation space has one or more presentation dimensions. A computer monitor has two space dimensions, while holography and stereophony need a third one. Time can occur as an additional dimension within each presentation space, which is critical for multimedia systems. Media are classified into two categories with regard to the time dimensions of their presentation space:

1. Text, graphics, and pictures are called discrete media, as they are composed of time-independent information items. Indeed, they may be displayed according to a wide variety of timing or even sequencing and still remain meaningful. We say that time is not part of the semantics of discrete media. The term discrete tends to blur, as modern computer-based text and graphics presentations are often value-discrete and time-continuous. For example, the text of a book is a discrete medium. Each method used to process discrete media should be as fast as possible. On the other hand, time is not the critical factor because the data's validity (and thus correctness) does not depend on a time condition (at least not within a time frame of seconds or less). We could also speak about longer of shorter time conditions.
2. Continuous media refers to sound or motion video, where the presentation requires a continuous playout as time passes. In other words, time, or more precisely time dependency between information items, is part of the information itself. If the timing is changed or the sequencing of the items is modified, the meaning is altered. We say that time is part of the semantics of continuous media. Continuous media are also called time-dependent media. Another technical consequence when dealing with continuous media is requiring the networks that

carry them to respect this time dependency. How these media are processed is time-critical because data validity (correctness) depends on a time condition. Suppose an audio sampling value is transmitted too late. In that case, it may become invalid or wrong since the audio data that follow this value have already been played out over the loudspeaker. In audio and video, the representation values form a continuous sequence, where video means pure moving images. A combination of audio and moving images, like in television or movies, is not synonymous with the term video. For this reason, they are called continuous media. When time-dependent representation values that occur periodically are distinguished, they are often not put under the continuous media category. For a multimedia system, we also have to consider such non-continuous sequences of representation values. This representation-value sequence occurs when information is captured by a pointer (e.g., a mouse) and transmitted within cooperative applications using a common screen window. Here, the continuous medium and time-dependent medium are synonymous. By this definition, continuous media are video (moving images) of natural or artificial origin, audio, which is normally stored as a sequence of digitized pressure-wave samples, and signals from various sensors, such as air pressure, temperature, humidity, pressure, or radioactivity sensors.

The terms that describe a temporally discrete or continuous medium do not refer to the internal data representation, for example, in how the term representation medium has been introduced. They refer to the impression that the viewer or auditor gets. The movie example shows that continuous-media data often consist of a sequence of discrete values, which follow one another within the representation space as a function of time. In this example, a sequence of at least 16 single images per second gives the impression of continuity due to the human eye’s perceptual mechanisms.

Based on word components, we call any system a multimedia system that supports more than one medium. However, this characterization falls short as it provides only a quantitative evaluation. Each system could be classified as a multimedia system that processes both text and graphics media. Such systems have been available for quite some time, so they would not justify the newly

coined term. The term multimedia is more of a qualitative than a quantitative nature.

The number of supported media is less decisive than the type of supported media for a multimedia system to live up to its name. Note that there is controversy about this definition. Even standardization bodies normally use a coarser interpretation.

1.1.3. A Classification of Multimedia

The classification of multimedia is as follows:

- Text - ASCII/Unicode, HTML, Postscript, PDF
- Audio – Sound, music, speech, structured audio (e.g. MIDI)
- Still Image - Facsimile, photo, scanned image
- Video (Moving Images) – Movie, a sequence of pictures
- Graphics – Computer-produced image
- Animation – A sequence of graphics images
- Discrete Media (DM, Static): Text, image, graphics
- Continuous Media (CM, Dynamic): Audio, video, animation
- Captured vs. Synthesized media
- Standalone vs. Networked media

1.1.4. System Implication of Multimedia

Multimedia imposes new requirements on all parts of the system architecture:

- Representation: digitization and coding (compressing)
- Storage: database, larger volumes, and new access patterns
- Processing: OS, scheduling, indexing, searching
- Understanding: speech/object recognition, content analysis
- Production: more complex authoring and user interface software
- Presentation: user perception, user friendly in HCI (Human Computer Interface)
- Protection: media encryption, copyright, privacy
- Distribution: media delivery and broadcast
- Communication: media transmission over network/internet, session control

1.1.5. Key Properties of a Multimedia System

Multimedia systems involve several fundamental notions. They must be computer-controlled. Thus, at least a computer must present the information to the user. They are integrated, and they use a minimal number of different devices. An example is the use of a single computer screen to display all types of visual information. They must support media independence. And lastly, they need to handle discrete and continuous media. The following sections describe these key properties.

1) Discrete and Continuous Media

Not just any arbitrary combination of media deserves the name multimedia. Many people call a simple word processor that handles embedded graphics a multimedia application because it uses two media. By our definition, we talk about multimedia if the application uses both discrete and continuous media. This means that a multimedia application should process at least one discrete and one continuous medium. A word processor with embedded graphics is not a multimedia application by our definition.

2) Independent Media

An important aspect is that the media used in a multimedia system should be independent. Although a computer-controlled video recorder handles audio and moving image information, there is a temporal dependence between the audio and video parts. In contrast, a system that combines signals recorded on a DAT (Digital Audio Tape) recorder with some text stored in a computer to create a presentation meets the independence criterion. Other examples are combined text and graphics blocks, which can be in an arbitrary space arrangement in relation to one another.

3) Computer-Controlled System

Media independence creates a way to combine media in an arbitrary form for presentation. For this purpose, the computer is the ideal tool. That is, we need a system capable of processing media in a computer-controlled way. The system can be optionally programmed by a system programmer and/or a user (within certain limits). The simple recording or playout of various media in a system, such as a video recorder, is insufficient to meet the computer-control criterion.

4) Integration

Computer-controlled independent media streams can be integrated to form a global system so that, together, they provide a certain function. To this end, synchronic relationships of time, space, and content are created between them. A word processor that supports text, spreadsheets, and graphics only meets the integration criterion if it allows program-supported references between the data. We achieve a high degree of integration only if the application is capable of, for example, updating graphics and text elements automatically as soon as the contents of the related spreadsheet cell change.

This kind of flexible media handling is not a matter to be taken for granted-even in many products sold under the multimedia system label. This aspect is essential when talking about integrated multimedia systems. Such systems should allow us to do with moving images and sound what we can do with text and graphics. While conventional systems can send a text message to another user, a highly integrated multimedia system provides this function and support for voice messages or a voice-text combination.

5) Summary

Several properties that help define the term multimedia have been described, where the media are of central significance. This book describes networked multimedia systems. This is important as almost all modern computers are connected to communication networks. We take a step backward if we study multimedia functions from a local computer's perspective. Also, distributed environments offer the most interesting multimedia applications as they enable us not only to create, process, represent, and store multimedia information but to exchange them beyond the limits of our computers.

1.1.6. Force Driving the Multimedia Revolution

It can be summarized as follows:

- Evolution of communication and data networks: Increasing bandwidth availability on demand in the office, home, and road. Thanks to high-speed data modems, cable modems, hybrid fiber-coax systems, 4G, 5G, xDSL, and wireless.
- Ubiquitous access to a network. Via local-area networks (LAN), wireline and wireless networks, Giga Internet, World Wide Web, "anywhere, anytime."

- Fast processor and large-capacity storage devices, including 3-D hardware
- New algorithms and data structures. Compression techniques, graphics, computer vision, speech understanding.
- Smart terminals, such as digital phones, smartphones, multimedia PCs, web TV, personal digital assistants, etc., access and interact with the network with wired and wireless connections.
- Furthermore, of foremost significance is the digitization of virtually any device: cameras, video capture, and playback devices, handwriting terminals, sound capture, etc., together with plug-and-play standards; and the digitization of text/audio/video documents and libraries that allows better communications, storage, and fast access and browsing.
- Techniques for compressing and coding the various media: models, algorithms, forms, standards, etc.
- Communications aspects: downloading and streaming techniques, synchronization, layering of signals, issues involved in the definition of QoS (quality of service).
- Techniques for accessing multimedia signals by providing tools that match the user to the machine: "natural" spoken language queries, media conversion tools and multimodal user interface (speech recognition, lip reading, face tracking, OCR), agents that monitor the multimedia sessions, and assist in all phases of access and utilization.
- Techniques for organizing, storing, and retrieving multimedia, searching and browsing individual multimedia documents and libraries

In a multimedia system, multimedia is the processing of audio, images, and video content. In this regard, we will discuss audio, images, and videos in detail.

1.2. Multimedia Data Compression

1.2.1. Storage Space

Uncompressed graphics, audio, and video data require substantial storage capacity, which is not possible in the case of uncompressed video data, even given today's storage unit. The same is true for multimedia communications. Data transfer of uncompressed video data over digital networks requires that very high bandwidth be provided for a

single point-to-point communication. Multimedia systems must use compressed video and audio streams to be cost-effective and feasible.

Most compression methods address the same problems, one at a time or in combination. Most are already available as products. Others are currently under development or are only partially completed. While fractal image compression may be significant in the future, the most important compression techniques in use today are JPEG for single pictures, H.263 (p×64) for video, MPEG for video and audio, as well as proprietary techniques such as QuickTime from Apple and Video for Windows from Microsoft.

Developers and multimedia experts often need a good understanding of the most popular techniques in their daily work. However, most of today's literature is either too comprehensive or is dedicated to just one of the above-mentioned compression techniques, which is then described from a very narrow point of view.

1.2.2. Coding Requirements

Images have considerably higher storage requirements than text, and audio and video have still more demanding properties for data storage. Moreover, transmitting continuous media also requires substantial communication data rates. The figures cited below clarify the qualitative transition from simple text to full-motion video data and demonstrate the need for compression. To be able to compare the different data storage and bandwidth requirements of various visual media (text, graphics, images, and video), the following specifications are based on a small window of 640×480 pixels on display.

The following always holds:

- 1kbit = 1000bit
- 1Kbit = 1024bit
- 1Mbit = 1024×1024bit

1) Screen Page Storage

1. For the representation of the text medium, two bytes are used for every 8×8pixel character.

   Character per screen page = $\frac{640 \times 480}{8 \times 8} = 4{,}800$

   Storage required per screen page = 4,800 × 2 byte = 9,600 byte = 9.4 Kbyte

2. We assume that a typical image consists of 500 lines representing vector images. Each line is defined by its coordinates in the x and y directions and by an 8-bit attribute field. Coordinates in the x direction require 10 bits (log2 (640)), while coordinates in the y direction require 9 bits (log2 (480)).

Bits per line = 9bits + 10bits + 9bits + 10bits + 8bits = 46bits

Storage required per screen page = $500 \times \frac{46}{8} = 2{,}875 \text{ byte} = 2.8 \text{Kbyte}$

3. Individual pixels of a bitmap can be coded using 256 different colors, requiring a single byte per pixel.

Storage required per screen page = 640×480 ×1byte = 307,200 byte 300Kbyte

2) One Second of Playback Storage

The following examples specify continuous media and derive the storage required for one second of playback.

1. Uncompressed speech of telephone quality is sampled at 8 kHz and quantized using 8 bits per sample, yielding a data stream of 64Kbit/s.

Required storage space/s = $\frac{64 \text{ Kbit/s}}{8 \text{ bit/byte}} \times \frac{1 \text{ s}}{1{,}024 \text{ byte/Kbyte}} = 8 \text{ Kbyte}$

2. An uncompressed stereo audio signal of CD quality is sampled at 44.1 kHz and quantized using 16 bits.

Data rate = $2 \times \frac{44{,}100}{\text{s}} \times \frac{16 \text{ bit}}{8 \text{ bit/byte}} = 176{,}400 \text{ byte/s}$

Required storage space/s = $176{,}400 \text{ byte/s} \times \frac{1 \text{ s}}{1{,}024 \text{ byte/Kbyte}} = 172 \text{ Kbyte}$

2. A video sequence consists of 25 full frames per second. The luminance and chrominance of each pixel are coded using a total of 3 bytes. According to the European PAL standard, each frame consists of 625 lines and has a horizontal resolution of more than 833 pixels. The luminance and color difference signals are encoded separately and transmitted together using a multiplexing technique (4:2:2).

According to the studio standard for digital video, the luminance (Y) is sampled at 13.5MHz, while chrominance (R–Y and B–Y) is sampled using 6.75MHz. Samples are coded uniformly using 8 bits.

Bandwidth = (13.5 MHz + 6.75 MHz + 6.75 MHz) × 8bit = 216×106 bit/s.

Data rate = 640 × 480 × 25 × 3 byte/s = 23,040,000 byte/s

Required storage space/s = $2{,}304 \times 10^4$ byte/s $\times \frac{1\,\text{s}}{1{,}024\ \text{byte/Kbyte}} = 22{,}500\text{Kbyte}$

High-resolution television uses twice as many lines and an aspect ratio of 16:9, yielding a data rate 5.33 times that of current televisions.

These examples briefly illustrate the increased demands on a computer system in terms of required storage space and data throughput if still images and, in particular, continuous media are to be processed. Processing uncompressed video data streams in an integrated multimedia system require storage space in the gigabyte range and buffer space in the megabyte range. The throughput in such a system can be as high as 140Mbit/s, which must also be transmitted over networks connecting systems (per unidirectional connection). This kind of data transfer rate is not realizable with today's technology or soon with reasonably priced hardware.

3) Compression Techniques

Table 1.1 shows only a sampling of all coding and compression techniques. The emphasis is on the most important algorithms for multimedia systems and their properties. To better understand the hybrid schemes, we consider a set of typical processing steps common to all techniques (entropy, source, and hybrid).

Table 1.1: Overview of Coding and Compression Techniques

Coding Type	Basis	Technique
Entropy	Run-length Coding	
	Huffman Coding	
	Arithmetic Coding	
Source Coding	Prediction	DPCM
		DM
	Transformation	FFT
		DCT

	Layered Coding (according to importance)	Bit Position
		Sub Sampling
		Sub-band Coding
	Vector Quantization	
Hybrid Coding	JPEG	
	MPEG	
	H.26x	
	Many Proprietary Systems	

Entropy Coding

Entropy coding can be used for different media regardless of the medium's specific characteristics. The data to be compressed are viewed as a sequence of digital data values, and their semantics are ignored. It is lossless because the data prior to encoding is identical to the data after decoding; no information is lost. Thus run-length encoding, for example, can be used for compression of any data in a file system, for example, text, still images for facsimile, or as part of a motion picture or audio coding.

Source Coding

Source coding takes into account the semantics of the information to be encoded. The degree of compression attainable with this often-lossy technique depends on the medium. In the case of lossy compression, a relation exists between the encoded data and the decoded data; the data streams are similar but not identical. The characteristics of the medium can be exploited. In the case of speech, a considerable amount of data reduction can be achieved by transforming the time-dependent signal into the frequency domain, followed by an encoding of the formants.

In the case of still images, spatial redundancies can be used for compression through a content prediction technique. Other techniques transform the spatial domain into the two-dimensional frequency domain, using the cosine transform. Low frequencies define the average color, and the information of higher frequencies contains sharp edges. Hence,

low frequencies are much more important than higher frequencies, a feature that can be used for compression.

Hybrid Coding

The hybrid coding of natural and synthetic data allows, for the first time, a smooth integration of natural and synthetic audiovisual objects and thus represents a first step towards the complete integration of all sorts of types of audiovisual information.

4) Well-Known Compression Algorithms

The critical compression techniques used in multimedia systems all represent a combination of many well-known algorithms.

JPEG

JPEG is the standard for still image coding that will have the most significance in the future. Its far-reaching definition allows a large number of degrees of freedom. For example, an image can have up to 255 components, that is, levels. An image can consist of up to 65,535 lines, each of which can contain up to 65,535 pixels. Compression performance is measured in bits per pixel. This is an average value calculated as the quotient of the total number of bits in the coded picture and the number of pixels in the picture. That said, the following statements can be made for DCT-coded still images:

- 0.25 to 0.50bit/pixel: moderate to good quality; sufficient for some applications.
- 0.50 to 0.75bit/pixel: good to very good quality; sufficient for many applications.
- 0.75 to 1.50bit/pixel: excellent quality; suitable for most applications.
- 1.50 to 2.00bit/pixel: often barely distinguishable from the original; sufficient for almost all applications, even those with the highest quality requirements.

In lossless mode, a compression ratio of 2:1 is achieved despite the remarkable simplicity of the technique. Today JPEG is commercially available in software as well as in hardware and is often used in multimedia applications that require high quality. The primary goal of JPEG is the compression of still images. However, in the form of Motion

JPEG, JPEG can also be used for video compression in applications such as medical imaging.

H.26x

H.26x are already established standards. These were mainly supported by associations of telephone and wide area network operators. Due to the very restricted resolution of the QCIF format and reduced frame rates, implementing H.26x encoders and decoders does not cause any significant technical problems today. This is especially true if motion compensation and the optical low-pass filter are not components of the implementation, although the quality is not always satisfactory in this case. The quality is acceptable if the image is encoded in CIF format at 25 frames/s using motion compensation. H.26x is mainly used for dialogue mode applications in network environments, for example, video telephony and conferencing. The resulting continuous bit rate is eminently suitable for today's wide area networks operating with ISDN, leased lines, or even GSM connections.

MPEG

MPEG is the most promising standard for future audio and video compression use. Although the JPEG group has a system that can also be used for video, it is overly focused on the animation of still images instead of using the properties of motion pictures. The quality of MPEG video (without sound) at about 1.2Mbit/s, appropriate for CD-ROM drives, is comparable to that of VHS recordings. The compression algorithm works very well at a resolution of about 360×240 pixels. Obviously, higher resolutions can also be decoded. However, quality is sacrificed at a resolution of, for example, 625 lines. The future of MPEG points towards MPEG-2, which defines a data stream compatible with MPEG-1, but provides data rates up to 100Mbit/s. This significantly improves the currently available quality of MPEG-coded data.

MPEG also defines an audio stream with various sampling rates, ranging up to DAT quality, at 16bit/sample. Another essential part of the MPEG group's work is the definition of a data stream syntax.

Further, MPEG was optimized using the retrieval model for application areas such as tutoring systems based on the Web and interactive TV. Embedding this optimization in MPEG-2 will allow TV and HDTV quality at the expense of a higher data rate. MPEG-

4 will provide high compression ratios for video and associated audio and is an appropriate tool for creating classes of new multimedia applications.

JPEG, H.26x, MPEG, and other techniques should not be viewed as competing alternatives for data compression. Their goals are different and partly complementary. Most of the algorithms are very similar but not identical. Technical quality, as well as market availability, will determine which of these techniques will be used in future multimedia systems. This will lead to cooperation and convergence of the techniques. For example, a future multimedia computer could generate still images using JPEG, use H.26x or MPEG-4 for video conferencing, and need MPEG-2 to retrieve stored multimedia information. It is, however, a purely hypothetical conception and is not in any way meant to prejudge future development or strategies for these systems.

Summary

In this chapter, you have learned:

A multimedia is a form of communication that uses a combination of different content forms, such as *text*, *audio*, *images*, *animations*, or *video*, into a single interactive presentation, in contrast to traditional mass media, such as printed material or audio recordings, which features little to no interaction between users. Popular examples of multimedia include video podcasts, audio slideshows, and animated videos. Multimedia also contains the principles and application of effective interactive communication, such as the building blocks of software, hardware, and other technologies.

The classifications of multimedia are text, audio, still image, video (moving images), graphics, animation, discrete media, captured vs. synthesized media, and standalone vs. networked media.

Multimedia systems involve several fundamental notions. They must be computer-controlled. Thus, at least a computer must present the information to the user. They are integrated; they use a minimal number of different devices. An example is the use of a single computer screen to display all types of visual information. They must support media independence. And lastly, they need to handle discrete and continuous media. Key properties of a Multimedia System:

- Discrete and Continuous Media
- Independent Media
- Computer-Controlled System
- Integration

Data compression is the process of encoding information using fewer bits than the original representation. Any particular compression is either lossy or lossless. Lossless compression reduces bits by identifying and eliminating statistical redundancy. No information is lost in lossless compression. Lossy compression reduces bits by removing unnecessary or less important information.

Questions

1) What is multimedia?
2) What is a multimedia system?
3) What are the benefits of multimedia?
4) Give four advantages and disadvantages of multimedia.
5) What are the driving forces for the multimedia revolution?
6) List some examples of multimedia applications.
7) List all basic elements of multimedia.
8) What are the four essential characteristics of the multimedia system?

Exercises

1) Summarize the history of multimedia.
2) Explain the key properties of multimedia systems.
3) Research and organize the multimedia used in everyday life.
4) Research more about storage devices that can store multimedia information.

Additional Reading:

1) A. Hampapur, R. Jain, and T. Weymouth. “Digital video indexing in multimedia systems.” In Proceedings of the Workshop on Indexing and Reuse in Multimedia Systems. American Association of Artificial Intelligence, Aug. 1994.
2) D.P. Anderson, R. Govindan, and G. Homsy. “Abstractions for Continuous Media in a Network Window System.” Technical Report UCB/CSD 90/596, Computer Science Division, UC Berkeley, Berkeley, CA, September 1990.
3) F. Arman, A. Hsu, and M.-Y. Chiu. “Image processing on compressed data for large video databases.” ACM Multimedia, pages 267–272, June 1993.
4) K. B. Benson and D. G. Fink. HDTV—Advanced Television for the 1990s. Intertext Publications, McGraw-Hill Publishing Company, Inc., 1991.
5) J. Chowning. “The simulation of a moving sound source.” Journal of the Audio Engineering Society, 41(11), 1971.
6) J.J. Encarnacao and J.D. Foley. Multimedia. Springer-Verlag, Berlin, 1994.
7) W. Effelsberg and R. Steinmetz. Video Compression Techniques. dpunktVerlag, Heidelberg, 1998.

Chapter 02

Audio, Image, Video

Learning Objective:

The objective of this chapter are to introduce audio, image, and video. It presents the principles of using audio, image, and video as a part of multimedia content. Further, this chapter examines audio, image, and video elements in depth.

After completing this chapter, students should be able to:

- Explain what audio is and how it works
- Describe what an image is
- Define video by explaining what it is

In this chapter, you will learn about:

2.1. Audio

Audiology is the discipline interested in manipulating acoustic signals that humans can perceive. Essential aspects are psychoacoustics, music, and the MIDI (Musical Instrument Digital Interface) standard. In addition to providing an introduction to basic audio signal technologies and the MIDI standard.

2.1.1. What is Sound?

Sound is a physical phenomenon caused by the vibration of material, such as a violin string or a wood log. This type of vibration triggers pressure wave fluctuations in the air around the material. The pressure waves propagate in the air. The pattern of this oscillation (*See Figure 2.1*) is called a waveform. We hear a sound when such a wave reaches our ears.

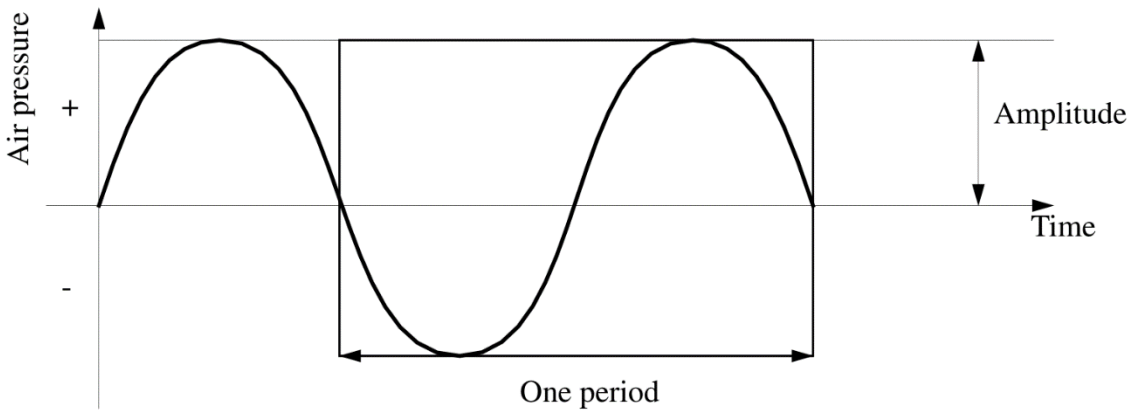


Figure 2.1: Pressure Wave Oscillation in the Air

This waveform repeatedly occurs at regular intervals or periods. Sound waves have a natural origin, so they are never absolutely uniform or periodic. A sound with a recognizable periodicity is referred to as music rather than sound, which does not have this behavior. Examples of periodic sounds are sounds generated by musical instruments, vocal sounds, wind sounds, or a bird's twitter. In contrast, non-periodic sounds are, for example, drums, coughing, sneezing, or the brawl or murmur of water.

1) Frequency

A sound's frequency is the reciprocal value of its period. Similarly, the frequency represents the number of periods per second and is measured in hertz (Hz) or cycles per second (cps). A common abbreviation is kilohertz (kHz), which describes 1,000 oscillations per second, corresponding to 1,000Hz.

Sound processes that occur in liquids, gases, and solids are classified by frequency range:

- Infrasonic: 0 to 20Hz
- Audiosonic: 20Hz to 20kHz
- Ultrasonic: 20kHz to 1GHz
- Hypersonic: 1GHz to 10THz

Sound in the audiosonic frequency range is primarily essential for multimedia systems. This text uses audio as a representative medium for all acoustic signals in this frequency range. The waves in the audiosonic frequency range are also called acoustic signals. Speech is the signal humans generate by the use of their speech organs. Machines can reproduce these signals. For example, music signals have frequencies in the 20Hz to 20kHz range. We could add noise to speech and music as another type of audio signal. Noise is defined as a sound event without functional purpose, but this is not a dogmatic definition. For instance, we could add unintelligible language to our definition of noise.

2) Amplitude

A sound has a property called amplitude, which humans perceive subjectively as loudness or volume. The amplitude of a sound is a measuring unit used to deviate the pressure wave from its mean value (idle state).

3) Sound Perception and Psychoacoustics

The way humans perceive sound can be summarized as a sequence of events: Sound enters the ear canal. At the eardrum, sound energy (air pressure changes) is transformed into mechanical energy of eardrum movement. The outer ear comprises the pinna, composed of cartilage, and has a relatively poor blood supply. Its presence on both sides of the head allows us to localize the source of sound from the front versus the back. Our ability to localize from side to side depends on the relative intensity and relative phase of sound reaching each the ear and the analysis of the phase/intensity differences within

the brainstem. The cochlea is a snail-shaped structure that is the sensory organ of hearing. The vibrational patterns initiated by vibration set up a traveling wave pattern within the cochlea. This wavelike pattern causes a shearing of the cilia of the outer and inner hair cells. This shearing causes hair cell depolarization resulting in on/off neural impulses the brain interprets as sound.

Psychoacoustics is a discipline that studies the relationship between acoustic waves at the auditory ossicle and the spatial recognition of the auditor. We distinguish between two main perspectives, described briefly in the following sections.

The Physical Acoustic Perspective

Figure 2.2 is a simplified schematic representation of an auditor who perceives sound. Sound from a sound source diffuses in concentric pressure waves. The distance can describe the position of the source to the center of the auditor's head by two angles: one on the horizontal and one on the vertical level. It is evident that sound waves originating from a source arranged on the right side of the auditor reach the right ear earlier than the left one. The time difference between sound waves reaching the ears is called interaural time difference (ITD). If a sound source prevails almost totally on one side, i.e., at an angle of 90 degrees from the auditor, then ITD reaches a maximum of approximately 0.7ms to 0.8ms. If the sound source is close, i.e., if the distance between the source and the auditor is very short, then the interaural intensity difference (IID) differs significantly from zero. These two characteristics of sound waves arriving at the ear can be measured and described and represent the basis for spatial recognition.

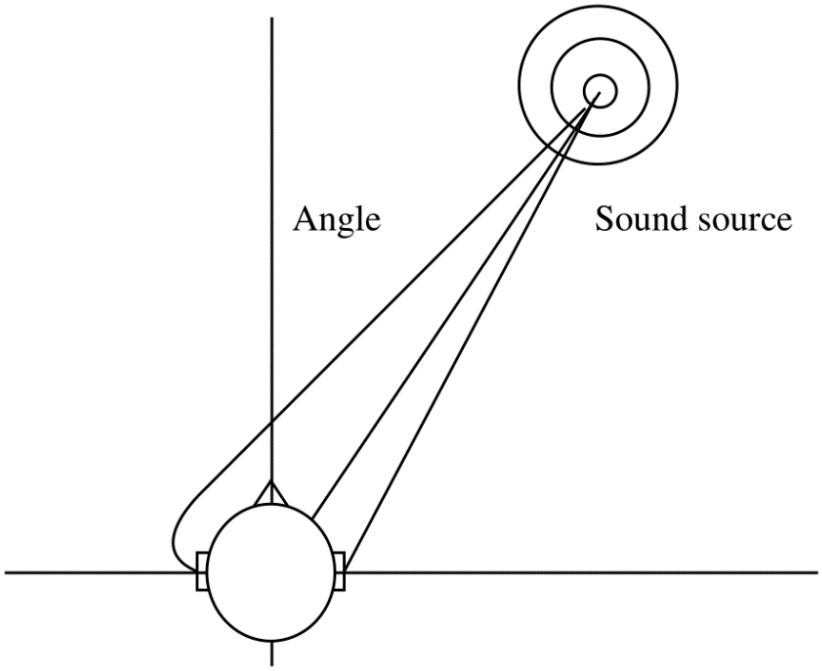


Figure 1.2: The Basics of Sound Perception

An important property of the basic hearing process can be determined in the frequency range. When sound waves reach the auditor's ear, they change due to the interaction between the original wave and the auditor's body. For example, in the 3-kHz range, there is a strong resonance in the perception of size caused by the resonance in the hearing canal. These properties can be measured and documented as a head-related transfer function (HRTF). Since the interaction between the sound waves and the auditor's body is complex, it generates a strong dependence on the horizontal and vertical angles in which the sound source is arranged.

Another important aspect of spatial sound recognition is the physical acoustics of natural sounds. Similarly, to all systems based on the wave model, the laws of reflection, refraction, and dispersion apply to the longitudinal diffusion of sound waves in air (these waves reach a speed of 344m/s). In a closed room, each surface reflects sound waves. All waves will eventually reach the human ear, reflected many times on the way from the sound source to the ear. The sound that reaches the ear directly includes information about the horizontal and vertical angles of the sound source. Other waves, derived from direct waves, arrive later and provide additional information about the room's properties. The relationship between direct and derived waves can be used to get an idea about the distance between the source and the auditor. This allows us to expand and apply basic

localization rules to moving sound sources or auditors. To achieve this expansion, we measure the sound speed, which is also called the doubling effect. The sound spectrum of a sound source moving towards an auditor drift upwards, while the source spectrum moving away from an auditor drift downwards. It is not difficult to determine this effect; an everyday example is when a piercing ambulance siren passes us.

The Psychoacoustic Perspective

The so-called first wave-front law is one of the fundamental properties of humans' spatial hearing perception. This law says that an auditor's judgment about the direction of an acoustic event is primarily influenced by the sound that takes the shortest and most direct way. In a test environment, a listener was seated in front of two loudspeakers of identical make. Although both issued sound at the same amplitude, the listener localized it stronger on the right side because the left loudspeaker transmitted with a delay of approximately 15ms. When the delay exceeded 50ms, the listener perceived two different sound events from the left and right loudspeakers. To compensate for the effect produced by this delay, we can increase the amplitude of the delayed channel (Haas effect).

As with all human perception channels, the ear's cochlea transforms stimulation logarithmically. The size of a sound pressure level (SPL) is measured in decibels. An audibility threshold value of 20 micropascal is the limit value above which a sound can just about be perceived. This value functions as a basis of the sound pressure, measured in decibels. The dynamic range of the ear's sound recognition is in the range of up to 130 dB.

Table 2.1: Various Sound Pressure Examples

Sound example	Sound pressure size
Rustling of paper	20 dB
Spoken language	60 Db
Heavy road traffic	80 Db
Rock band	120 dB
Pain sensitivity threshold	130 dB

The perception sensitivity we call loudness is not linear across all frequencies and intensities. The Fletcher-Munson graphics (of 1933) show the sound intensity required

to enable the perception of constant loudness. Human sound perception is most sensitive in the mean frequency ranges between 700Hz and approximately 6,600Hz. The equal loudness curves of Fletcher and Munson (*See Figure 2.3*) show that the human hearing system responds much better to the mean frequency range than it does to low and very high frequencies.

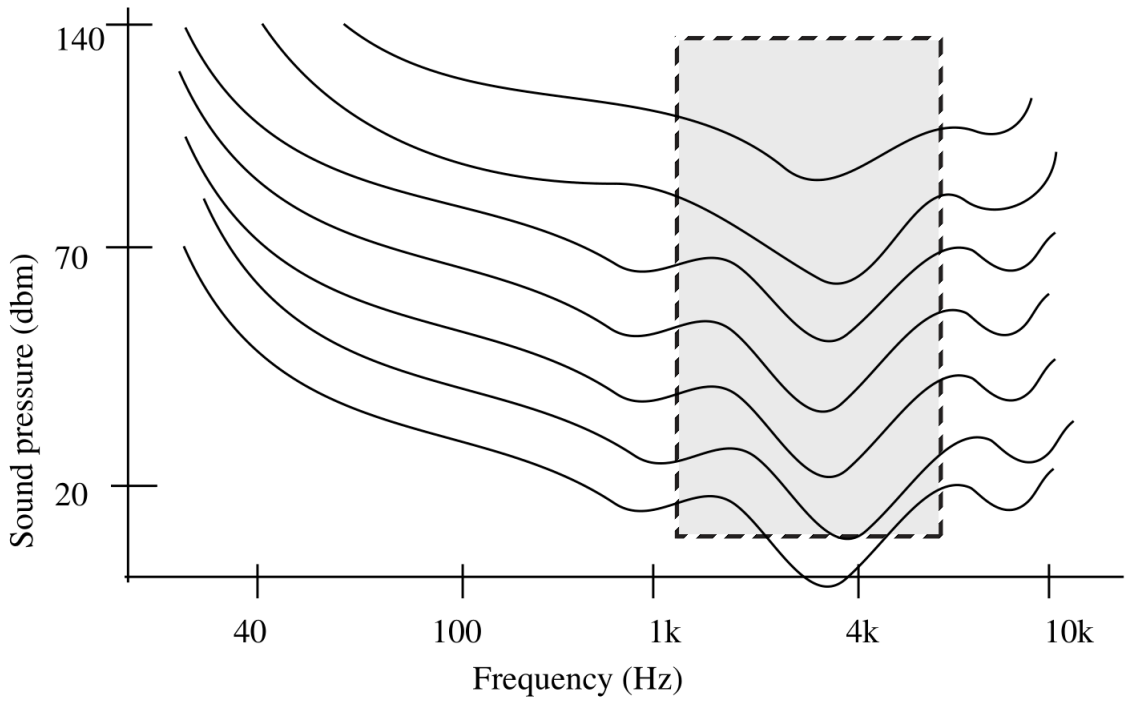


Figure 2.3: Equal Loudness Curves (Fletcher and Munson)

Human aural perception uses a subjective tone pitch, which is not proportional to the frequency. With dark tones, two tones that differ by a factor of two in the frequency scale correspond to exactly one octave. Such a frequency mixture is sensed in higher frequencies as a smaller interval.

Some parts of an acoustic event can be measured in special situations, although they cannot be heard. The reason is that part of a sound mixture masks another part. This masking effect can be observed in the time and frequency ranges. It is important to understand this effect because it contributes to encoding and compression techniques applied to sound signals. For example, an auditor perceives two distinct waves when a loud and a lower sinus wave have very different frequencies. On the other hand, if the lower wave is near the frequency of the louder wave, the lower is no longer heard; that

is, it will fall below the frequency masking threshold. In this case, the auditor will no longer perceive the lower wave. On the other hand, a loud gunshot will mask lower sounds in the time range several seconds after they occur.

2.1.2. Audio Representation on Computers

Before the continuous curve of a sound wave can be represented on a computer, the computer has to measure the wave's amplitude in regular time intervals. It then takes the result and generates a sequence of sampling values or samples for short. Figure 2.4 shows the period of a digitally sampled wave.

Figure 2.4: Sampling a Wave

The mechanism that converts an audio signal into a sequence of digital samples is called an analog-to-digital converter (ADC), and a digital-to-analog converter (DAC) is used to achieve the opposite conversion.

1) Sampling Rate

The rate at which a continuous waveform is sampled (*See Figure 2.4*) is called the sampling rate. Like frequency, the sampling rate is measured in Hz. For example, CDs are sampled at a rate of 44,100 Hz, which may appear above the frequency range perceived by humans. However, the bandwidth—in this case, 20,000Hz–20Hz = 19,980Hz-that can represent a digitally sampled audio signal is only about half as big as a CD's sampling rate because CDs use the Nyquist sampling theorem. This means that a

sampling rate of 44,100Hz covers only frequencies in the range from 0Hz to 22,050Hz. This limit is very close to human hearing capability.

Table 2.2: Sampling Rate and PCM Data Rate

Quality	Sampling Rate (kHz)	Bits per Sample	Data Rate Kbits/s Kbytes/s	Freq. Band
Telephone	8	8(Mono)	64 8	200-3,400Hz
AM Radio	11.025	8(Mono)	88.2 11.0	100-5,000Hz
FM Radio	22.050	16(Stereo)	705.6 88.2	50-10,000Hz
CD	44.1	16(Stereo)	1411.2 176.4	20-20,000Hz

2) Quantization

The digitization process requires two steps. First, the analog signal must be sampled. This means only a discrete set of values is retained at the (generally regular) time or space intervals. The second step involves quantization. The quantization process consists of converting a sampled signal into a signal that can take only a limited number of values. An 8-bit quantization provides 256 possible values, while a 16-bit quantization in CD quality results in more than 65,536 possible values. Figure 2.5 shows a 3-bit quantization.

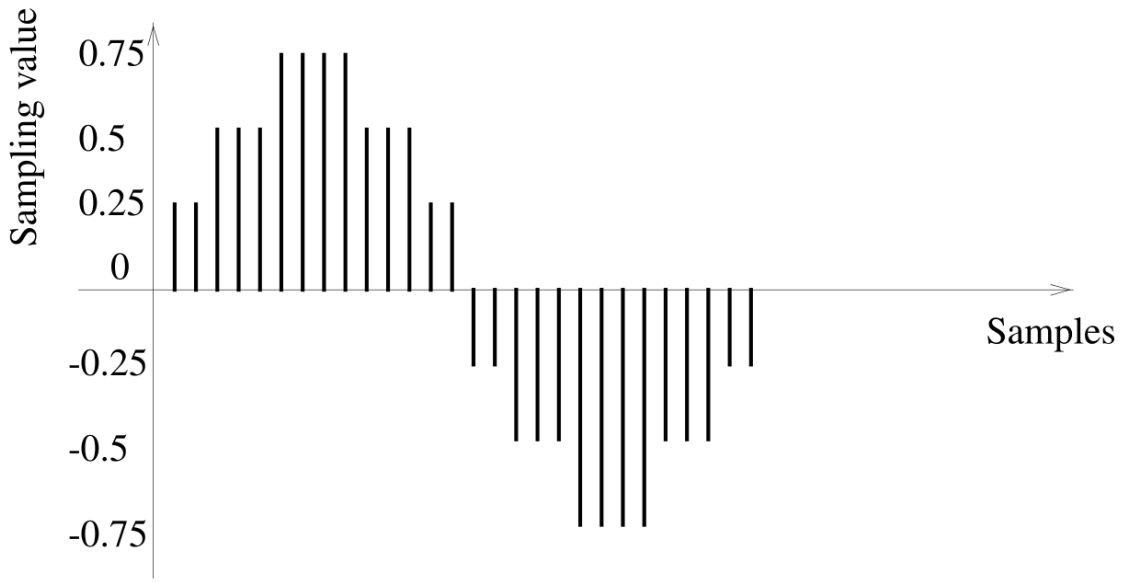


Figure 2.5: 3-bit Quantization

The values transformed by a 3-bit quantization process can accept eight different characteristics: 0.75, 0.5, 0.25, 0, -0.25, -0.5, -0.75, and -1, so that we obtain an "angular-shape" wave. This means that the lower the quantization (in bits), the more the resulting sound quality deteriorates.

2.1.3. Music and the MIDI Standard

We know from previous sections that any sound can be represented as a digitized sound signal that is a sequence of samples, each encoded with binary digits. This sequence may be uncompressed as on audio compact disks or compressed. We know that any sound, including music, may be represented in that way. A characteristic of this representation mode is that it does not preserve the sound's semantic description. Unless complex recognition techniques are used, the computer does not know whether a bit sequence represents speech or music, for example, and if music, what notes are used and by which instrument.

Music can be described in a symbolic way. On paper, we have the full scores. Computers and electronic musical instruments use a similar technique, and most of them employ the Musical Instrument Digital Interface (MIDI), a standard developed in the early 1980s. The MIDI standard defines how to code all the elements of musical scores, such as sequences of notes, timing conditions, and the instrument to play each note.

1) Introduction to MIDI

MIDI represents a set of specifications used in instrument development so that instruments from different manufacturers can easily exchange musical information. The MIDI protocol is an entire music description language in binary form. Each word describing an action of a musical performance is assigned a specific binary code.

A MIDI interface is composed of two different components:

- Hardware to connect the equipment. MIDI hardware specifies the physical connection of musical instruments. It adds a MIDI port to an instrument, specifies a MIDI cable (that connects two instruments), and processes electrical signals received over the cable.

- A data format that encodes information to be processed by the hardware. The MIDI data format does not include encoding individual sampling values, such as audio data formats. Instead, MIDI uses a specific data format for each instrument, describing things like the start and end of scores, the basic frequency, and loudness, in addition to the instrument itself.

The MIDI data format is digital, and data are grouped into MIDI messages. When a musician plays a key, the MIDI interface generates a MIDI message that defines the start of each score and its intensity. This message is transmitted to machines connected to the system. As soon as the musician releases the key, another signal (MIDI message) is created and transmitted.

2) MIDI Devices

An instrument that complies with both components defined by the MIDI standard is a MIDI device (e.g., a synthesizer) able to communicate with other MIDI devices over channels. The MIDI standard specifies 16 channels. A MIDI device is mapped onto a channel. Musical data transmitted over a channel are reproduced in the synthesizer at the receiver's end. The MIDI standard identifies 128 instruments utilizing numbers, including noise effects (e.g., a phone ringing or an airplane take-off). For example, 0 specifies a piano, 12 a marimba, 40 a violin, and 73 a flute.

Some instruments enable a user to play one single score (e.g., a flute) exclusively, while other instruments allow concurrent playing of scores (e.g., an organ). The maximum number of scores that can be played concurrently is an essential property of synthesizers. This number can vary between 3 and 16 scores per channel.

A computer uses the MIDI interface to control instruments for playout. The computer can use the same interface to receive, store, and process encoded musical data. In the MIDI environment, these data are generated on a keyboard and played out by a synthesizer-the heart of each MIDI system. A typical synthesizer is similar to a regular piano keyboard but has an additional operating element. A sequencer is used to buffer or modify these data. In a multimedia application, the sequencer resides in the computer.

3) The MIDI and SMPTE Timing Standards

A receiver uses the MIDI clock to synchronize itself to the sender's clock. To allow synchronization, 24 identifiers for each quarter note are transmitted. Alternatively, the SMPTE (Society of Motion Picture and Television Engineers) timing code can be sent to allow receiver-sender synchronization. SMPTE defines a frame format by hours:minutes:seconds: for example, 30 frames/s. This information is transmitted at a rate that would exceed the bandwidth of existing MIDI connections. For this reason, the MIDI time code is typically used for synchronization because it does not transmit the entire time representation of each frame.

2.2. Graphics and Images

Graphics and images are both non-textual information that can be displayed and printed. They may appear on screens and printers but cannot be displayed with devices only capable of handling characters.

Graphics are normally created in a graphics application and are internally represented as an assemblage of objects such as lines, curves, or circles. Attributes such as style, width, and color define the appearance of graphics. We say that the representation is aware of the semantic contents. The objects graphics are composed of can be individually deleted, added, moved, or modified later. In contrast, images can be from the real world or virtual and are not editable in the sense given above. They ignore the semantic contents. They are described as spatial arrays of values. The smallest addressable image element is called a pixel. The array, and thus the set of pixels, is called a bitmap.

Object-based editing is impossible, but image editing tools exist to enhance and retouch bitmap images. The drawback of bitmaps is that they need much more storage capacity than graphics. Their advantage is that no processing is necessary before displaying them, unlike graphics, where the abstract definition must be processed first to produce a bitmap. Of course, images captured from an analog signal via scanners or video cameras are represented as bitmaps unless semantic recognition takes place, such as in optical character recognition.

2.2.1. Capturing Real-World Images

A picture is a two-dimensional image captured from a real-world scene representing a momentary event from the three-dimensional spatial world.

An image-capturing device, such as a CCD scanner, CCD camera for still images, or a frame grabber for moving images, converts the brightness signal into an electrical signal. In contrast to conventional TV standards that use a line structure system, the line direction of the output signal that the capturing device generates is normally continuous in the row direction but discrete and analogous in the column direction. The first step in processing real-world pictures is to sample and digitize these signals. The second step typically involves quantization to achieve aggregation of color regions to reduce the number of colors, depending on the hardware used to output the images. Video technologies normally work with an 8-bit PCM quantization, which means they can represent 2^8=256 different colors or gray levels per pixel. It results in $2^8 \times 2^8 \times 2^8$ or approximately 16 million different colors.

Next, the digitized picture is represented by a matrix composed of rows and columns to accommodate numerical values. Each matrix entry corresponds to a brightness value. If I specifies a two-dimensional matrix, then I(r,c) is the brightness value at the position corresponding to row r and column c of the matrix.

The spatial two-dimensional matrix representing an image comprises pixels-the smallest image resolution elements. Each pixel has a numerical value, the number of bits available to code a pixel (also called amplitude depth or pixel depth). A numerical value may represent either a black (numerical value 0) or a white (numerical value 1) dot in bitonal (binary) images, a level of gray in continuous-tone monochromatic images, or the color attributes of the picture element in color pictures. Numerical values for gray levels range from 0 for black to FF for white. Figure 2.6 shows an example with different tones.

2 gray Levels

4 gray Levels

Figure 2.6: Images with Different Numbers of Gray Levels

A rectangular matrix is commonly used to represent images. The pixels of an image are equally distributed in the matrix, and the distance between the matrix dots is obviously a measure of the original picture's quality. It also determines the degree of detail and the image's resolution, but the resolution of an image also depends on the representation system.

Digital images are normally huge. If we were to sample and quantize a standard TV picture (525 lines) by use of a VGA (Video Graphics Array) video controller in a way to be able to represent it again without noticeable deterioration, we would have to use a matrix of at least 640×480 pixels, where each pixel is represented by an 8-bit integer, allowing a total of 256 discrete gray levels. This image specification results in a matrix containing 307,200 eight-bit numbers, a total of 2,457,600 bits. In many cases, the sampling would be more complex. So the question is how to store such high-volume pictures. The following section deals with image formats because they influence the storage requirements of images. Later we describe image storage options.

2.2.2. Image Formats

The literature describes many different image formats and normally distinguishes between image capturing and image storage formats, that is, the format in which the image is created during the digitizing process and the format in which images are stored (and often transmitted).

1) Image Capturing Formats

The format of an image is defined by two parameters: the spatial resolution, indicated in pixels, and the color encoding, measured in bits per pixel. The values of both parameters depend on the hardware and software used to input and output images.

2) Image Storage Formats

To store an image, the image is represented in a two-dimensional matrix, in which each value corresponds to the data associated with one image pixel. In bitmaps, these values are binary numbers. In color images, the values can be one of the following:

- Three numbers typically specify the intensity of the red, green, and blue components.
- Three numbers represent references to a table containing red, green, and blue intensities.
- A single number that works as a reference to a table containing color triples.
- An index points to another set of data structures, which represents colors.

Assuming sufficient memory is available, an image can be stored in uncompressed RGB triples. If storage space is scarce, images should be compressed in a suitable way. When storing an image, information about each pixel, i.e., the value of each color channel in each pixel, has to be stored. Additional information may be associated with the image as a whole, such as a width, height, depth, or the name of the person who created the image. The necessity to store such image properties led to several flexible formats, such as RIFF (Resource Interchange File Format), or BRIM (derived from RIFF), often used in database systems. RIFF includes bitmaps, vector drawings, animation, audio, and video formats. In BRIM, an image consists of width, height, authoring information, and a history field specifying the generation process or modifications.

The most popular image storing formats include PostScript, GIF (Graphics Interchange Format), XBM (X11 Bitmap), TIFF (Tagged Image File Format), PBM, (Portable Bitmap), BMP (Bitmap), PNG (Portable Network Graphic) and JPEG.

PostScript

PostScript is a fully-fledged programming language optimized for printing graphics and text (whether on paper, film, or CRT). Adobe introduced it in 1985. The primary purpose of PostScript was to provide a convenient language in which to describe images in a device-independent manner. This device independence means that the image is described without reference to any specific device features (e.g., printer resolution), so the same description can be used on any PostScript printer without modification. In practice, some PostScript files make assumptions about the target device (such as its resolution or the number of paper trays it has), but this is a terrible practice and limits portability. During its lifetime, PostScript has been developed in levels, the most recent being Level 3:

- Level 1 PostScript: The first generation was designed mainly as a page description language, introducing the concept of scalable fonts. A font was available in either 10 or 12 points but not in an arbitrary intermediate size. This format was the first to allow high-quality font scaling.
- Level 2 PostScript: In contrast to the first generation, Level 2 PostScript made a huge step forward as it allowed the filling of patterns and regions, though normally unnoticed by the non-expert user. The improvements of this generation include better control of free storage areas in the interpreter, a more significant number of graphics primitives, more efficient text processing, and a complete color concept for device-dependent and device-independent color management.
- Level 3 PostScript: Level 3 takes the PostScript standard beyond a page description language into a fully optimized printing system that addresses the broad range of new requirements in today's increasingly complex and distributed printing environments. It expands the previous generation's advanced features for modern digital document processing, as document creators draw on a variety of sources and increasingly rely on color to convey their messages.

At some point, you may want to include some nice PostScript images in a document. There are several problems associated with this, but the main one is that your page layout program needs to know how big the image is and how to move it to the correct place on the page. Encapsulated PostScript (EPS) is that part of Adobe's Document Structuring

Convention (DSC) that provides this information. An EPS file is a PostScript file that follows the DSC, and that follows a couple of other rules. In contrast to Postscript, the EPS format has some drawbacks:

- EPS files contain only one image.
- EPS files always start with comment lines, e.g., specifying the author and resources (e.g., fonts).

The PostScript language and DSC specifications are available at www.adobe.com.

Graphics Interchange Format (GIF)

The Graphics Interchange Format (GIF) was developed by CompuServe Information Service in 1987. Three variations of the GIF format are in use. The original specification, GIF87a, became a *de facto* standard because of its many advantages over other formats. Creators of drawing programs quickly discovered how easy it was to write a program that decodes and displays GIF images. GIF images are compressed to 20 to 25 percent of their original size with no loss in image quality using a compression algorithm called LZW. The next update to the format was the GIF89a specification. GIF89a added some valuable features, including transparent GIFs.

Unlike the original GIF specifications, which support only 256 colors, the GIF24 update supports true 24-bit colors, which enables you to use more than 16 million colors. One drawback to using 24-bit color is that, before a 24-bit image can be displayed on an 8-bit screen, it must be dithered, which requires processing time and may distort the image. GIF24 uses a compression technique called PNG.

Tagged Image File Format (TIFF)

The Tagged Image File Format (TIFF) was designed by Aldus Corporation and Microsoft in 1987 to allow portability and hardware independence for image encoding. It has become a *de facto* standard format. It can save images in an almost infinite number of variations. As a result, no available image application can claim to support all TIF/TIFF file variations, but most support a large number of variations.

TIFF documents consist of two components. The baseline part describes the properties that should support display programs. The second part is extensions used to define properties, using the CMYK color model to represent print colors.

A significant basis for exchanging images is whether or not a format supports various color models. TIFF offers binary levels, gray levels, palettes, RGB, and CMYK colors. Whether or not an application supports the color system specified in TIFF extensions depends on the respective implementation.

TIFF supports a broad range of compression methods, including run-length encoding (which is called PackBits compression in TIFF jargon), LZW compression, FAX Groups 3 and 4, and JPEG (see Chapter 7). In addition, various encoding methods, including Huffman encoding, can be used to reduce the image size.

TIFF differs from other image formats in its generics. In general, the TIFF format can be used to encode graphical contents in different ways, for example, to provide previews (thumbnails) for a quick review of images in image archives without the need to open the image file.

X11 Bitmap (XBM) and X11 Pixmap (XPM)

X11 Bitmap (XBM) and X11 Pixmap (XPM) are graphic formats frequently used in the UNIX world to store program icons or background images. These formats allow monochrome (XBM) or color (XPM) images to be defined inside a program code. The two formats use no compression for image storage. In the monochrome XBM format, the pixels of an image are encoded and written to a list of byte values (byte array) in the C programming language, grouping 8 pixels into a byte value.

Portable Bitmap plus (PBMplus)

PBMplus is a software package that allows the conversion of images between various image formats and their script-based modification. PBMplus includes four different image formats, Portable Bitmap (PBM) for binary images, Portable Graymap (PGM) for gray-value images, Portable Pixmap (PPM) for true-color images, and Portable Anymap (PNM) for format-independent manipulation of images. These formats support both text and binary encoding. The software package contains conversion tools for internal graphic formats and other formats to offer free and flexible conversion options.

The contents of PBMplus files are the following:

- A magic number identifying the file type (PBM, PGM, PPM, or PNM), that is, “P1” for PBM.

- Blanks, tabs, carriage returns, and line feeds.
- Decimal ASCII characters that define the image width.
- Decimal ASCII characters that define the image height.
- ASCII numbers plus blanks that specify the maximum value of color components and additional color information (for PPM, PNM, and PBM).

Filter tools are used to manipulate internal image formats. The functions offered by these tools include color reduction; quantization and analysis of color values; modification of contrast, brightness, and chrominance; cutting, pasting, and merging of several images; changing the size of images; or generating textures and fractal backgrounds.

Bitmap (BMP)

BMP files are device-independent bitmap files most frequently used in Windows systems. The BMP format is based on the RGB color model. It does not compress the original image; its format defines a header and data region. The header region (BITMAPINFO) contains information about size, color depth, color table, and compression method. The data region contains the value of each pixel in a line. Lines are flush-extended to a value divisible by 32 and padded with zero values.

Valid color depth values are 1, 4, 8, and 24. The BMP format uses the run-length encoding algorithm to compress images with a color depth of 4 or 8 bits/pixel, where two bytes each are handled as an information unit. Suppose the first-byte value contains zero and the second value is greater than three. In that case, the second value contains the number of bytes that follow and contains the color of the next pixel as a reference to the color table (no compression). Otherwise, the first-byte value specifies the number of pixels that follow, which are to be replaced by the color of the second-byte value to point to the color table. An image encoded with 4 bits/pixel uses only four bits for this information. In the header region, BMP defines an additional option to specify a color table to select colors when the image is displayed.

PNG (Portable Network Graphic)

The PNG image format was launched in 1995. IT expert Oliver Fromme came up with the name PING, later shortened to PNG. PNGs are the next evolution of the GIF format, which had already been around for eight years when PNGs first launched. GIFs had

several drawbacks, like requiring a patent license and a limited range of just 256 colors, which did not keep pace with ever-improving computer screen resolution. PNG files were made patent-free to avoid these issues and included a significantly larger color palette. PNGs, as opposed to GIFs, are a single-image format-they do not support animation.

It is a trendy file type with web designers because it can handle graphics with transparent or semi-transparent backgrounds. The file format is not patented, so you can open a PNG using any image editing software without licensing. PNG files, which use the .png extension, can handle 16 million colors-which certainly sets them apart from most file types.

JPEG (Portable Network Graphic)

JPEG is also a term for any graphic image file produced using a JPEG standard. A JPEG file is created by choosing from a range of compression qualities. When you create a JPEG or convert an image from another format to a JPEG, you are asked to specify the quality of the image you want. Since the highest quality results in the largest file, you can make a trade-off between image quality and file size. Formally, the JPEG file format is specified in ISO standard 10918. The JPEG scheme includes 29 distinct coding processes, although a JPEG implementor may not use them all.

Together with the Graphic Interchange Format (GIF) and Portable Network Graphics (PNG) file formats, the JPEG is one of the image file formats supported on the World Wide Web, usually with the file suffix ".jpg." You can create a progressive JPEG that is similar to an interlaced GIF.

2.2.3. Creating Graphics

1) Input Devices

Modern graphical input devices include mice (with or without cables), tablets, and transparent, highly sensitive screens, or input devices that allow three-dimensional or higher-dimensional input values (degrees of freedom) in addition to the x and y positions on the screen, such as trackballs, spaceballs, or data gloves.

2) Graphic Software

Graphics are generated by the use of interactive graphic systems. The conceptual

environment of almost all interactive graphic systems is an aggregated view consisting of three software components (application model, application program, and graphics system and one hardware component).

The application model represents data or objects to be displayed on the screen. It is commonly stored in an application database. The model acquires descriptions of primitives that describe the form of an object's components, attributes, and relations that explain how the components relate to each other. The model is specific to an application and independent of a system used for display. It means that the application program has to convert a description of parts of the model into procedure calls or commands the graphic system can understand to create images. This conversion process is composed of two phases. First, the application program searches the application database for parts to be considered, applying specific selection or search criteria. Second, the extracted geometry is brought into a format that can be passed on to the graphics system.

The application program processes user input and produces views by sending a series of graphical output commands to the third component, the graphics system. These output commands include a detailed geometric description of what is to be viewed and how the objects should appear.

The graphics system is responsible for image production involving detailed descriptions and for passing user input to the application program (for processing purposes). Similar to an operating system, the graphics system represents an intermediate component between the application program and the display hardware. It influences the output transformation of objects of the application model into the model's view. Symmetrically, it also influences the input transformation of user actions for application program inputs leading to changes in the model and/or image. A graphics system usually consists of a set of output routines corresponding to various primitives, attributes, and other elements. The application program passes geometric primitives and attributes into these routines. Subroutines control specific output devices and cause them to represent an image.

Interactive graphics systems are an integral part of distributed multimedia systems. The application model and the application program can represent applications and user interfaces. The graphics system uses (and defines) programming abstractions supported by the operating system to establish a connection to the graphics hardware.

2.2.4. Storing Graphics

Graphics primitives and their attributes are on a higher image representation level because they are generally not specified by a pixel matrix. This higher level has to be mapped to a lower level at one point during image processing, for example, when representing an image. Having the primitives on a higher level is an advantage because it reduces the data volume that has to be stored for each image and allows simpler image manipulation. A drawback is that an additional step is required to convert graphics primitives and their attributes into a pixel representation. Some graphics packages, for example, the SRGP (Simple Raster Graphics Package), include this type of conversion. Such packages generate either a bitmap or a pixmap from graphics primitives and their attributes.

We have seen that a bitmap is a pixel list that can be mapped one-to-one to pixel screens. The pixel information is stored in 1bit, resulting in a binary image that consists exclusively of black and white. The term pixmap is a more general description of an image that uses several bits for each pixel. Many color systems use 8 bits per pixel (e.g., GIF), so 256 colors can be represented simultaneously. Other formats (including JPEG) allow 24 bits per pixel, representing approximately 16 million colors.

Other packages—for example, PHIGS (Programmer's Hierarchical Interactive Graphics System) and GKS (Graphical Kernel System)-use graphics specified by primitives and attributes in pixmap form.

File formats for vector graphics allow the loading and storing of graphics in a vector representation, such as files created in a vector graphics application. The most important file formats include:

- **IGES:** The Initial Graphics Exchange Standard was developed by an industry committee to formulate a standard for transferring 2D and 3D CAD data.
- **DXF:** AutoDesk's 2D and 3D format was initially developed for AutoCAD, a computer-aided design application. It has become a de facto standard.
- **HPGL:** The Hewlett Packard Graphics Language has been designed to address plotters, which is why it only supports 2D representation.

The combination of vector and raster graphics is generally possible in modern vector graphics systems. With regard to representing data in files, the two graphics types are often totally separated from one another. Only a few so-called meta file formats, for example, CGM (Computer Graphics Metafile), PICT (Apple Macintosh Picture Format), and WMF (Windows Metafile)—allow an arbitrary mixture of vector and raster graphics.

2.3. Video

We now consider concepts and developments from this area that are significant for a basic understanding of the video medium.

2.3.1. Basics

The human eye is the human receptor for taking still pictures and motion pictures. In conjunction with neuronal processing, its inherent properties determine some of the basic requirements underlying video systems.

1) Representation of Video Signals

In conventional black-and-white television sets, the video signal is usually generated utilizing a Cathode Ray Tube (CRT).

To lay the groundwork for a later understanding of the transmission rates of films, we cover television signals in detail here. However, we do not consider camera or monitor technology. We begin by analyzing the video signal produced by a camera and the resulting pictures.

The representation of a video signal comprises three aspects: visual representation, transmission, and digitization.

Visual Representation

A key goal is to present the observer with as realistic as possible a representation of a scene. To achieve this goal, the television picture must accurately convey the scene's spatial and temporal content. Essential measures for this are:

- **Vertical details and viewing distance:** The geometry of a television image is based on the ratio of the picture width W to the picture height H.

This width-to-height ratio is also called the aspect ratio. The conventional aspect ratio (for television) is 4/3=1.33. Figure 2.7 shows an example of this ratio. The viewing distance D determines the angular field of view. This angle is usually calculated as the ratio of the viewing distance to the picture height (D/H).

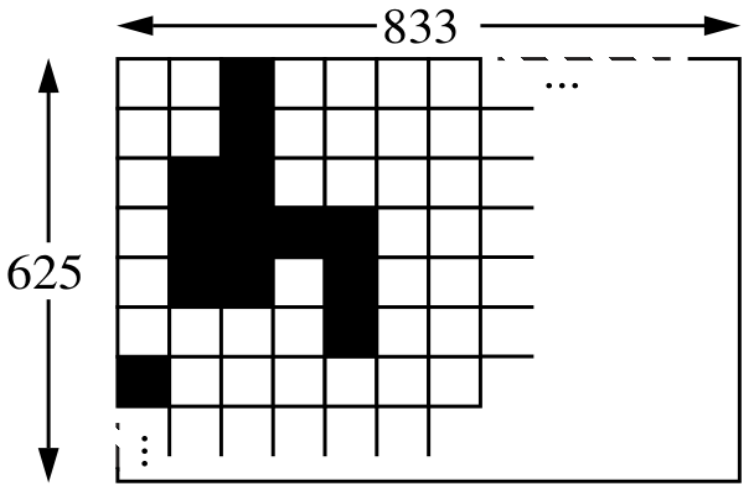


Figure 2.7: Decomposition of a Motion Picture. Width to Height in Ratio 4:3

- **Horizontal detail and picture width:** The picture width generally used for television is 4/3 times the picture height. The horizontal field of view can be determined using the aspect ratio.
- **Total detail content of a picture:** The vertical resolution is equal to the number of picture elements of the picture height, while the number of horizontal picture elements is equal to the product of the vertical resolution and the aspect ratio. The product of the picture's elements vertically and horizontally is the total number of picture elements in the image. However, in the case of television pictures, not all lines (and columns) are visible to the observer. The invisible areas are often used to transmit additional information.
- **Depth perception:** In nature, humans perceive the third dimension, depth, by comparing the images perceived by each eye, which view from different angles. In a flat television picture, a considerable portion of depth perception is derived from the perspective appearance of the subject matter. Further, the choice of the camera lens's focal length and changes in focus influence depth perception.

- **Luminance:** Color perception is achieved by three signals, proportional to the relative intensities of red, green, and blue light (RGB) present in each portion of the scene. These are conveyed to the monitor separately, and the tube reproduces them at each point in time (unlike a camera). A different signal division is often used for transmission and storage: one brightness signal (luminance) and two-color difference signals (chrominance). This division will be explained in more detail below.
- **Temporal aspects of illumination:** Another property of human visual perception is the limit of motion resolution. In contrast to the continuous pressure waves of an acoustic signal, a discrete sequence of individual still pictures is perceived as a continuous sequence. This property is used in television, in films, and for video data in computer systems. The impression of motion is created by presenting a rapid succession of barely differing still pictures (frames). Between frames, the light is cut off briefly. Two conditions must be met to represent a visual reality through motion pictures. First, the rate of repetition of the images must be high enough to ensure continuity of movements (smooth transition) from frame to frame. Second, the rate must be high enough that the dark intervals between pictures do not disrupt the continuity of perception.
- **Continuity of motion:** It is known that continuous motion is only perceived as such if the frame rate is higher than 15 frames per second. To make motion appear smooth, at least 30 frames per second must be used if the scene is filmed by a camera and not generated synthetically. Films recorded using only 24 frames per second often appear strange, especially when large objects move quickly and close to the viewer, as in pan shots. Showscan is a technology for producing and presenting films at 60 frames per second using 70-millimeter film. This scheme produces a large image that occupies a greater portion of the field of view, resulting in smoother motion. There are various standards for motion video signals that establish frame rates, ensuring suitable continuity of motion. The standard used in the United States, NTSC (National Television Systems Committee), initially set the frame rate at 30Hz. It was later changed to 29.97Hz to fix the separation between the visual and audio carriers at precisely 4.5MHz. NTSC scanning equipment represents frames using the

24Hz standard by translating them to the 29.97Hz scanning rate. A European standard for motion video, PAL (Phase Alternating Line), adopted a repetition rate of 25Hz but used a frame rate of 25Hz.

- **Flicker:** If the refresh rate is too low, a periodic fluctuation of the perceived brightness can result. It is called the flicker effect. The minimum refresh rate to avoid flicker is 50Hz. Achieving continuous, flicker-free motion would thus require a high refresh rate. However, in both movies and television, technical measures allow lower refresh rates to be used. The flicker effect would be very disturbing in films with, for example, 16 pictures per second without any additional technical measures. To reduce flicker, the light is interrupted an additional two times during the projection of a frame, yielding a picture refresh rate of 3×16Hz = 48Hz. In television, display refresh buffers—expensive until recently—can be used to alleviate the flicker effect. Picture data are written into the buffer at a rate higher than needed for motion resolution (e.g., 25Hz). The monitor reads the display data at a rate that eliminates the flicker effect (e.g., 70Hz). This corresponds to the 70Hz refresh rate of higher-quality computer screens. In television, the full picture is divided into two half pictures consisting of interleaved scanning lines. One half of the picture is transmitted after the other using interlaced scanning. The transmission of full pictures takes place at around 30Hz (exactly 29.97Hz), or 25 Hz in Europe, whereas the transmission of half pictures takes place at 2×30Hz = 60Hz or 2×25Hz = 50Hz, respectively. Figure 2.8 shows an example of this. Visual perception drops considerably more with a refresh rate of 25Hz (unbroken line) than 50Hz.

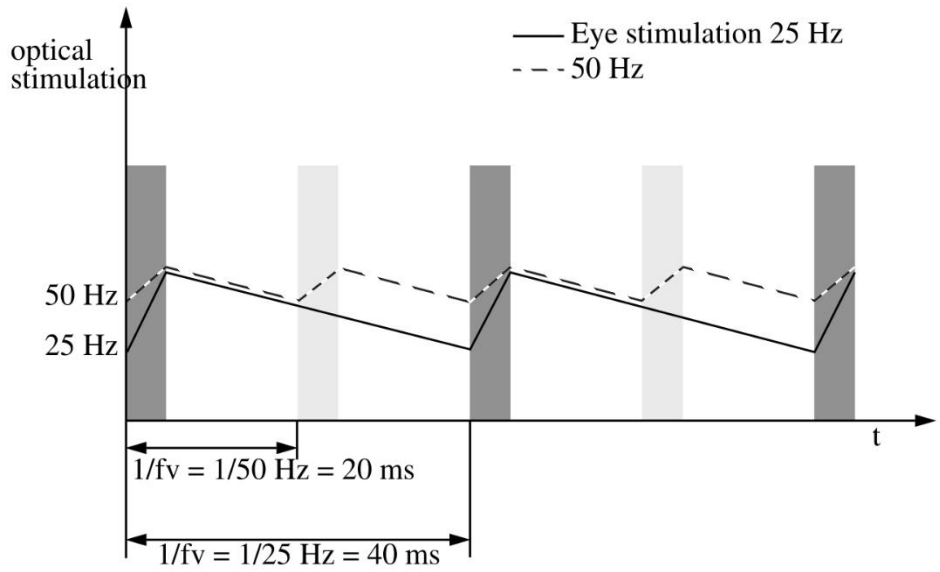


Figure 2.8: Flicker effect. Eye Stimulation with Refresh Rates 25 Hz and 50 Hz

2) Signal Formats

Video signals are often transmitted to the receiver over a single television channel. To encode color, consider the decomposition of a video signal into three sub-signals. For transmission reasons, a video signal comprises a luminance signal and two chrominance (color) signals. In NTSC and PAL systems, the component transfers of luminance and chrominance in a single channel are accomplished by specifying the chrominance carrier as an odd multiple of half the line-scanning frequency. It causes the component frequencies of chrominance to be interleaved with those of luminance. The goal is to separate the sets of components in the receiver and avoid interference between them before the primary color signals are recovered for display. In practice, however, there are degradations in the picture quality, known as color crosstalk and luminance crosstalk. These effects have led the manufacturers of NTSC receivers to reduce the luminance bandwidth to less than 3MHz, under the carrier frequency of 3.58MHz and far below the broadcast signal theoretical maximum limit of 4.2MHz. It limits the vertical resolution in such devices to about 25 lines. Chrominance and luminance signals are separated using a simple notch filter tuned to the subcarrier's frequency. Today comb filters are also used for this purpose. The transmitter also uses a comb filter in the coding process.

Several approaches to color encoding are described below.

Color Encoding

- RGB signal: An RGB signal consists of separate red, green, and blue signals. Every color can be encoded as a combination of these three primary colors using additive color mixing. The values R (for red), G (for green), and B (for blue), are normalized such that white results when R+G+B = 1 in the normalized representation.
- YUV signal: Since human vision is more sensitive to brightness than color, a more suitable encoding separates the luminance from the chrominance (color information). Instead of separating colors, the brightness information (luminance Y) is separated from the color information (two chrominance channels U and V). For reasons of compatibility with black-and-white receivers, the luminance must always be transmitted. For black-and-white reception, the chrominance components' utilization depends on the television set's color capabilities.

  The YUV signal can be calculated as follows:

  - $Y = 0.30R + 0.59G + 0.11B$
  - $U = (B–Y) \times 0.493$
  - $V = (R–Y) \times 0.877$

  An error in the resolution of the luminance (Y) is more severe than one in the chrominance values (U, V). Thus, the luminance values can be encoded using higher bandwidth than the chrominance values.

  Due to the different component bandwidths, the encoding is often characterized by the ratio between the luminance component and the two chrominance components. For example, the YUV encoding can be specified as a (4:2:2) signal. Further, the YUV encoding is sometimes called the Y, B–Y, R–Y signal from the dependencies among U, B–Y, V, and R – Y in the equations above.
- YIQ signal: A similar encoding exists for NTSC's YIQ signal:
  - $Y = 0.30R + 0.59G + 0.11B$
  - $I = 0.60R – 0.28G – 0.32B$
  - $Q = 0.21R – 0.52G + 0.31B$

Composite Signal

An alternative to component encoding is to combine all information in one signal. It implies that a single signal must combine the individual components (RGB, YUV, or YIQ). The basic information consists of luminance information and chrominance difference signals. However, the luminance and chrominance signals can interfere since they are combined into one signal. For this reason, television technology uses appropriate modulation methods to eliminate this interference.

The basic bandwidth needed to transmit the luminance and chrominance signals for the NTSC standard is 4.2MHz.

Computer Video Format

The video format processed by a computer depends on the video input and output devices. Current video digitalization hardware differs with respect to the resolution of the digital images (frames), quantization, and frame rate (frames/second). Motion video output depends on the display hardware used, usually a raster display. The typical architecture of such a device is shown in Figure 2.9.

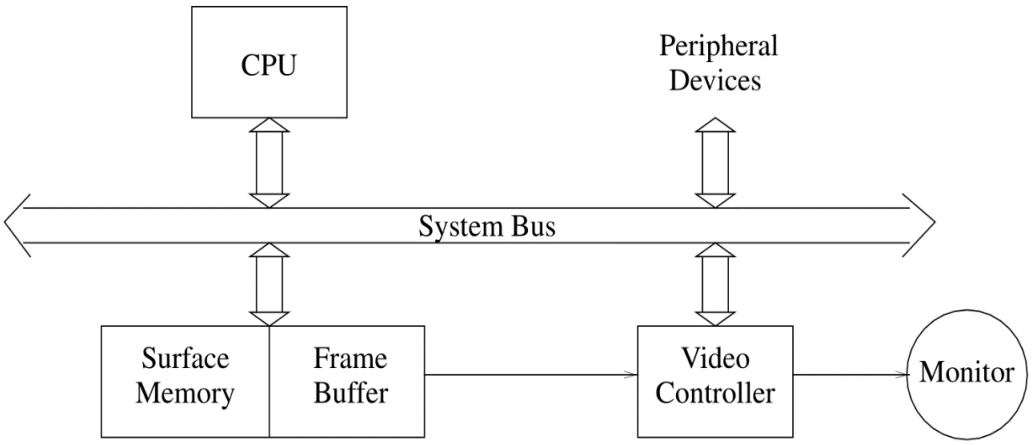


Figure 2.9: Architecture of a Raster Display

The video controller displays the image stored in the frame buffer, accessing the buffer through a separate port as often as the video scanning rate requires. The most important task is the constant refresh of the display. Due to the disturbing flicker effect, the video controller cycles through the frame buffer, one scan line at a time, typically 60 times/second. The system works with a Color Look-Up Table (CLUT or LUT) to display different colors on the screen. At any given time, a limited number of colors (n) are available for the whole picture. The set of the n most

frequently used colors are chosen from a color palette consisting of m colors, whereby in general, n<<m.

Some examples of well-known computer video formats are presented here. Each system supports various resolutions and color presentations.

- The Color Graphics Adapter (CGA) has a resolution of 320× 200 pixels with simultaneous display of four colors, among other modes. The necessary storage capacity per frame is thus

$$320 \times 200 \text{ pixel} \times \frac{2 \text{ bit/pixel}}{8 \text{ bit/byte}} = 16{,}000 \text{ bytes}$$

- The Enhanced Graphics Adapter (EGA) supports a display resolution of 640×350 pixels with 16 simultaneous colors. The necessary storage capacity per frame is

$$640 \times 350 \text{ pixel} \times \frac{4 \text{ bit/pixel}}{8 \text{ bit/byte}} = 112{,}000 \text{ bytes}$$

- The Video Graphics Array (VGA) works mostly with a resolution of 640×480 pixels with 256 simultaneous colors. The monitor is controlled via an analog RGB output. The necessary storage capacity per frame is

$$640 \times 480 \text{ pixel} \times \frac{8 \text{ bit/pixel}}{8 \text{ bit/byte}} = 307{,}200 \text{ bytes}$$

- The Super Video Graphics Array (SVGA) can present 256 colors at a resolution of 1,024×768 pixels. The necessary storage capacity per frame is

$$1{,}024 \times 768 \text{ pixel} \times \frac{8 \text{ bit/pixel}}{8 \text{ bit/byte}} = 786{,}432 \text{ bytes}$$

Other SVGA modes include 1,280×1,024 pixels and 1,600×1,280 pixels.

SVGA video adapters are available with video accelerator chips that overcome reduced performance at higher resolution and/or higher numbers of colors. Video accelerator chips can be used to improve video playback, which typically appears in a window of at most 160×120 pixels. A video accelerator chip allows for the playback of recorded video sequences at a significantly higher rate and quality.

2.3.2. Television System

Television is one of the most important applications driving the development of motion video. Since 1953, television has undergone many far-reaching changes. This section

provides an overview of television systems, encompassing conventional black-and-white and color systems, enhanced resolution television systems intended as an intermediate solution, and digital interactive video systems and Digital Video Broadcasting (DVB).

1) Conventional Systems

- NTSC stands for National Television Systems Committee and is the oldest and most widely used television standard. Additionally, the standard originated in the US and uses color carriers of approximately 4.429MHz or approximately 3.57MHz. NTSC uses quadrature amplitude modulation with a suppressed color carrier and a refresh rate of about 30Hz. A picture consists of 525 rows. NTSC can use 4.2MHz for the luminance and 1.5MHz for each of the two chrominance channels. Television sets and video recorders use only 0.5MHz for the chrominance channels.
- SECAM stands for Sequential Couleur avec Memoire and is used primarily in France and Eastern Europe. In contrast to NTSC and PAL, it is based on frequency modulation. Like PAL, SECAM uses a refresh rate of 25Hz. Each picture consists of 625 rows.
- PAL stands for Phase Alternating Line and was proposed in 1963 by W. Bruch of Telefunken. It is used in parts of Western Europe.

2) High-Definition Television (HDTV)

Research in High-Definition Television (HDTV) began in Japan in 1968. This phase is considered the third technological change in television, after black-and-white and the introduction of color television. HDTV strives for picture quality at least as good as 35mm film.

Promoters of HDTV pursued the goal of approaching integrating the viewer with the events taking place on the screen. Television systems, filming techniques, and viewing requirements were chosen to give the viewer the impression of being involved in the scene.

The parameters that had to be defined to achieve this goal were resolution, frame rate, aspect ratio, interlaced and/or progressive scanning formats, and viewing conditions.

- **Resolution:** An HDTV picture has about twice as many horizontal and vertical columns and lines compared to conventional systems. The

improved vertical resolution is achieved by using more than 1,000 scanning lines. Improved luminance details in the picture can be accomplished with a higher video bandwidth, about five times that used in conventional systems. Two resolution schemes are recommended for practical applications: the so-called "High 1440 Level" with 1,440×1,152 pixels and the "High Level" containing 1,920×1,152 pixels.

- **Frame rate:** The number of frames per second was bitterly discussed in the ITU Working Groups. For practical reasons, namely compatibility with existing TV systems and with movies, agreement on a single HDTV standard valid worldwide could not be achieved; options of 50 or 60 frames per second were established. Newly developed, very efficient standard-conversion techniques based partly on movement estimation and compensation can mitigate this problem.
- **Aspect ratio:** The aspect ratio is defined as the ratio of picture width to picture height. Initially, a ratio of 16:9 = 1.777 was adopted; the ratio in current televisions is 4:3.
- **Interlaced and/or progressive scanning formats:** Conventional TV systems are based on alternating scanning lines. Each frame is composed of two consecutive fields, each containing half the scanning lines of a picture, which are scanned and presented in interlaced mode. In progressive scanning, used for example, in computer displays, there is only one such field per picture, and the number of scanning lines per field is doubled.
- **Viewing conditions:** The field of view and, thus, the screen size play an important role in visual effects and thus also for the feeling of "reality." Early studies found that the screen area must be bigger than 8,000cm^2. The line count per picture is about twice as large as in conventional television so that the normal viewing distance can be halved compared to conventional systems and results in three times the picture height (3H). In 1991, researchers at NTT Labs reported further progress in HDTV technology. Their concept integrated various video media with their corresponding quality levels (communication, broadcast, and display) into one system. To achieve this integration, a minimum spatial resolution of 2k×2k pixels is needed, along with a temporal resolution of at least 60

frames per second and a signal resolution of at least 256 steps (corresponding to 8 bits). A resolution of 2k×2k corresponds to a high-resolution photo or a color A4 print.

Table 2.3: Properties of TV Systems (P: progressive, i: interlaced)

System	Total Channel (MHz)	Video basebands (MHz)			Frame rate (Hz)	
		Y	R-Y	B-Y	Recording: Camera	Playback: Monitor
HDTV (USA)	9.0	10.0	5.0	5.0	59.94-p	59.94-i
NTSC	6.0	4.2	1.0	0.6	59.94-i	59.94-i
PAL	8.0	5.5	1.8	1.8	50-i	50-i
SECAM	8.0	6.0	2.0	2.0	50-i	50-i

2.3.3. Digital Television

When the topic of digital television was taken up by the relevant Working Groups of the ITU, the discussion centered around the digital representation of television signals, that is, composite coding or component coding. After considerable progress in compression technology and an agreement to use exclusively component coding, at least in the TV studio, the work concentrated on the distribution of digital signals. Consequently, it took on more of a system-oriented viewpoint.

In Europe, the development of digital television (Digital Television Broadcasting, DTVB, or-less Precisely-Digital Video Broadcasting, DVB) started in the early 90s. At this time, universities, research facilities, and businesses were already intensely working on pushing a European HDTV system. Interested partners founded a European consortium-the European DVB Project-that made quick headway upon beginning work and thus played a major role in the preliminary standardization of all digital television system components. Excluded, however, are studio and display technologies.

One of the first important decisions was the selection of MPEG-2 for the source coding of audio and video data and the MPEG-2 system technology for creating elementary program streams and transport streams.

Although the original MPEG-2 standard met practical requirements, it was too broad to be implemented economically in its entirety. As a result, the syntax and possible parameters were restricted; these DVB recommendations are contained in the "Guidelines Document."

The former, also called DVB-TXT, specifies how to handle "analog" teletext in a DVB environment. The Service Information Document (SI) covers program descriptions and navigation tools.

Satellite connections, CATV networks, and (S) MATV (Small) Master Antenna (TV) systems are best suited for distributing digital television signals. Terrestrial broadcast services, for example, data distribution to households over telephone connections or using "Multichannel Microwave Distribution Systems" (MMDS), are other technical possibilities. Suitable transmission systems had to be developed for all these options and standardized by the DVB Project.

The European Telecommunications Standards Institute (ETSI) adopted the DVB system digital broadcast proposals for satellites (DVB-S) and CATV systems (DVB-C) as official standards.

If microwaves are used to transmit DVB signals, there are two specifications, depending on the frequency range used. ETSI standards also describe MMDS for use at frequencies above 10GHz (DVB-MS). This transmission system is based on the use of DVB-S technology. This specification is based on DVB-C technology and is thus designated as DVB-MC.

Additionally, recommendations were published for conditional access, for establishing backward channels in interactive video applications, and for the private use of specific networks. In conclusion, the DVB solutions for digital television afford many advantages, the most important being the following:

- The increased number of programs that can be transmitted over a television channel

- The option of adapting video and audio quality to each application
- The availability of exceptionally secure encryption systems for pay-TV services
- The availability of tools to develop and implement new services, such as data
- Broadcast, multimedia broadcast, and video-on-demand

- The option of integrating new Internet services represents the "convergence" of computers and TV

2.3.4. FHD, QHD, HUD, 4K, 5K, 8K

We thought we would help clear up this confusion related to screen resolution sizes and explain exactly is the difference between qHD and QHD, HD and Full HD, and what is 1K, 2K, 4K, 5K, and 8K.

1) HD/720p and Full HD/1080p

In terms of displays, HD refers to the resolution of the original HD TVs that first came around. There were a few, but the most basic was 1280 x 720 pixels, more commonly called 720p. The 'p' is for progressive can as opposed to 720i, where the 'i' stands for interlaced. The difference between the 'p' and 'i' is a whole different topic, so we will not go over it here. These days though, especially when it comes to TVs, HD is not so HD anymore.

Full HD is the real HD and displays with this resolution pack in about 2 million pixels. That is twice as much as HD. Full HD measures 1,920 x 1,080 pixels, often referred to as 1080p. Most basic TVs today are 1080p, which is true for many smartphones as well.

2) qHD, QuadHD/WQHD/1440p, and 2K Resolutions

qHD and QHD, while spelled pretty much the same, could not be any more different. qHD stands for a quarter of full HD, i.e., four times less than 1080p. The typical qHD resolution is 960 x 540 pixels or 540p. QHD, on the other hand, is four times the standard HD resolution. Keep in mind, four times the HD resolution, not Full HD. The typical QHD resolution is 2,560 x 1,440 pixels or 1440p. That is four times as many pixels as 1280 x 720 or 720p.

If you're counting, Quad HD or QHD contains 4 million pixels. As is the case with all HD derived resolutions, QHD also has an aspect ratio of 16:9 which is considered wide. For this reason, some manufacturers like to put a W in front, marketing it as WQHD. The W is there to explicitly state a wide aspect ratio, although it is essentially the same thing as QHD.

QHD displays are very common in Android flagship smartphones these days. QHD is also often called 2K because it is half of 4K. However, mainly, 2K refers to a resolution where the larger of the pixel measurements is over 2000 pixels. The typical 2K resolution is 2,048 × 1,080 pixels. So it is basically a 1080p display but with a much wider aspect ratio. 2K is, therefore, not quite the same as QHD, and in fact, QHD is better.

3) 4K and UHD Resolutions

Many of you may think 4K and UHD are the same, which is not your fault. Companies often use these interchangeably and together. Pick up any Blu-Ray Cover for a 4K movie, and it will most definitely also have the Ultra HD label. 4K is not a consumer display and broadcast standard, unlike UHD. 4K displays are used in professional production and digital cinemas and feature 4,096 x 2,160 pixels. That is a wider aspect ratio than 16:9, much like 2K.

On the other hand, UHD features a 16:9 aspect ratio and is four times the resolution of full HD. In other words, four times 1080p, four times 1920 x 1080 pixels is 3,840 x 2,160 pixels. Having the same 16:9 aspect ratio means it is backward compatible with other HD derivates. However, both 4K and UHD can be shortened to 2160p to match the HD standard; therefore, companies use the terms interchangeably.

4) 5K Resolutions

5K describes a display resolution of 5120 x 2880 and is mostly found in Apple's 27-inch iMac display. LG's 27-inch Ultrafine 5K also monitors output at 5120 x 2880. Outside of these, the 5K resolution is not all that common.

5) 8K and 8K UHD Resolutions

All digital displays or images with a width or higher pixel value of approximately 8000 pixels have an 8K resolution. 8K resolution produces vivid colors and details. It is said

that at this level of resolution, the human eyes cannot notice the pixels, and the displayed images look very clear as no dots are visible to the eyes. As for 8K UHD resolution displays, they have an aspect ratio of 16:9 and have around 7680 × 4320 pixels.

Table 2.4: Screen Resolution Sizes

Resolution name	Horizontal x vertical pixels	Other names	Devices
8K	7680 x 4320 px	8K UHD	TVs
“Cinema” 4K	4096 x [unspecified]	4K	Projectors
UHD	3840 x 2160 px	4K, Ultra HD, Ultra-High Definition	TVs, monitors, smartphones
2K	2048 x [unspecified]	none	Projectors
WUXGA	1920 x 1200 px	Widescreen Ultra Extended Graphics Array	Monitors, projectors
1080p	1920 x 1080 px	Full HD, FHD, HD, High Definition	TVs, monitors, smartphones
720p	1280 x 720 px	HD, High Definition	TVs, Smartphones

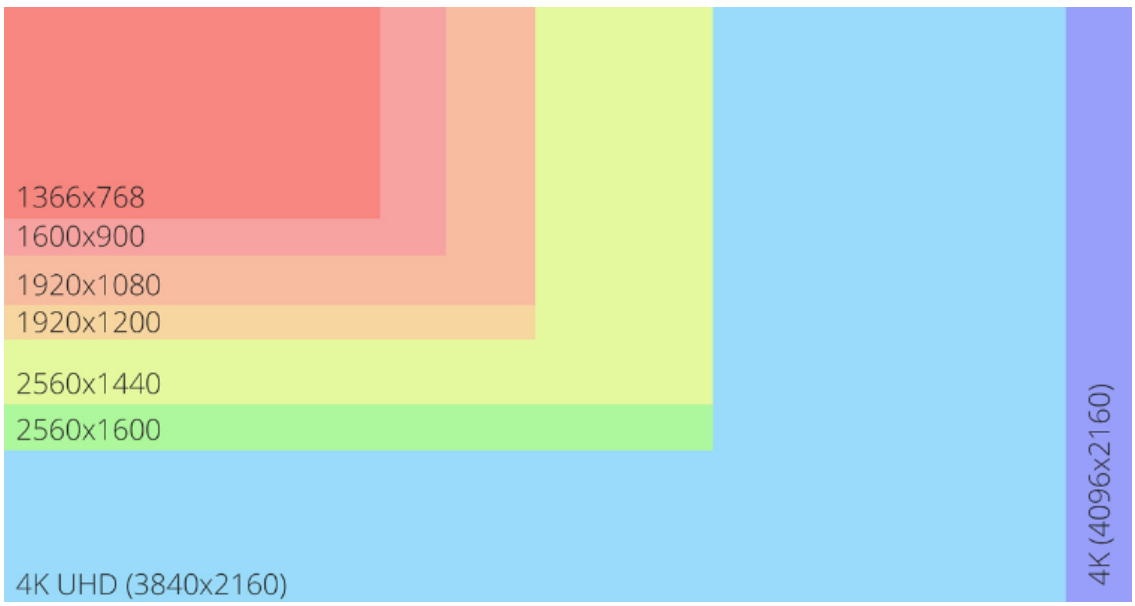


Figure 2.10: Compare to Screen Resolution Sizes

Summary

In this chapter, you have learned:

Audio is sound that exists within the human acoustic range. An audio frequency (AF) is an alternating electrical current with a frequency range of 20 to 20,000 hertz (cycles per second) that can be used to generate acoustic sound. Audio in computers refers to the sound system that comes standard with or can be added to a computer. An audio card includes a dedicated built-in processor and memory for processing audio files and transmitting them to the computer's speakers. An audio file is a digital recording of the sound that may be played back. Sound is a series of naturally analog impulses converted to digital signals by the audio card, which employs an analog-to-digital converter microprocessor (ADC). When sound is played, digital signals are transmitted.

An image consists of a rectangular array of dots called pixels. The size of the image is specified in terms of width X height in the number of pixels. The image's physical size, in inches or centimeters, depends on the device's resolution on which the image is displayed. The resolution is usually measured in DPI (Dots per Inch). An image will appear smaller on a device with a higher resolution than on a lower resolution. For color images, one needs enough bits per pixel to represent all the colors in the image. The number of bits per pixel is called the depth of the image.

Video refers to a moving picture accompanied by sound, such as a picture on television. The video element of multimedia applications gives much information over a short time. Digital video is useful in a multimedia application for showing real-life objects. Video has the highest performance demand on the computer memory and bandwidth if placed on the internet. Digital video files can be stored like any other files in the computer, and the quality of the video can still be maintained. Digital video files can be transferred within a computer network. Digital video clips can be edited easily.

Questions

1) How can audio and sound be defined?
2) What is MIDI?
3) Identify the following types of sounds: infrasonic, audiosonic, ultrasonic, and hypersonic. Provide an example to illustrate your point.
4) What is the audio representation on the computer like? Give a brief description.
5) What are the differences between ADCs and DACs?
6) List image formats and explain them one by one.
7) Explain the difference between a vector and a bitmap image.
8) Why is it essential to understand different image file types?
9) What are the differences between animation and video?
10) Explain what FHD, QHD, HUD, 4K, 5K, and 8K are.

Exercises

1) Analyze the history of the television system. What are the pros and cons of the revolution? Please explain.
2) Research and make a chart of resolutions and explain them.
3) Investigate how Audio, Graphics, and Images influence our lives.

Additional Reading:

1) F. Arman, A. Hsu, and M.-Y. Chiu. “Image processing on compressed data for large video databases.” ACM Multimedia, pages 267–272, June 1993.
2) J. Chowning. “The simulation of a moving sound source.” Journal of the Audio Engineering Society, 41(11), 1971.3. K. B. Benson and D.
3) N. Dimitrova and M. Abdel-Mottaleb. “Content-based video retrieval by example video clip.” In Storage and Retrieval for Image and Video Databases (SPIE), SPIE Proceedings Vol. 3022, pages 59–70, San Jose, CA, 1997.
4) European Telecommunications Standards Institute. Digital Broadcasting Systems for Television, Sound and Data Services: Specification for Service Information (SI) in Digital Video Broadcasting Systems. ETSI, ETSI 300 468 edition, November 1994.
5) Mohammed Ghanbari. Video Coding: An Introduction to Standard Codecs. Number 42 in Telecommunications Series. IEE Press, London, UK, 1999.
6) 6. R. C. Gonzales and R. E. Woods. Digital Image Processing. Addison Wesley Publishing Company, Inc., 1993.
7) George Lekakos, Konstantinos Chorianopoulos and Georgios Doukidis. Interactive Digital Television: Technologies and Applications 2007.

Chapter 03

Video Editor and Audio Editor

Learning Objective:

The objective of this chapter is to introduce the concept of the applications for utilizing video and audio editors. Likewise, it provides a fundamental understanding of using these applications for video and audio editors.

After completing this chapter, students should be able to:

- Implement video editor
- Implement audio editor

In this chapter, you will learn about:

3.1. Video Editor

3.2. Audio Editor

3.1. Video Editor

3.1.1. Introduction to OpenShot

OpenShot Video Editor is an award-winning, open-source video editor available on Linux, Mac, and Windows. OpenShot can create stunning videos, films, and animations with an easy-to-use interface and rich feature set.

1) Features

- Cross-platform (Supports Linux, OS X, and Windows)
- Support for many videos, audio, and image formats (based on FFmpeg)
- Powerful curve-based key frame animations
- Desktop integration (drag and drop support)
- Unlimited tracks/layers
- Clip resizing, scaling, trimming, snapping, rotation, and cutting
- Video transitions with real-time previews
- Compositing, image overlays, watermarks
- Title templates, title creation, sub-titles
- 2D animation support (image sequences)
- 3D animated titles (and effects)
- SVG friendly, to create and include vector titles and credits
- Scrolling motion picture credits
- Advanced Timeline (including drag & drop, scrolling, panning, zooming, and snapping)
- Frame accuracy (step through each frame of video)
- Time-mapping and speed changes on clips (slow/fast, forward/backward, etc…)
- Audio mixing and editing
- Digital video effects, including brightness, gamma, hue, greyscale, chroma key (bluescreen / greenscreen), and many more!

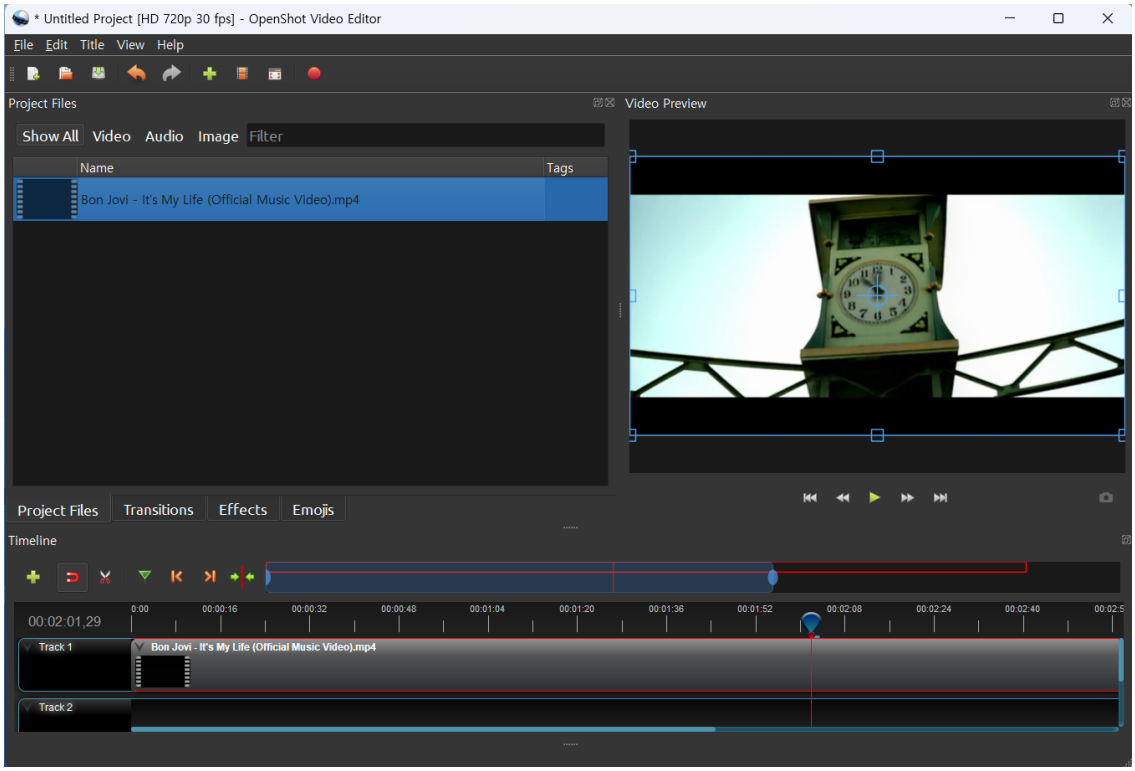


Figure 3.1: Screenshot of the OpenShot

2) System Requirements

- Video editing benefits from large amounts of memory, modern CPUs, and fast disks. Basically, you want the best computer you can afford when editing video. Here are the minimum system requirements:
- 64-bit Operating System (Linux, OS X, Windows 7/8/10)
- Multi-core processor with 64-bit support
- 4GB of RAM (16GB recommended)
- 500 MB of hard-disk space for installation
- Optional: Solid-state drive (SSD), if utilizing disk-caching (and an additional 10GB of hard-disk space)

3.1.2. Installation

The latest and greatest version of OpenShot Video Editor for Linux, Mac, and Windows can be downloaded from the official download page at https://www.openshot.org/download/.

1) Linux

Most Linux distributions have a version of OpenShot in their software repositories, so installation should be easy. Some might have an outdated version, though (make sure to check the version number). The easiest way to ensure you have the latest version is to download an AppImage from the project website. Once downloaded, right-click on the AppImage file, choose Properties, and mark the file as Executable. Now, go ahead and double-click the AppImage to launch it.

2) Mac

Download the DMG file from the project website, double-click it, and then drag the OpenShot application icon into your Applications shortcut. This is very similar to how most other Mac applications are installed. Now launch OpenShot from Launchpad.

3) Windows

Download the Windows installer executable from the project website, double-click it, and follow the directions on the screen. Once completed, OpenShot will be installed and available in your Start menu.

3.1.3. Main Window

1) Overview

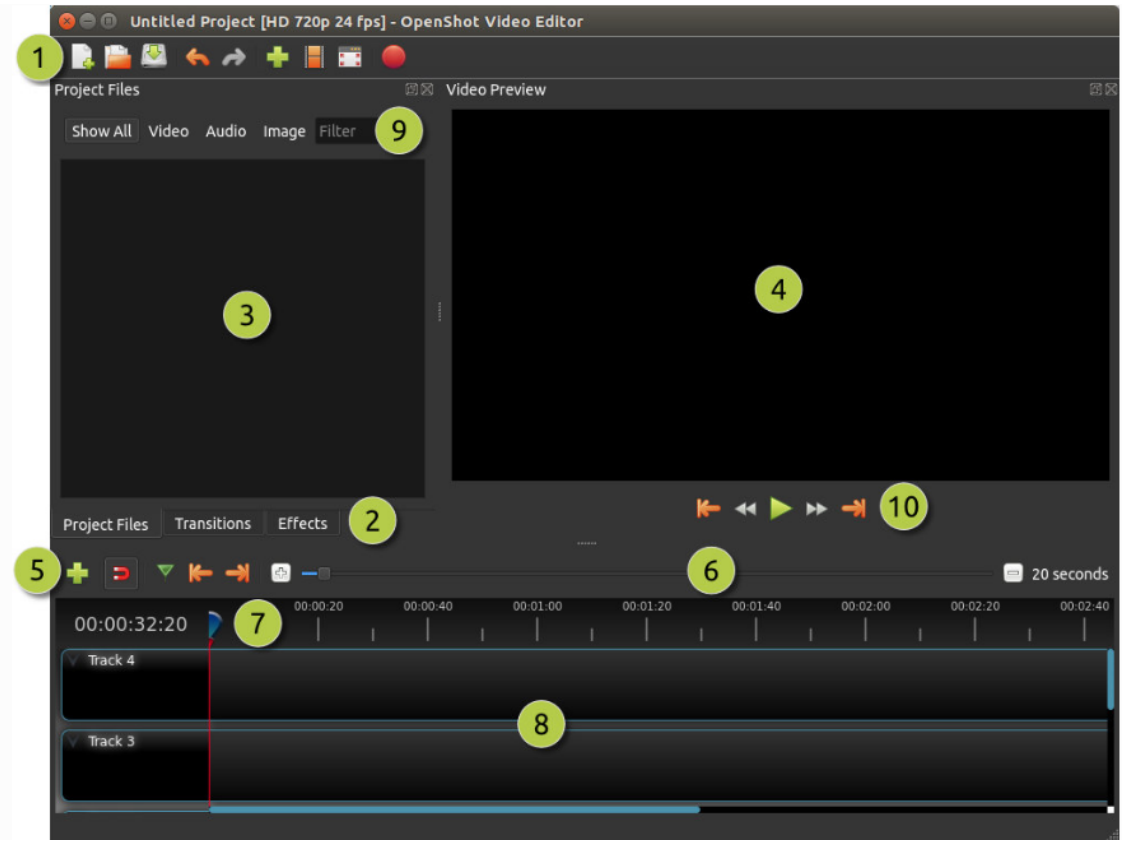


Figure 3.2: OpenShot Video Editor Layout

Table 3.1: OpenShot Manu

#	Name	Description
1	Main Toolbar	Contains buttons to open, save, and export your video project.
2	Function Tabs	Switch between Project Files, Transitions, and Effects.
3	Project Files	All audio, video and image files have been imported into your project.
4	Preview Window	This is the area where the video will playback on the screen.
5	Edit Toolbar	This toolbar contains buttons used for snapping, inserting markers, and jumping between markers.

#	Name	Description
6	Zoom Slider	This slider will adjust the time scale of your timeline.
7	Play-head / Ruler	The ruler shows the time scale, and the red line is the play-head. The play-head represents the current playback position.
8	Timeline	The timeline visualizes your video project and each clip and transition in your project.
9	Filter	Filter the list of items shown (project files, transitions, and effects) by using these buttons and the filter textbox. Enter a few letters of what you are looking for, and the results will be shown.
10	Playback	Left to Right: Jump to Start, Rewind, Play/Pause, Fast Forward, and Jump to End.

2) Built-in Tutorial

When you first launch OpenShot, you will be presented with a friendly built-in tutorial. It will point out and explain the basics. Clicking **Next** will jump to the next topic. You can always view this tutorial again from the **Help ➔ Tutorial** menu.

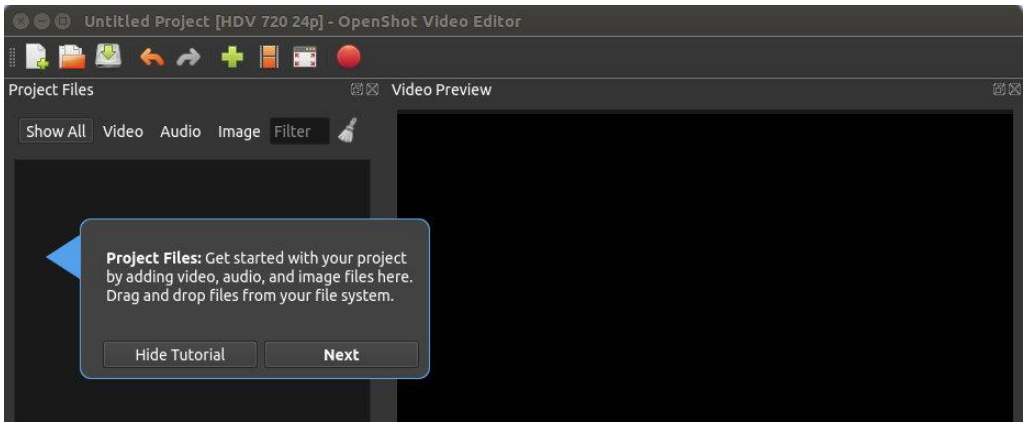


Figure 3.3: Screenshot of OpenShot

3) Tracks and Layers

OpenShot uses tracks to layer videos and images. The topmost track is the top layer, and the bottom track is the bottom layer. If you are familiar with layers in a photo editing application, then you should be familiar with this concept. OpenShot will mix each layer, just like a photo editing application. You can have an unlimited number of tracks, but typically a video project will only need up to 10 (or so) tracks.

For example, imagine a 3 track video project

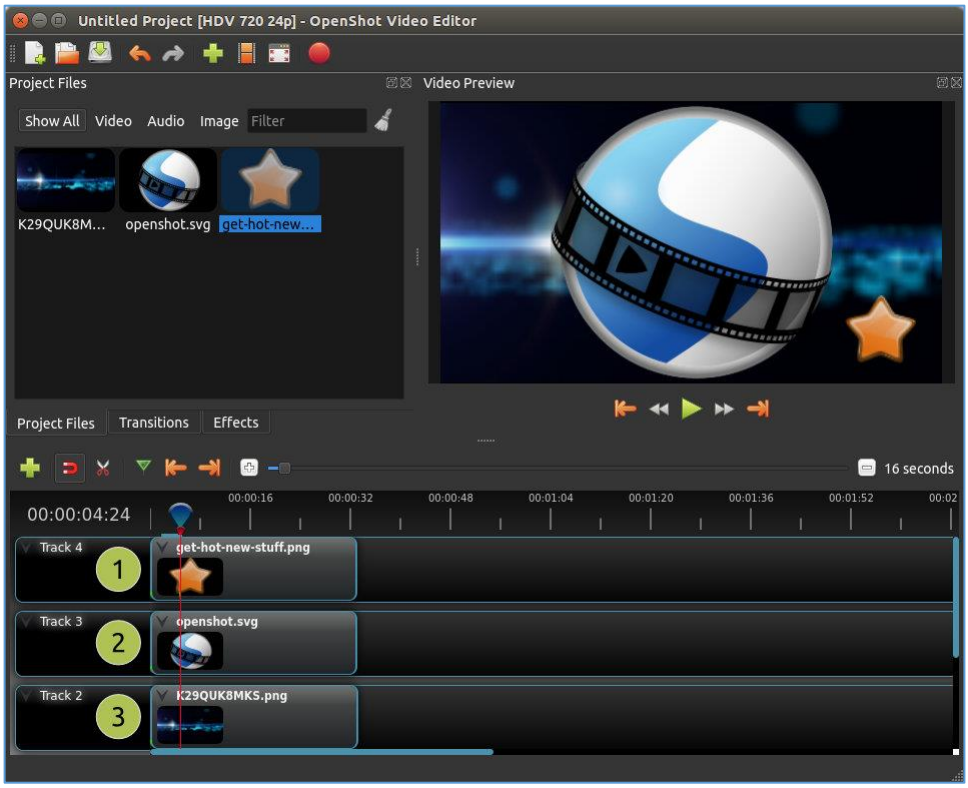


Figure 3.4: OpenShot Track and Layer

Table 3.2: About OpenShot track

#	Name	Description
1	Top Track	Clips on this track will always be on top and visible.
2	Middle Track	Clips in the middle (might or might not be visible, depending on what is above them).
3	Bottom Track	Clips on this track will always be on the bottom.

4) Keyboard Shortcuts

Here is a list of the default keyboard shortcuts supported by OpenShot. You can configure these shortcuts in the Preferences dialog. Learning a few of these shortcuts can save you a bunch of time!

Table 3.3: Keyboard Shortcuts

#	Shortcut	Action
1	Ctrl+H	About OpenShot
2	Ctrl+M	Add Marker
3	Ctrl+Shift+T	Add Track
4	Ctrl+W	Add to Timeline
5	Ctrl+B	Animated Title
6	Ctrl+P	Choose Profile
7	Ctrl+C	Copy
8	Delete	Delete Item
9	Backspace	Delete Item
10	Ctrl+D	Details View
11	Ctrl+E	Export Video
12	L	Fast Forward
13	F11	Fullscreen
14	Ctrl+F	Import Files
15	Ctrl+End	Jump to End
16	Ctrl+Home	Jump to Start
17	Ctrl+N	New Project
18	Right	Next Frame
19	Ctrl+Right	Next Marker
20	Ctrl+O	Open Project
21	Ctrl+V	Paste

#	Shortcut	Action
22	Space	Play/Pause Toggle
23	Up	Play/Pause Toggle
24	Down	Play/Pause Toggle
25	K	Play/Pause Toggle
26	Ctrl+Shift+P	Preferences
27	Left	Previous Frame
28	Ctrl+Left	Previous Marker
29	Ctrl+I	Properties
30	Ctrl+Q	Quit
31	Ctrl+Y	Redo
32	J	Rewind
33	Ctrl+S	Save Project
34	Ctrl+Shift+S	Save Project As…
35	Ctrl+A	Select All
36	Ctrl+Shift+A	Select None
37	Ctrl+K	Slice All: Keep Both Sides
38	Ctrl+L	Slice All: Keep Left Side
39	Ctrl+J	Slice All: Keep Right Side
40	Ctrl+G	Toggle Snapping
41	R	Toggle Razor tool
42	Ctrl+X	Split Clip
43	Ctrl+Shift+D	Thumbnail View
44	Ctrl+T	Title Editor
45	Ctrl+Z	Undo
46	=	Zoom In
47	–	Zoom Out
48	Ctrl+Scroll	Zoom In/Out

3.1.4. File

To create a video, we need to make media files available to our project by importing files into OpenShot. Most media file types, such as videos, images, and audio files, are recognized. Files can be viewed and managed in the Project Files panel.

Note that imported files are not copied anywhere; they remain in the physical location they were before and are simply being made available to your video project. So, they must be kept from being deleted or moved after adding them to your project. The “Show All,” “Video,” “Audio,” and “Image” filters above the files allows you only to see the file types you are interested in. You can also toggle the view between details and the thumbnail view of your files.

1) Import Files

These are all possible methods to import media files into OpenShot:

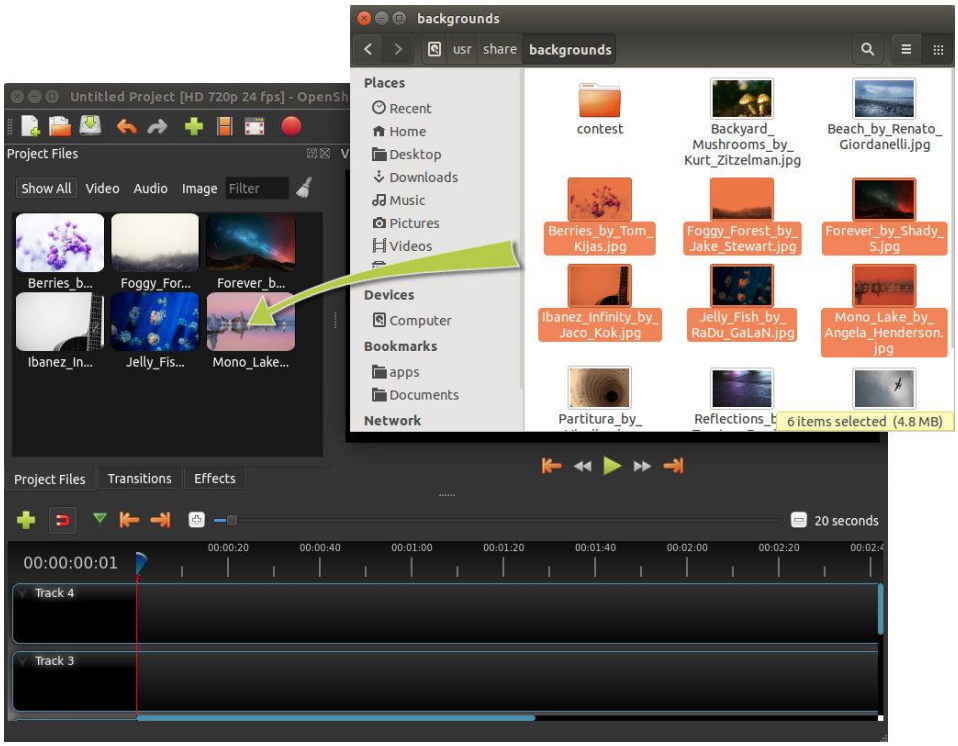


Figure 3.5: Import Files

Table 3.4: Importing Files in OpenShot

Name	Description
Drag and Drop	Drag and drop the files from your file manager (file explorer, finder, etc…).
Context menu (File Menu)	Right-click anywhere in the **Project Files** panel and choose **Import Files**.
Main Menu	In the main menu, choose **File ➔ Import Files.**
Toolbar button	Click the toolbar button in the main toolbar.
Keyboard shortcut	Press Ctrl-F (Cmd-F on Mac).

2) File Menu

To view the file menu, right-click on a file (in the **Project Files** panel). Here are the actions you can use from the file menu.

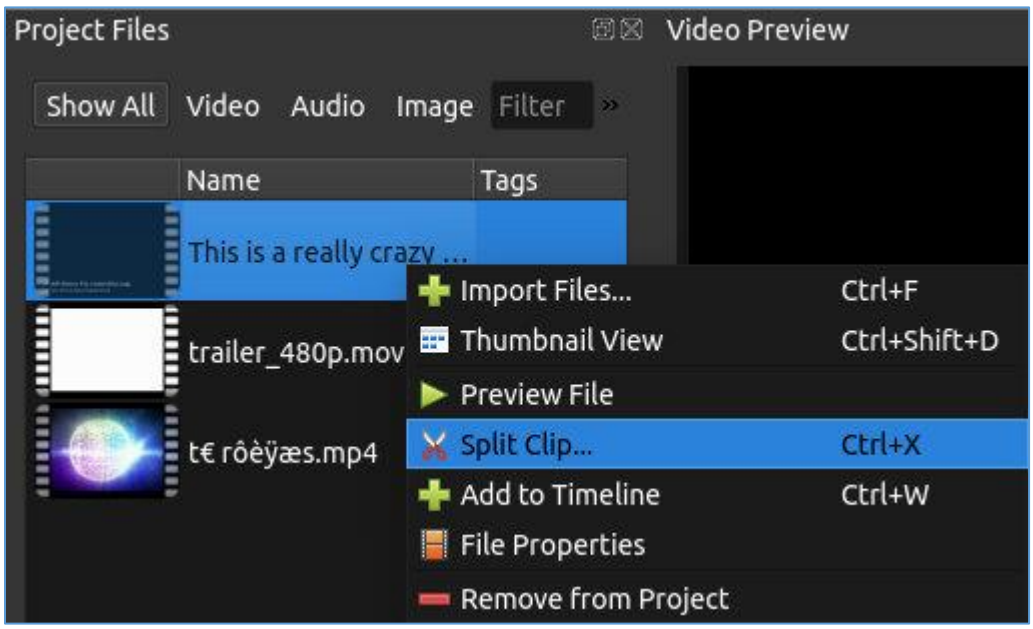


Figure 3.6: File Menu in OpenShot

Table 3.5: Menu File in OpenShot

Name	Description
Import Files	Import files into your project.
Thumbnail/Detail	Toggle the view between details and thumbnails.
Preview File	Preview a media file.
Split Clip	Split a file into many smaller clips.
Edit Title	Edit an existing title SVG file.
Duplicate Title	Make a copy, and then edit the copied title SVG file.
Add to Timeline	Add many files to the timeline in one step.
File Properties	View the properties of a file, such as a frame rate, size, etc…
Remove from Project	Remove a file from the project.

3) Split Clip

If you need to cut a file into many smaller clips before editing, the Split Clip dialog is built precisely for this purpose. Right-click on a file, and choose Split Clip from the file menu. This opens the Split Clip dialog. Use this dialog to quickly cut out as many small clips as you need. The dialog stays open after you create a clip to allow you to repeat the steps for your following clip. When you are finished, close the dialog.

Figure 3.7: Spilt Clip in OpenShot

Table 3.6: About the spilt clip in OpenShot

#	Name	Description
1	Start of Clip	Choose the starting frame of your clip by clicking this button.
2	End of Clip	Choose the ending frame of your clip by clicking this button.
3	Name of Clip	Enter an optional name.
4	Create Clip	Create the clip (which resets this dialog, so you can repeat these steps for each clip).

Please refer to the section Cutting & Slicing for more ways to cut and slice clips directly in the timeline.

4) Export Clip

If you want your clips available outside of your OpenShot project or want to copy all your video assets to one place, you can do this with the Export Clip dialog. Simply **Ctrl+Click** to select any clips or files you like. Then right-click and choose **Export Clips**. In the dialog that appears, choose a destination folder, and click **Export**.

5) Add to Timeline

In certain cases, you might need to add many files to the timeline simultaneously—for example, a photo slide show or a large number of short video clips. The Add to Timeline dialog can automate this task for you. First, select all files you need to add, right-click, and choose to **Add to Timeline.**

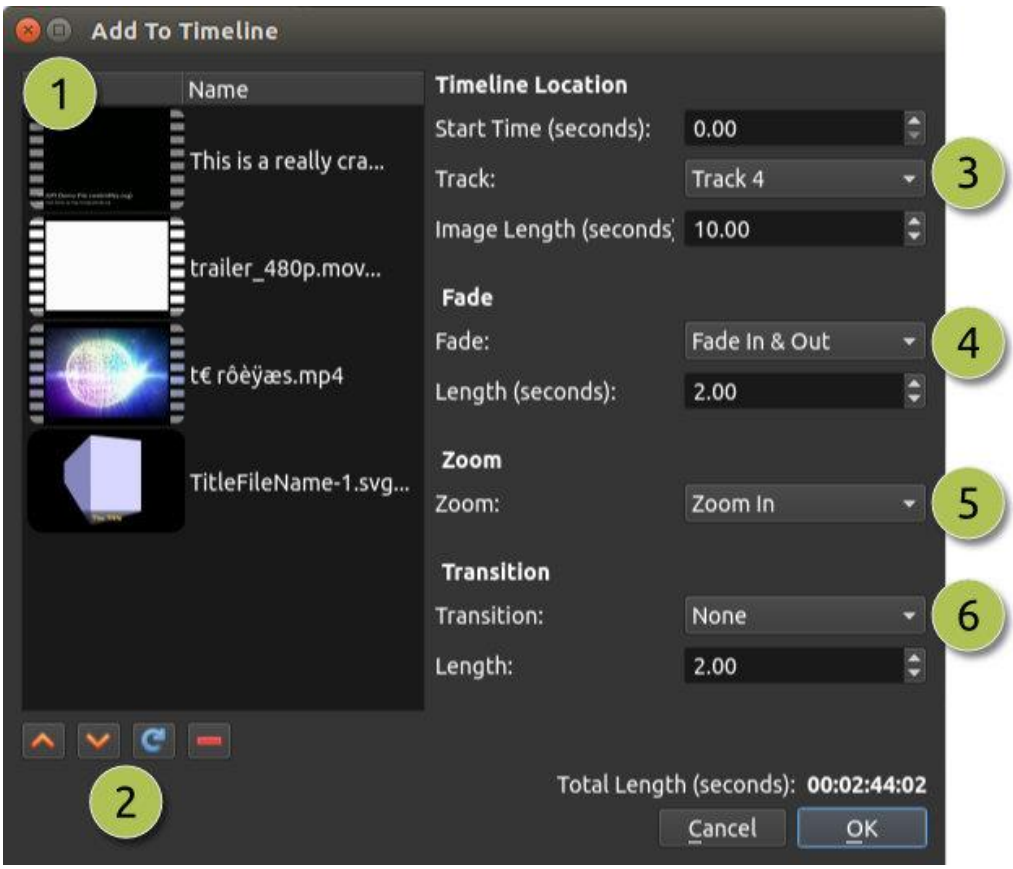


Figure 3.8: Add to Timeline

Table 3.7: Add to Timeline

#	Name	Description
1	Selected Files	The list of selected files that need to be added to the timeline.
2	Order of Files	Use these buttons to reorder the list of files (move up, move down, randomize, remove).
3	Timeline Position	Choose the starting position and track where these files need to be inserted on the timeline.
4	Fade Options	Fade in, fade out, both, or none.
5	Zoom Options	Zoom in, zoom out, or none.
6	Transitions	Choose a specific transition to use between files, random, or none.

6) Properties

To view the properties of any imported file in your video project, right-click on the file and choose File Properties. This will launch the file properties dialog, which displays information about your media file. For certain types of images (i.e., image sequences), you can also adjust the frame rate on this dialog.

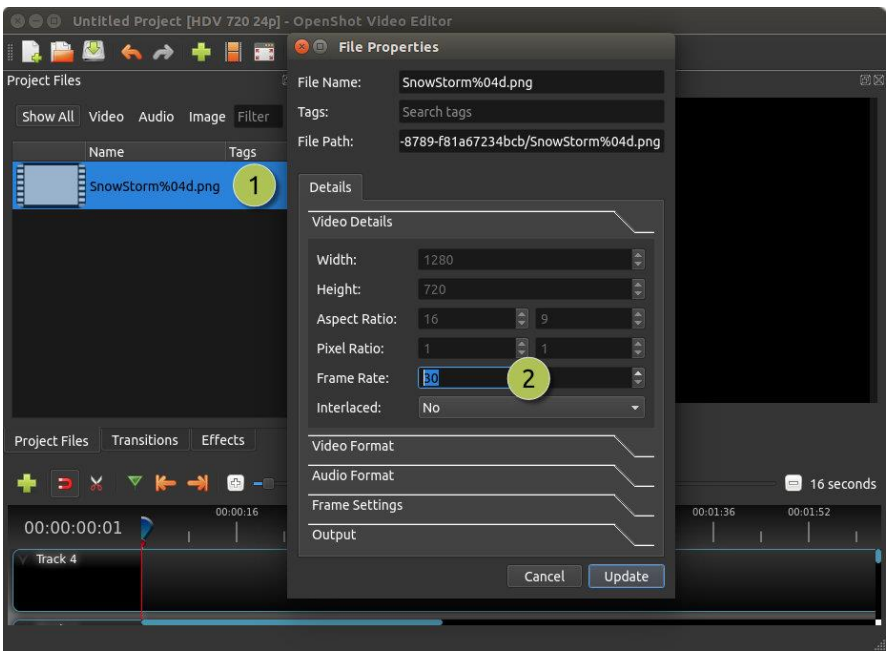


Figure 3.9: File Properties

Table 3.8: File properties

#	Name	Description
1	File Properties	Select an image sequence in the **Project Files** panel, right click and choose **File Properties.**
2	Frame Rate	For image sequences, you can also adjust the frame rate of the animation.

7) Remove from Project

This will remove a file from the project. It will not delete the underlying physical file, so removing a file from the project merely makes it unavailable for this video project.

3.1.5. Clips

Each media file you add to the OpenShot timeline is called a clip and is visualized by a dark, rounded rectangle (as seen in the screenshot below). A clip has many properties that affect how the clip is rendered and composited, such as scale, location, rotation, and alpha. These properties can also be animated over time and, when combined together, can create some amazing effects.

1) Overview

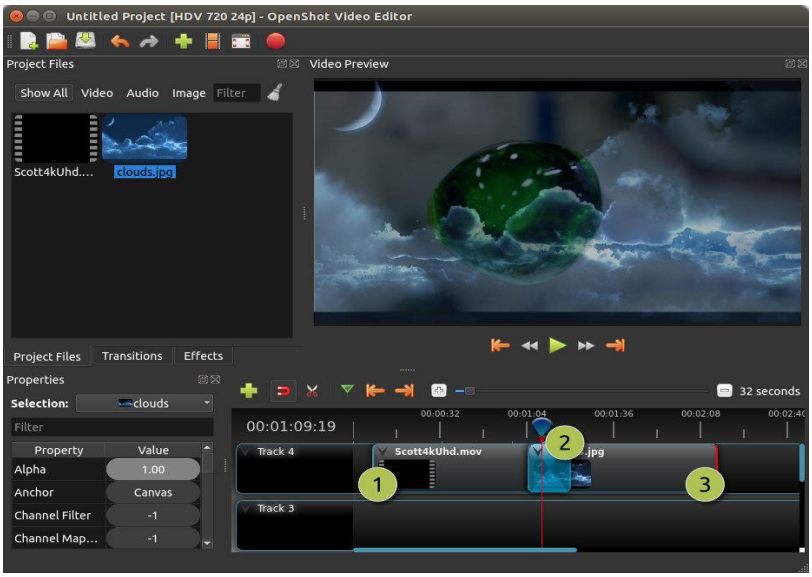


Figure 3.10: OpenShot Clip

Table 3.9: About clip in OpenShot

#	Name	Description
1	Clip 1	A video clip.
2	Transition	A gradual fade transition between the 2 clips.
3	Clip 2	An image clip.

2) Cutting and Slicing

OpenShot has many easy ways to adjust a clip's start and end positions (otherwise known as cutting). The most common method is simply grabbing the clip's left (or right) edge and dragging. Here is a list of methods for cutting clips in OpenShot:

Table 3.10: Cutting and Slicing in OpenShot

Name	Description
Slice	When the play-head (i.e., vertical red playback line) is overlapping a clip, right-click on the clip, and choose **Slice**.
Slice All	When the play-head overlaps many clips, right-click on the play-head, and choose **Slice All** (it will cut all intersecting clips on all tracks).
Resizing Edge	Mouse over the edge of a clip, and resize the edge.
Split Dialog	Right-click on a file, and choose **Split Clip**. A dialog will appear, which allows for creating lots of small cuts in a single video file.
Razor Tool	The razor tool from the **Edit Toolbar** cuts a clip wherever you click on it. So be careful. It is easy and dangerous!

Keep in mind that the above cutting methods also have Keyboard Shortcuts to save even more time.

3) Preset Menu

OpenShot has tons of great preset animations and clip properties, such as fading, sliding, zooming, etc… These presets can be accessed by right-clicking on a clip.

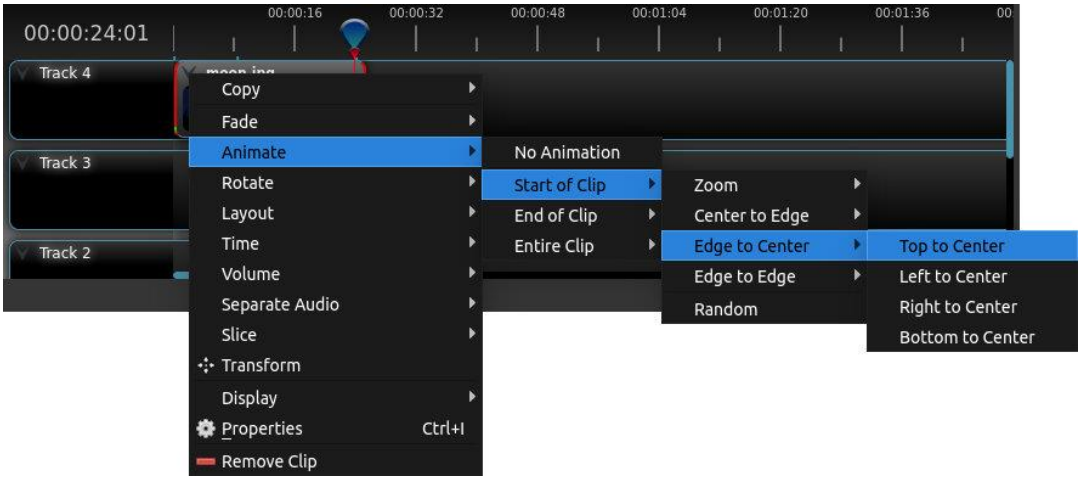


Figure 3.11: Preset Menu in OpenShot

Table 3.11: Preset Menu in OpenShot

Name	Description
Fade	Fade in or out a clip (often easier than a transition).
Animate	Zoom and slide a clip.
Rotate	Rotate or flip a video.
Layout	Make a video smaller or larger, and snap it to any corner.
Time	Reverse and speed up or slow down the video.
Volume	Fade in or fade out the volume for a clip.
Separate Audio	Create a clip for each audio track.
Slice	Cut the clip at the play-head position.
Transform	Enable transform mode.
Display	Show waveform or thumbnail for a clip.
Properties	Show the properties panel for a clip.
Copy / Paste	Copy and paste keyframes or duplicate an entire clip (with all keyframes).
Remove Clip	Remove a clip from the timeline.

4) Transform

To quickly adjust the location and scale of a clip, select a clip on the timeline, right click and choose **Transform**. Grab any small blue handles to adjust the scale, and grab the middle circle to move the image. Note: Pay close attention to where the play-head (i.e., red playback line) is. Keyframes are automatically created at the current playback position to help create animations.

Figure 3.12: Transform

5) Effects

In addition to the many clip properties that can be animated and adjusted, you can drop an effect directly onto a clip. A small letter icon represents each effect. Clicking the effect icon will populate the properties of that effect and allow you to edit (and animate) them.

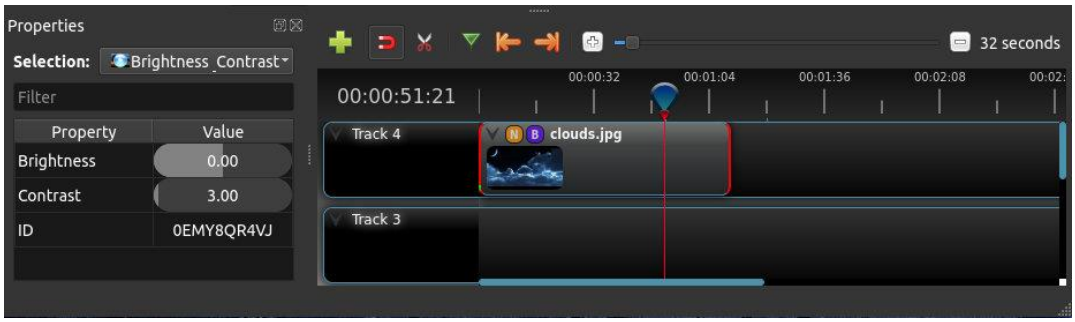


Figure 3.13: Effects in OpenShot

6) Properties

Below is a list of clip properties that can be edited and, in most cases, animated over time. To view a clip's properties, right-click and choose **Properties**. The property editor will appear, where you can change these properties. Note: Pay close attention to where the play-head (i.e., red playback line) is. Keyframes are automatically created at the current playback position to help create animations.

Table 3.12: About properties

Name	Description
Gravity Type	The gravity of a clip determines where it snaps to its parent.
Scale Type	The scale determines how a clip should be resized to fit its parent.
Frame Display Type	The format to display the frame number (if any).
Scale X	A curve represents the horizontal scaling in percent (0 to 1).
Scale Y	The curve represents the vertical scaling in percent (0 to 1).
Location X	The curve represents the relative X position in percent based on gravity (-1 to 1).
Location Y	The curve represents the relative Y position in percent based on gravity (-1 to 1).
Rotation	The curve represents the rotation (0 to 360).
Alpha	The curve represents the alpha (1 to 0).
Time	The curve represents the frames over time to play (used for speed and direction of video).
Volume	The curve represents the volume (0 to 1).
Shear X	The curve represents X shear angle in degrees (-45.0=left, 45.0=right).
Shear Y	The curve represents Y shear angle in degrees (-45.0=down, 45.0=up).
Channel Filter	A number representing an audio channel to filter (clears all other channels).
Channel Mapping	A number representing an audio channel to output (only works when filtering a channel).

Name	Description
Has Audio	An optional override to determine if this clip has audio (-1=undefined, 0=no, 1=yes).
Has Video	An optional override to determine if this clip has a video (-1=undefined, 0=no, 1=yes).
Waveform	Should a waveform be used instead of the clip's image?
Waveform Color	The curve representing the color of the audio waveform.

3.1.6. Animation

OpenShot has been explicitly designed with animation in mind. The powerful curve-based animation framework can easily handle most jobs and is flexible enough to create just about any animation. Keyframes specify values at specific points on a clip, and OpenShot does the hard work of interpolating the in-between values.

1) Overview

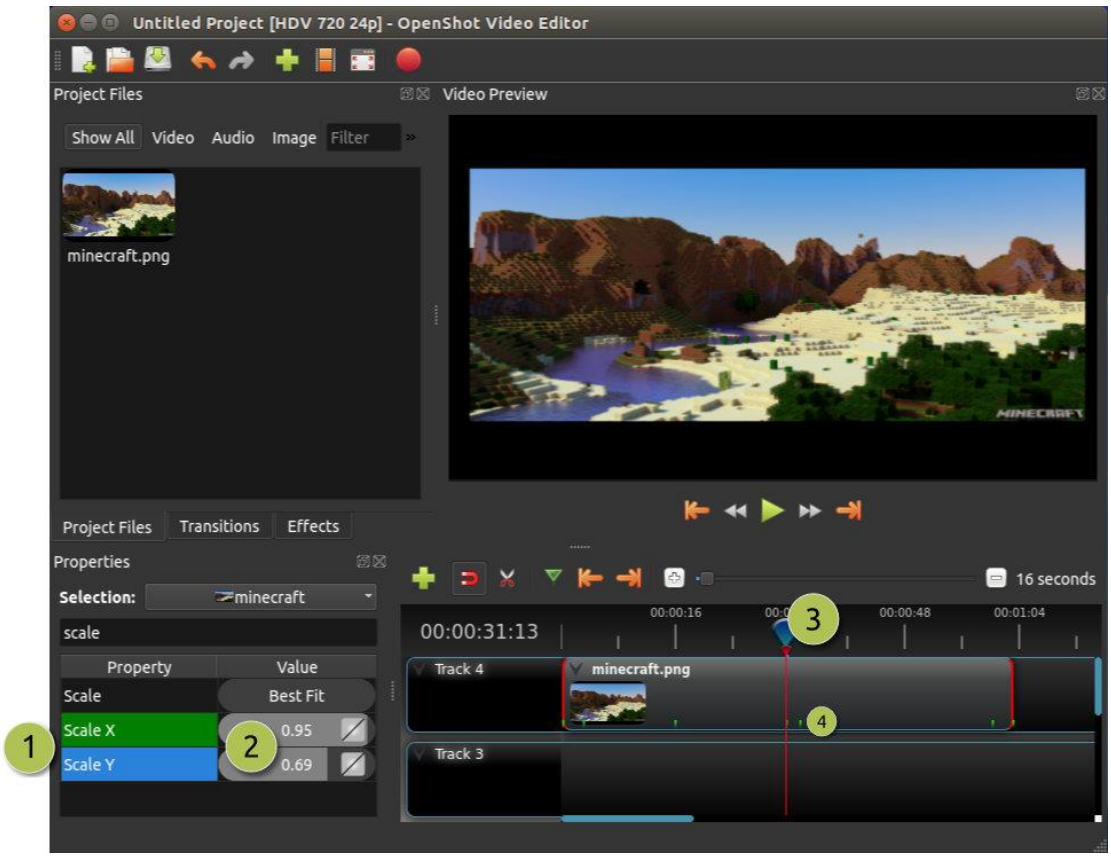


Figure 3.14: Animation Overview

Table 3.13: Animation Overview

#	Name	Description
1	Green Property	When the play-head is on a keyframe, the property appears green.
1	Blue Property	When the play-head is on an interpolated value, the property appears blue.
2	Value Slider	Click and drag your mouse to adjust the value (this automatically creates a keyframe if needed).
3	Play-head	Position the play-head over a clip where you need a keyframe.
4	Keyframe Markers	Small green tick marks are drawn at all key frame positions (on a clip).

2) Keyframes

To create a keyframe in OpenShot, simply position the play-head (i.e., playback position) at any point over a clip, and edit properties in the property dialog. If the property supports keyframes, it will turn green, and a small green tick mark will appear on your clip at that position. Move your play-head to another point over that clip, and adjust the properties again. All animations require at least 2 keyframes but can support an unlimited number of them.

To adjust the **interpolation mode**, right-click on the small graph icon next to a property value.

Table 3.14: Keyframes

Name	Description
Bezier	Interpolated values use a quadratic curve, and ease-in and ease-out.
Linear	Interpolated values are calculated linear (each step value is equal).
Constant	Interpolated values stay the same until the next keyframe, and jump to the new value.

3) Bezier Presets

When using a Bezier curve for animation, OpenShot includes more than 20 curve presets (which affect the shape of the curve). For example, **Ease-In** has a more gradual slope at the beginning, making an animation move slower at the beginning and faster at the end. **Ease-In/Out (Back)** has a gradual beginning and ending but actually goes past the expected value and then back (producing a bounce effect).

To choose a curve preset, right-click on the small graph icon next to a keyframe.

Figure 3.15: Bezier Preset

4) Image Sequences

If you have a sequence of similarly named images (such as cat001.png, cat002.png, cat003.png, etc…), you can simply drag and drop one of them into OpenShot, and you will be prompted to import the entire sequence.

To adjust the animation's frame rate, right-click and choose **File Properties** in the **Project Files** panel and adjust the frame rate. Once you have set the correct frame rate, drag the animation onto the timeline.

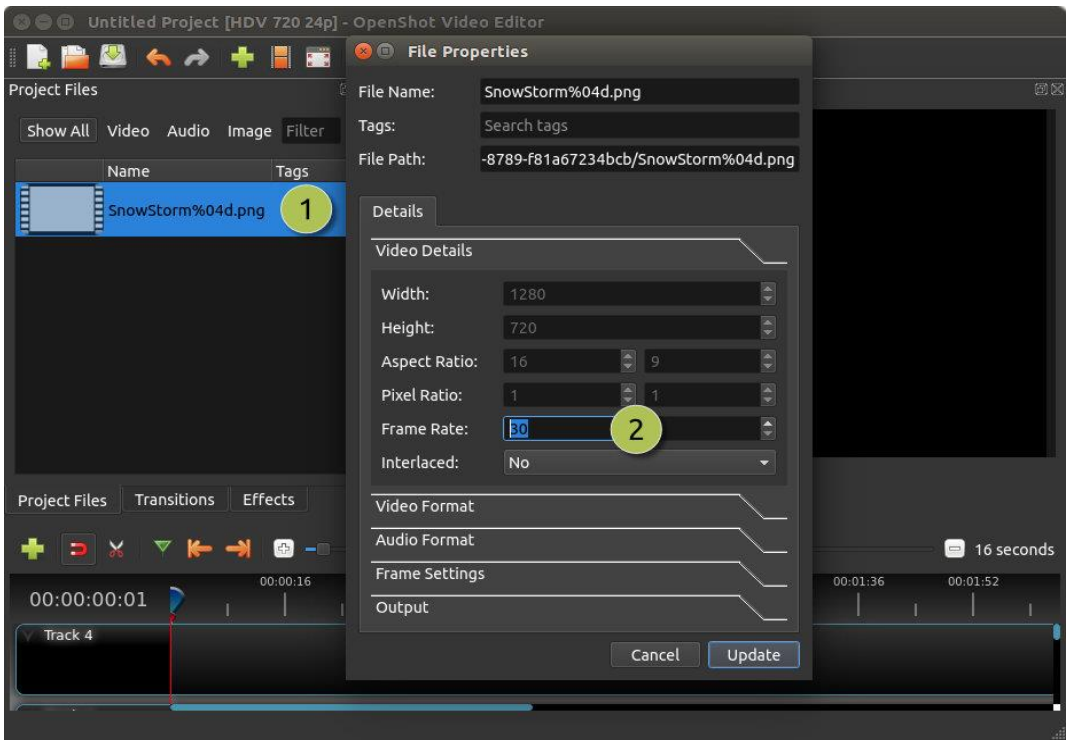


Figure 3.16: Image Sequences

Table 3.15: Image sequences

#	Name	Description
1	File Properties	Select an image sequence in the **Project Files** panel, right click, and choose **File Properties.**
2	Frame Rate	Adjust the frame rate of the animation. Typically, hand-drawn animations use 12 frames per second.

3.1.7. Titles

Adding text and titles is an essential aspect of video editing, and OpenShot comes with an easy-to-use Title Editor. Use the Title menu (located in the main menu of OpenShot) to launch the Title Editor. You can also use the keyboard shortcut **Ctrl+T**.

1) Overview

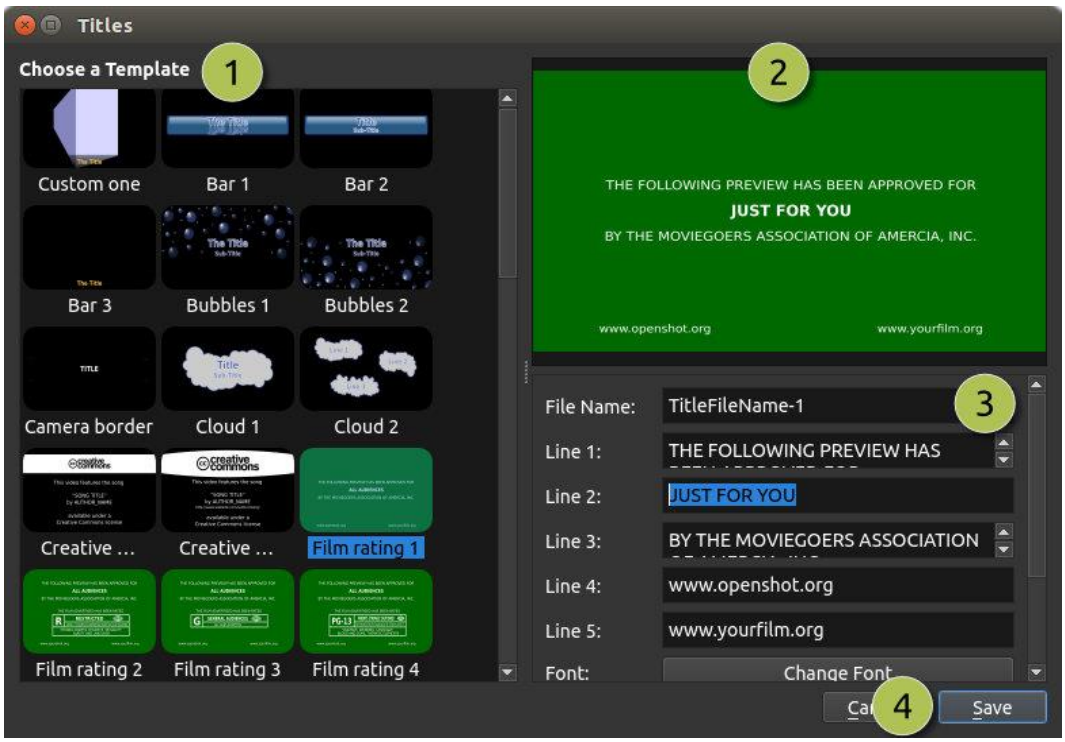


Figure 3.17: Titles-overview

Table 3.16: Titles-overview

#	Name	Description
1	Choose a Template	Choose from any available vector title template.
2	Preview Title	Preview your title as you make changes.
3	Title Properties	Change the text, and colors, or edit in an advanced SVG image editor (such as Inkscape).
4	Save	Save and add the title to your project.

2) Custom Titles

OpenShot can use any vector SVG image file as a title template. Just add an SVG image file to your .openshot_qt/title_templates/ folder, and it will appear the next time you open the Title Editor interface. You can also right-click on any SVG files in your **Project Files** panel and choose **Edit Title** or **Duplicate Title**.

3) 3D Animated Titles

Adding a 3D animated title is easier using our Animated Title dialog. Use the Title menu (located in the main menu of OpenShot) to launch the Animated Title editor. You can also use the keyboard shortcut **Ctrl+B.**

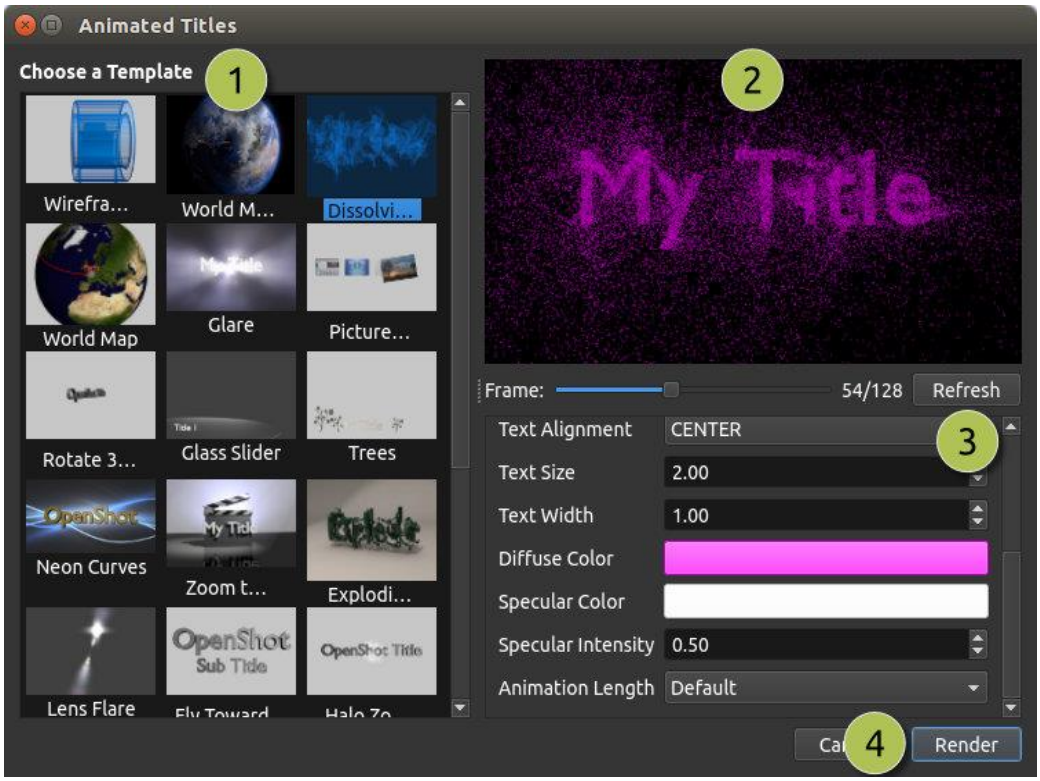


Figure 3.18: 3D Animated Titles

Table 3.17: About 3D animated titles

#	Name	Description
1	Choose a Template	Choose from any available 3D title templates.
2	Preview Title	Preview your title as you make changes.

#	Name	Description
3	Title Properties	Change the text, colors, and advanced properties.
4	Render	Render the 3D animation, and add it to your project.

This feature requires the latest version of Blender (https://www.blender.org/download/) to be installed and the OpenShot Preferences updated with the correct path to the Blender executable (for example: /home/USER/blender-2.78/blender).

3.1.8. Transitions

A transition is used to fade (or wipe) between two clips gradually. In OpenShot, transitions are represented by blue, rounded rectangles on the timeline. They are automatically created when you overlap two clips and can be added manually by dragging one onto the timeline from the Transitions panel. A transition must be placed on top of a clip (overlapping it), with the most common location being the beginning or end.

1) Overview

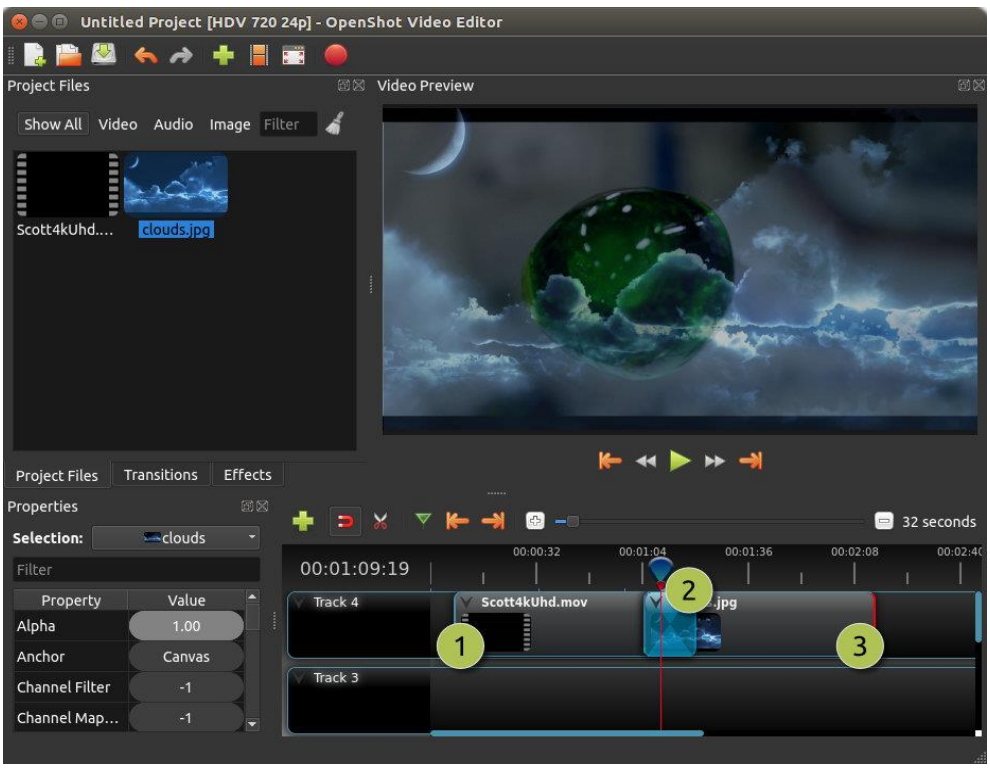


Figure 3.19: Transitions-overview

Table 3.18: Transition-overview

#	Name	Description
1	Clip 1	A video clip.
2	Transition	A gradual fade transition between the 2 clips, is created automatically by overlapping the clips.
3	Clip 2	An image clip.

2) Direction

Transitions adjust the alpha/transparency of the clip below it and can either fade from opaque to transparent or transparent to opaque. Right-click and choose **Reverse Transition** to change the direction of the fade. You can also manually adjust the **Brightness** curve, animating the fade in any way you wish.

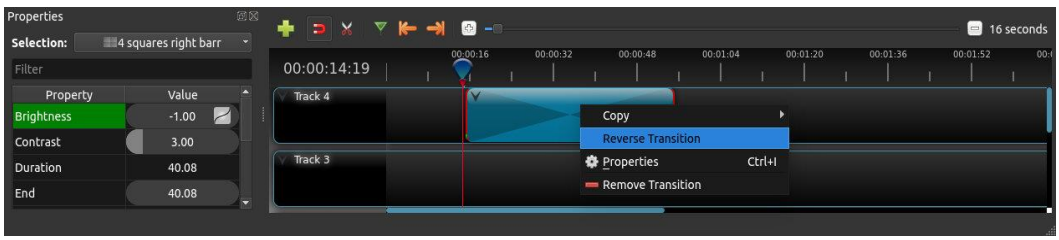


Figure 3.20: Direction

3) Cutting and Slicing

OpenShot has many easy ways to adjust a transition's start and end positions (otherwise known as cutting). The most common method is simply grabbing the transition's left (or right) edge and dragging. Here is a list of methods for cutting transitions in OpenShot.

Table 3.19: Cutting and Slicing

Name	Description
Slice	When the play-head (i.e., red playback line) overlaps a transition, right-click on the transition, and choose Slice.
Slice All	When the play-head overlaps many transitions, right-click on the play-head, and choose Slice All (it will cut all intersecting transitions).
Resizing Edge	Mouse over the edge of a transition, and resize the edge.
Razor Tool	The razor tool cuts a transition wherever you click, so be careful. Easy and dangerous.

4) Mask

Like Clips, transitions also have properties that can be animated over time. The fade (or wipe) can be adjusted with the **Brightness** curve or held at a constant value to create a transparency mask on top of a clip.

5) Custom Transition

Any grayscale image can be used as a transition (or mask) by adding it to your /.openshot_qt/transitions/ folder. Just be sure to name your file something easily recognizable, and restart OpenShot. Your custom transition/mask will now appear in the transitions list.

6) Properties

Below is a list of transition properties that can be edited and, in most cases, animated over time. To view a transition's properties, right-click and choose **Properties**. The property editor will appear, where you can change these properties. **NOTE:** Pay close attention to where the play-head (i.e., red playback line) is. Keyframes are automatically created at the current playback position to help create animations.

Table 3.20: Properties

Name	Description
Brightness	A curve represents the brightness of the transition image, which affects the fade/wipe (-1 to 1).
Contrast	The curve represents the contrast of the transition image, which affects the softness/hardness of the fade/wipe (0 to 20).
Replace Image	For debugging a problem, this property displays the transition image (instead of becoming a transparency).

3.1.9. Profiles

A profile is a collection of common video settings (size, frame rate, aspect ratio, etc.…). Profiles are used during editing, previewing, and exporting to provide a quick way to switch between common combinations of these settings.

1) Project Profile

The project profile is used when previewing your project and editing. The default project profile is “HD 720p 24fps”. It is best practice to always switch to your target profile before you begin editing. For example, if you are targeting 1080p 30fps, switch to that profile before you begin editing your project.

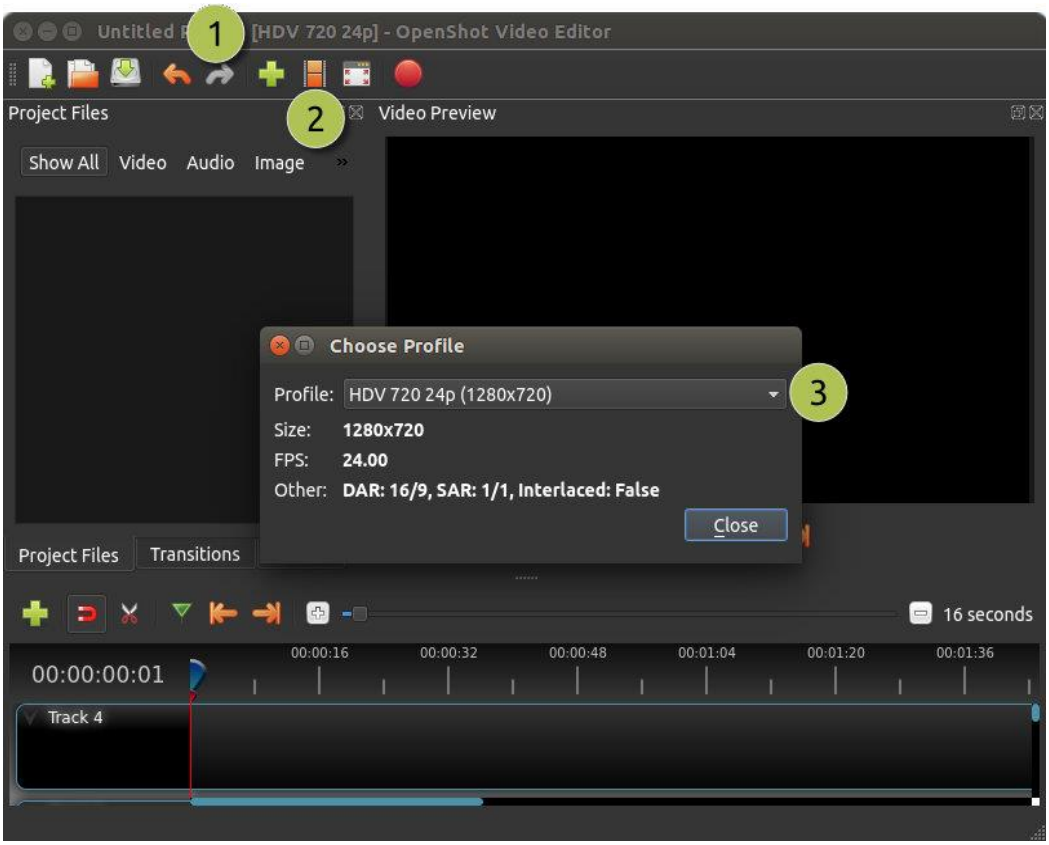


Figure 3.21: Project Profile

Table 3.21: Project Profile

#	Name	Description
1	Title Bar	The title bar of OpenShot displays the current profile.
2	Profile Button	Launch the profiles dialog.
3	Choose Profile	Select a profile for editing and preview.

2) Export Profile

The export profile always defaults to your current project profile but can be changed to target different profiles.

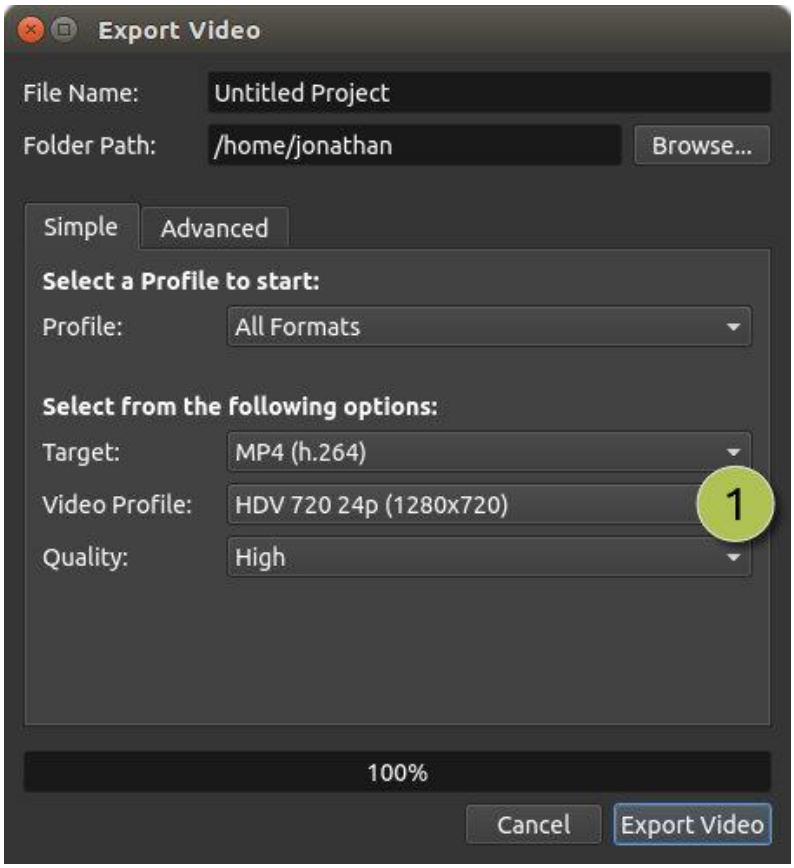


Figure 3.22: Export Video

Table 3.22: Export video

#	Name	Description
1	Choose Profile	Select a profile for export.

3.2. Audio Editor

3.2.1. Introduction to Audacity

Audacity is the default software for many multimedia content creators because not only is it free, but it is also relatively easy to use. Unlike other digital audio workstations (DAWs), which are much more expensive and reserved for professional audio engineers, Audacity's minimal approach to audio editing simplifies the whole experience.

1) Features

- Clip-handles
- Smart Clips
- Playback Looping
- Context Menus
- New defaults
- Bug fixes
- Updating from Audacity 2.x to 3.x

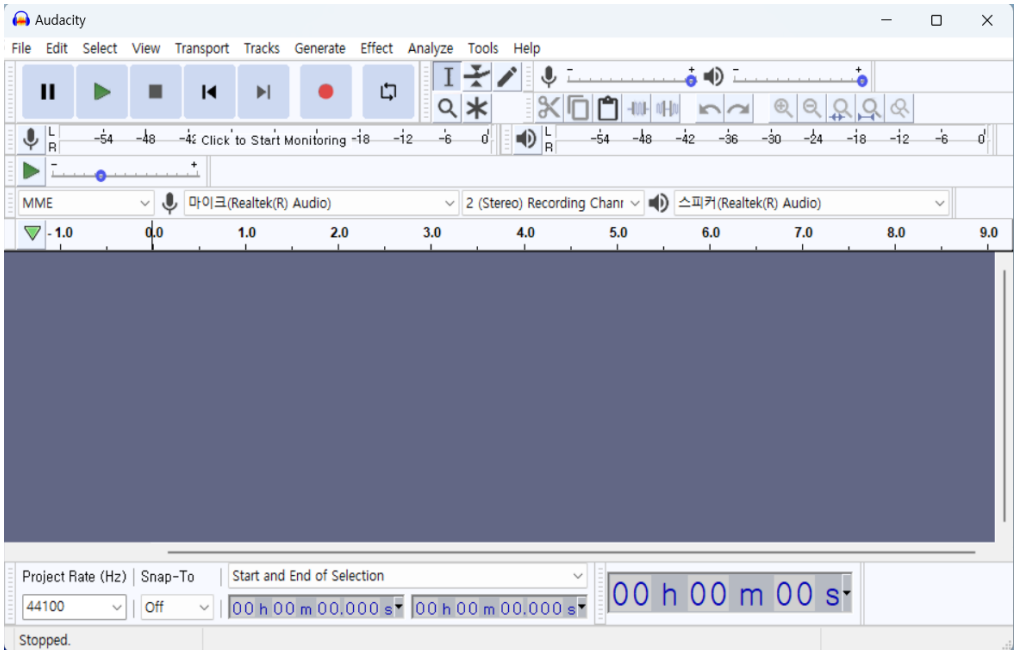


Figure 3.23: Screenshot of Audacity

2) System Requirements

Table 3.23: System Requirements of Audacity

Windows Version	Recommended Ram/Processor Speed	Minimum Ram/Processor Speed
Windows 7 (64-bit)	4 GB / 2 Ghz	2 GB / 1 Ghz
Windows Vista Home Premium/Business/Ultimate/7 (32-bit)	4 GB / 2 Ghz	1 GB / 1 Ghz
Windows Vista Home Basic	2 GB / 1 Ghz	512 MB / 1 Ghz
Windows 2000, XP	512 MB / 1 Ghz	128 MB / 300 Mhz

Macs: Audacity runs best with at least 1 GB RAM and a 1 GHz processor (2 GB RAM/2 GHz on OS X 10.7 or later). Where Audacity is to be used for lengthy multi-track projects, we recommend a minimum of 2 GB RAM and 2 GHz processor (4 GB RAM on OS X 10.7 or later).

For GNU/Linux: We recommend using the latest version of GNU/Linux from your distribution that is compatible with your hardware specifications. Audacity will run best with at least 64 MB RAM and a 300 MHz processor.

3.2.2. Installation

1) Linux

Head to the download page: https://www.audacityteam.org/download/linux/. It will automatically download the AppImage after 5 seconds. Make the downloaded AppImage runnable. To do this, you can right-click the file ➔ Properties ➔ Permissions or run the following command in the terminal: chmod +x <path to your Audacity.AppImage>. Copied! Double-click the AppImage to run Audacity. Additionally, your Linux distribution (for example Ubuntu, Fedora or Debian) may have a version of Audacity as part of the repository.

2) Mac

Head to the download page: https://www.audacityteam.org/download/mac/. It will automatically download the latest version of Audacity after 5 seconds. If prompted, click Save. Once the download has been completed to your Downloads folder, double-click the DMG file to mount it. Drag the Audacity app icon rightwards onto the "Applications" folder shortcut. You can also drag Audacity out of the DMG to any other location. You need the administrator password to copy Audacity to "Applications."

3) Windows

Head to the download page: https://www.audacityteam.org/download/windows/. It will automatically download the latest version of Audacity after 5 seconds. If prompted, click Run or Save. If you click Save, head to your download, locate the Audacity installer, and double-click it. In Windows 11, it is possible that you get a warning about Audacity being a non-Microsoft-verified app. Click Install anyway.

3.2.3. Main Window

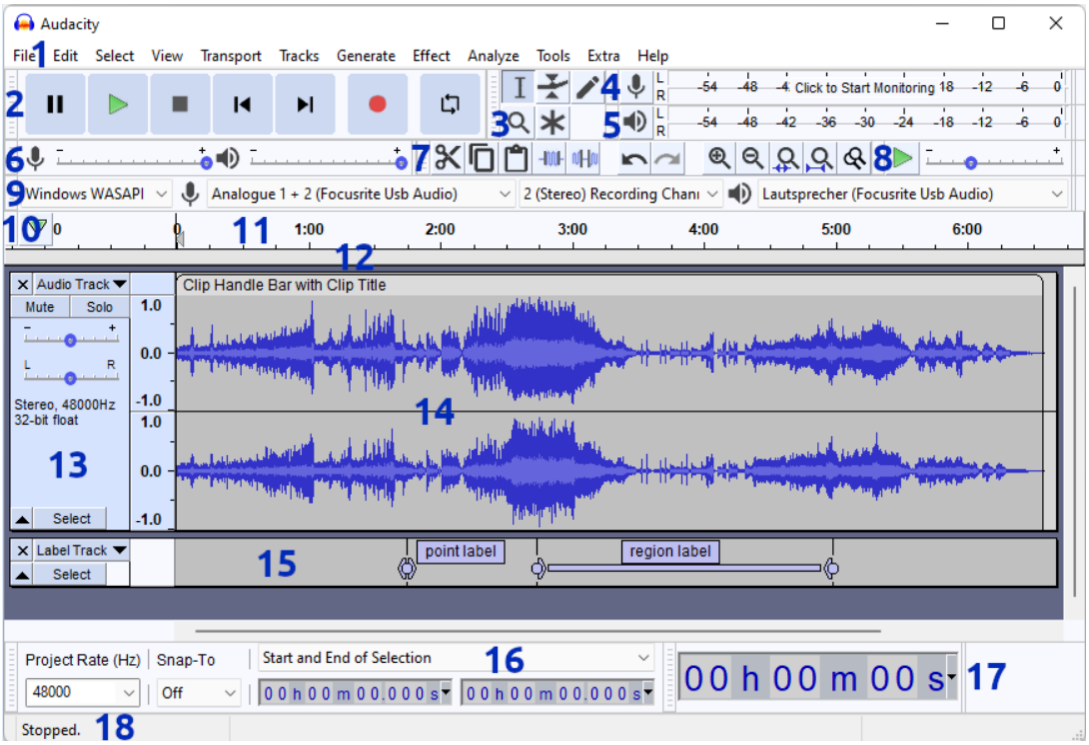


Figure 3.24: Audacity Interface Layout

Table 3.24: Audacity Interface Layout

#	Name	Description
1	Manu bar	The menu bar is at the top of the Audacity window. The menu bar is slightly different on Mac. It has an 'Audacity' and 'Window' menu, due to the conventions of that operating system.
2	Transport Toolbar	Transport Toolbar has buttons for controlling playback, recording, and for moving to the project start or end.
3	Tools Toolbar	Tools Toolbar enables your current tool for tasks such as selection, volume adjustment, or horizontal zooming.
4	Recording Meter Toolbar	Recording Meter Toolbar inactive. Recording Meter Toolbar in use.
5	Playback Meter Toolbar	The Playback Meter will activate when you start playback, or if you start Recording with Software Playthrough turned on in the Transport menu.
6	Mixer Toolbar	Mixer Toolbar is where you adjust Recording Volume (the amplitude at which recordings will be made) and Playback Volume (how loud the

#	Name	Description
		project's audio sounds, not affecting the volume of exported audio).
7	Edit Toolbar	These tools perform the same functions as those accessible through the Edit Menu, View Menu, Tracks Menu, and keyboard shortcuts.
8	Play-at-Speed Toolbar	Play-at-Speed Toolbar lets you Play or Loop Play audio at a slower or faster speed than normal, also affecting pitch. Slower than normal speeds can make it easier to transcribe speech or song lyrics.
9	Device Toolbar	The device Toolbar provides an easy way to select your required combination of audio host, recording device, recording channels, and playback device, without having to open Devices Preferences.
10	Unpinned Play/Recording Head	You can change Audacity to play and record with a fixed head pinned to a position in the Timeline. In this mode, the head remains static, and the waveforms will move as the audio is played or recorded.
11	Timeline	The Timeline displays a horizontal ruler above the tracks measuring time from zero (the start of the track). Depending on zooming the ruler may span minutes of audio or give a "close up" view of a few seconds or fractions of a second.
12	Scrub Ruler	A useful alternative method for scrubbing is with the Scrub Ruler, the gray strip immediately below the Timeline.
13	Track Control Panel	The Track Control Panel at the left of the audio track has controls and status indicators for this track. Left-clicking other than on a control performs track selection. Left-clicking other than on control and dragging up and down rearranges the order of the tracks.
14	Audio Track	Each audio track contains digital audio contains from left to right.
15	Label Track	A Label Track is an additional track that can be created in your project.
16	Selection Toolbar	Selection Toolbar: The primary function of the selection toolbar is to show you the precise timing of any current selection that you may have.
17	Time Toolbar	Time Toolbar is a read-only toolbar that displays the current audio position.

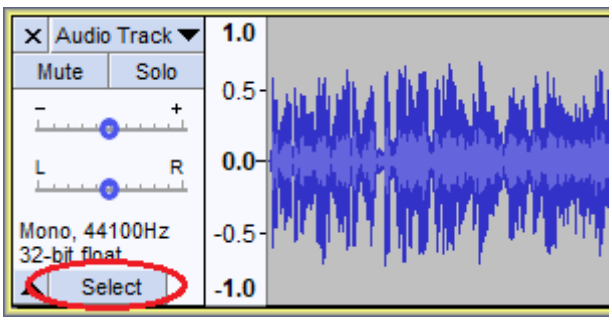
#	Name	Description
18	Status Bar	The Audacity Status Bar is the gray horizontal bar to be found at the bottom of the Audacity window (normally, and by default, just below the Selection Toolbar).

3.2.4. Audio Editing

1) Selecting Audio

1. Selecting the whole of an individual track

The whole of an individual track can be selected by clicking on the Select button in the Track Control Panel to the left of a track. Holding Ctrl (or ⌘ + A on a Mac) and clicking on the Select button toggles the selectness of the track.



You can also select the whole of a track by double-clicking anywhere in the track.

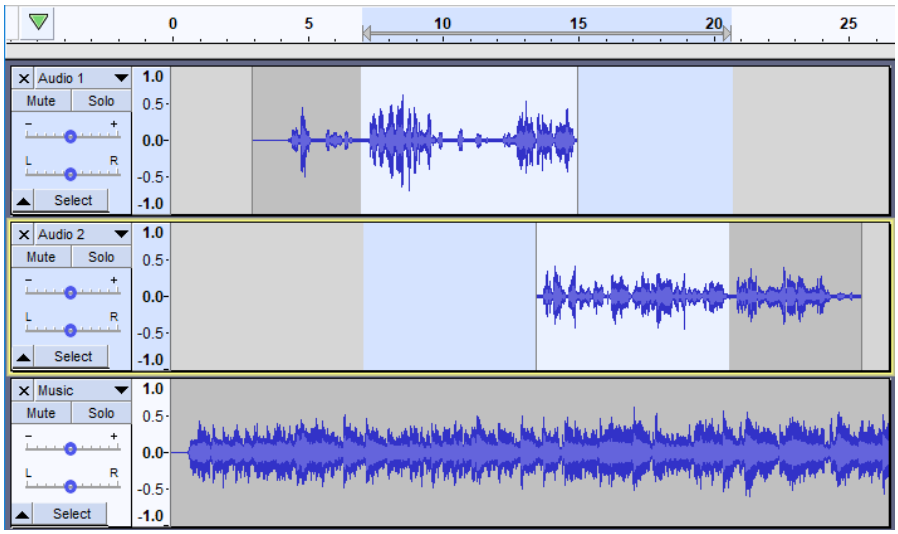
2. Selecting Regions Using the Mouse

The easiest way to select a region of audio is to click the left mouse button anywhere inside of an audio track, then drag (in either direction) until the other edge of your selection is made, then release the mouse.

If it is not already selected, choose the Selection tool from Tools Toolbar, as below:

Now click the left mouse button anywhere inside of an audio track and click and drag to the other edge of your selection, and release.

Normally, you select both the tracks and the range simultaneously, by clicking and dragging. For example, to create the selection in the image below, make sure you are using Selection Tool I, click in the track just after 7.0 seconds in the first track, then drag rightwards to 20.5 seconds as displayed on the Timeline, then downwards so that the gray selection region now includes the second track:

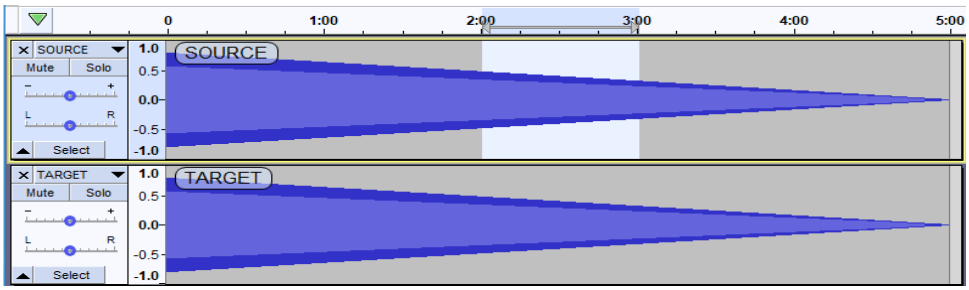


Because the drag started in the second track (as indicated by the yellow focus border) and extended up into the first track, only those two tracks are selected, as indicated by the blue color of the Track Control Panel. Therefore, any operation you perform will now only affect the selected area of the first two tracks. This and the method for selecting all audio are enough for using selections in Audacity.

2) Copy and Paste a Section of Audio

1. Select the Required Audio

Use the Selection Tool to select a section of audio from the source track with click-and-drag (the source and target tracks are labeled SOURCE and TARGET in the examples.)



To ensure your selection includes precisely the section of audio you want, you can use the zoom tools under the View menu or the zoom tools in the Edit Toolbar to zoom in to the beginning and end of your selection and select the exact samples you want.

See this section for advice on how to prevent "popping" sounds in your final audio track.

2. Making a Copy

Copy the selected audio to the Audacity clipboard by clicking **Edit ➔ Copy** or press the shortcut Ctrl + C or ⌘ + C on Mac).

3. Pasting into Existing TARGET Track

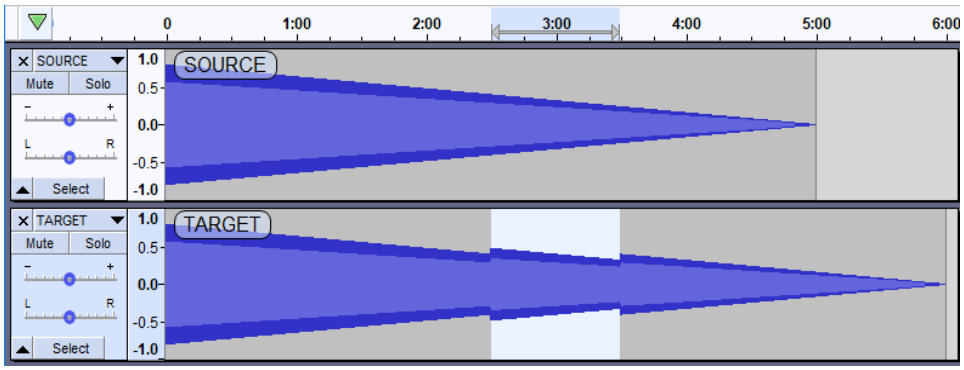
- **Apply the Paste**
  To make the paste select **Edit ➔ Paste** from the Edit Menu or press the shortcut Ctrl + V or (⌘ +V on Mac).

Restrictions

- You can paste from a mono track into a stereo track - the mono audio will be replicated in both stereo channels.
- You cannot paste from a stereo track into a mono track *(you will get an error message if you try to do this.)*.

Note that the TARGET track can be the same track as the SOURCE track - that is, it is possible to cut and paste within the same track.

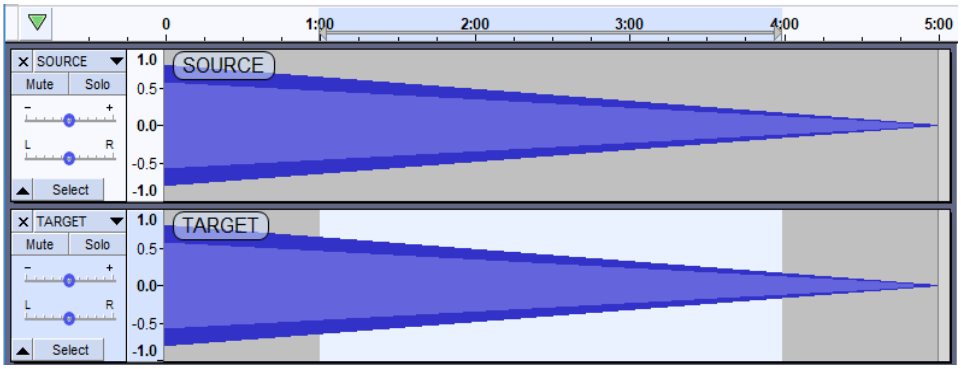
- **Pasting into a Point Selection**
  If you make a point selection in the TARGET track at 2m 30s and paste the above 1-minute selection, the pasted section will start at 2m 30s
  and will push the existing audio rightwards lengthen the track by 1 minute to now be 6 minutes long.



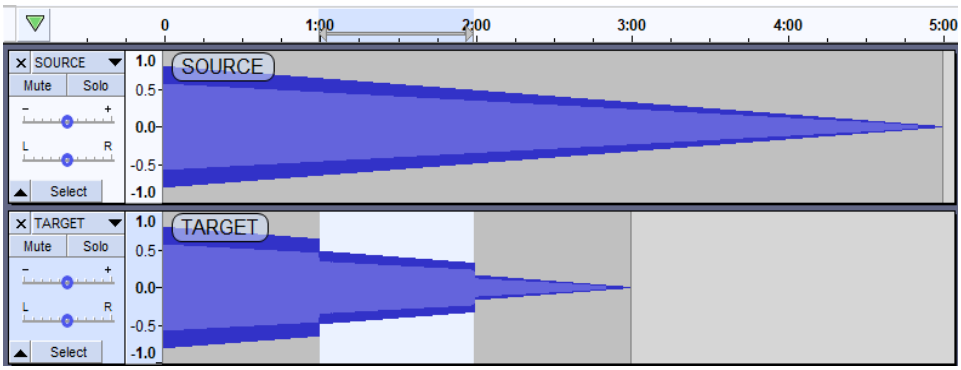
Posted 1-minute selection starts at 2m 30s and extends the TARGET track by 1 minute to be 6 minutes long.

- **Pasting into a Longer Selection**

  If you paste over a selection that is longer than the one on the clipboard, this will overwrite the longer selection and shorten the track.



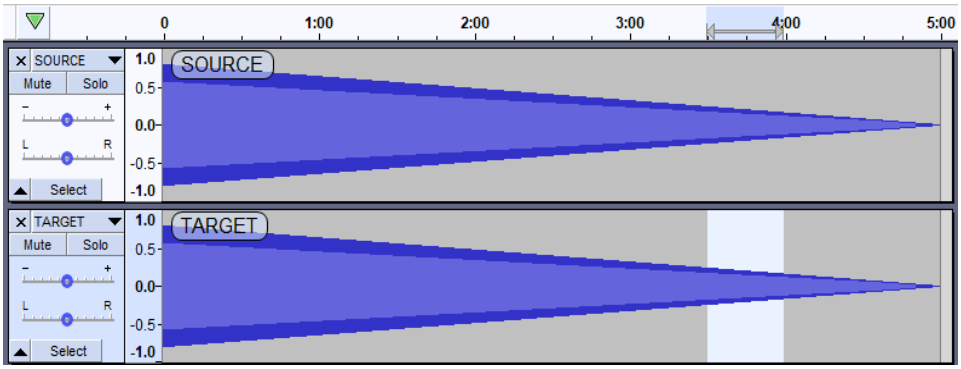
Selecting 3 minutes from 1 minute to 4 minutes to paste over



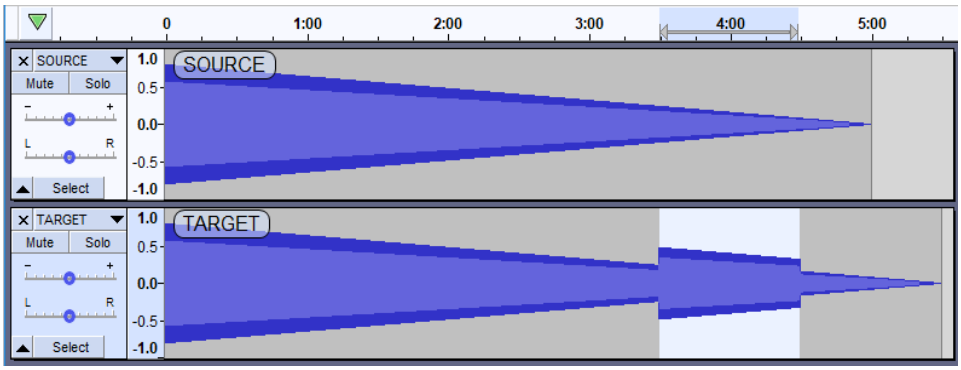
After the paste the TARGET track is shortened to 3 minutes

- **Pasting into a Shorter Selection**

  If you paste over a selection that is shorter than the one on the clipboard, this will overwrite the shorter selection and lengthen the track, pushing the audio to the right of the selection rightwards.



Selecting 30 seconds from 3:30 to 4 minutes to paste over



After the paste, the TARGET track is lengthened to 5 minutes and 30 seconds.

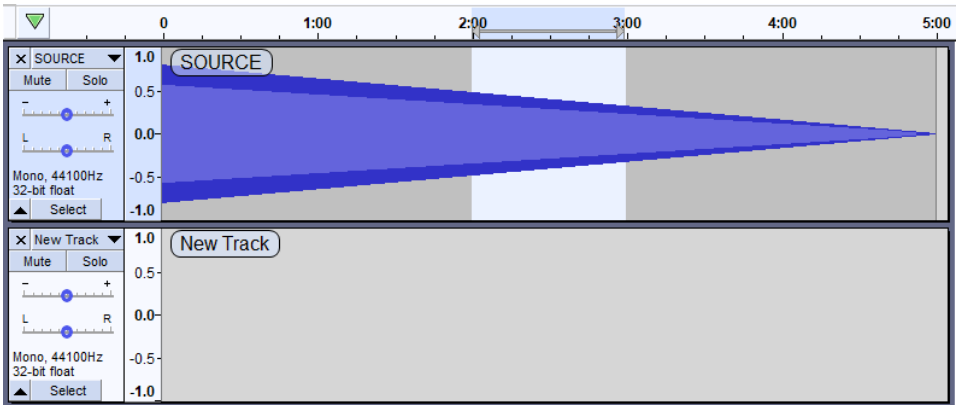
If you need to paste into a target track at precisely the same size and position in the source track, you can:

- Make the selection in the source track and use ***Ctrl* + *C*** to make the copy.
- Hold down the ***Ctrl*** and click on the ***Select*** button in the target track's Track Control Panel. This will extend the selection to the target track.
- Hold down the ***Ctrl*** and click on the ***Select*** button in the source track's Track Control Panel. This will remove the selection from the source track.
- Make the paste into the target track with ***Ctrl* + *V***.

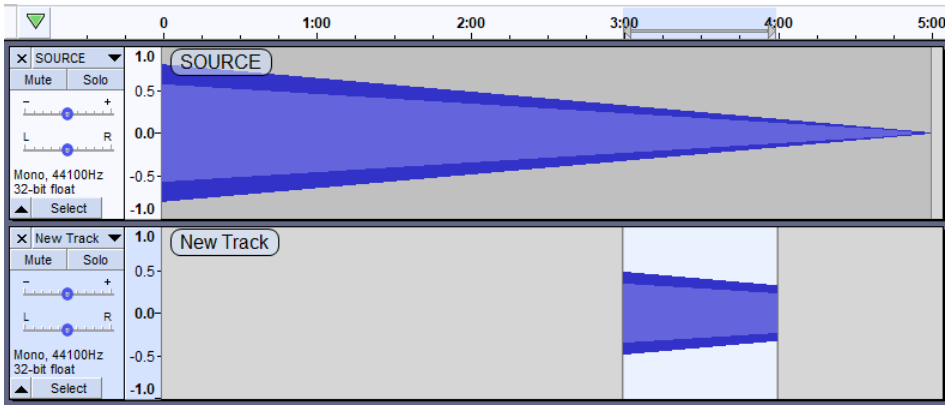
On Mac use ⌘ in place of ***Ctrl***.

- **Pasting into a New Track**

  If you want to paste into a new track at a specific start time, you must first create the new track, then select the start time in that track, and then make the paste.



Selecting in the source track after having added the new track



After clicking at T=3 minutes in the New Track and then making the paste

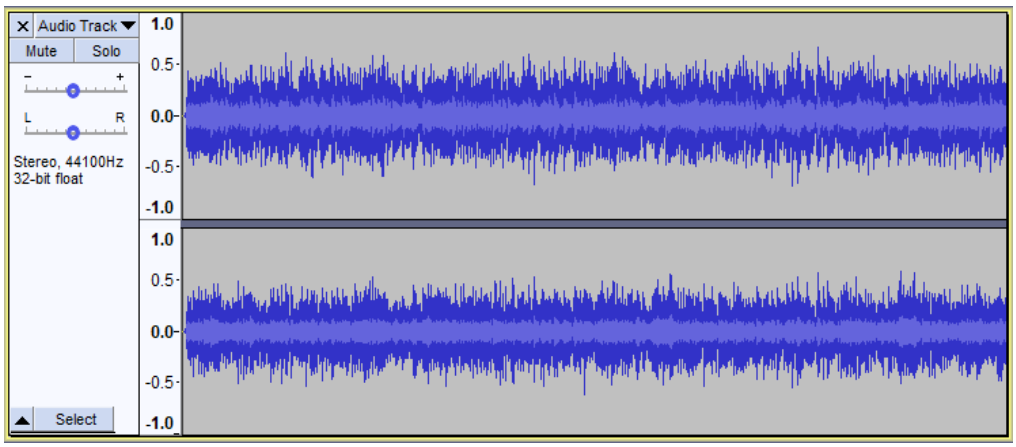
If you want to create a new track and paste it into that, the paste will automatically create a new mono or stereo track as appropriate, with the audio starting at time zero, if you:

- Paste into an empty project window
- Click in the gray background underneath the last track in the project to deselect all the tracks, then paste.

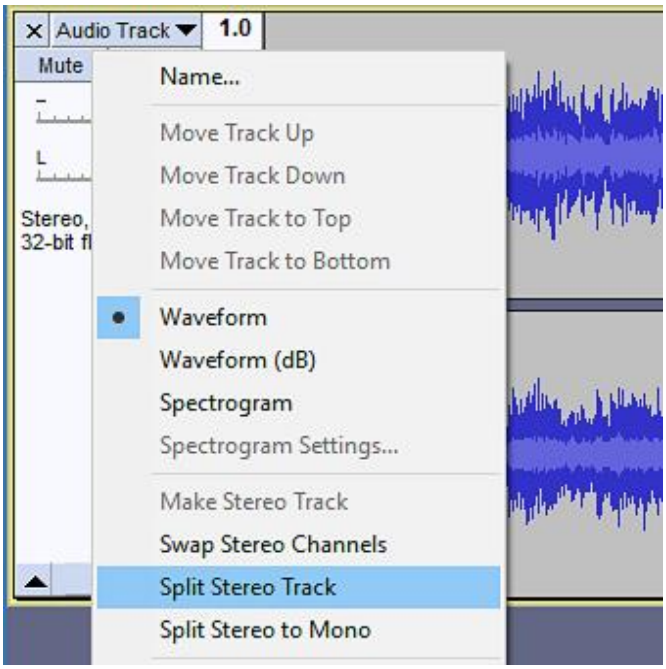
3) Splitting and Joining Stereo Tracks

1. Splitting a Stereo Track

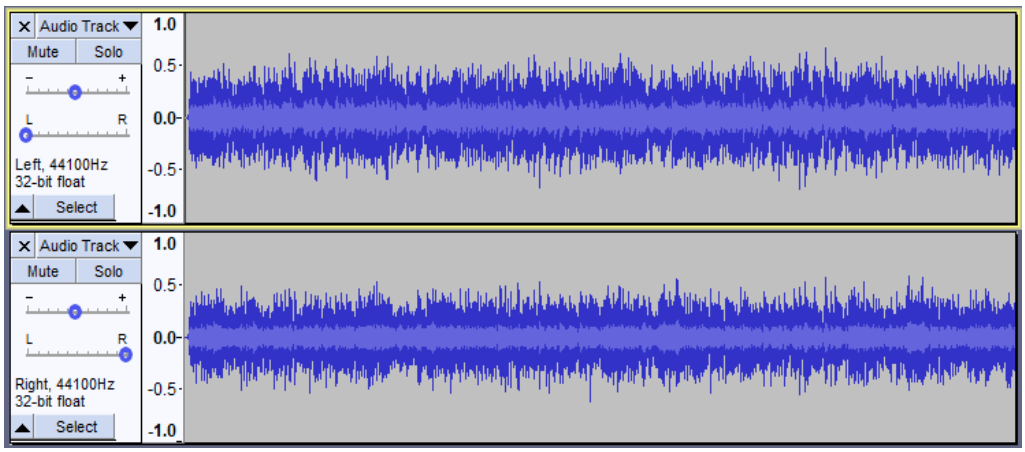
Here is a stereo track:



You can make separate left-channel and right-channel tracks to edit them separately. Open the Audio Track Dropdown Menu and choose Split Stereo Track:



Now you can see the two tracks marked “Left” and “Right”:

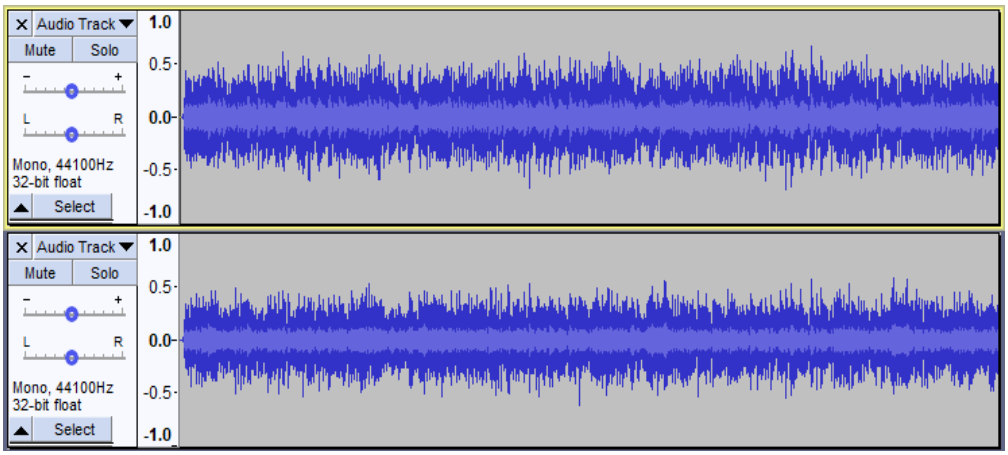


Note carefully that after this split, the Left channel is panned hard left, and the Right channel is panned hard right. You can change these pan settings as part of your editing if required.

2. Splitting a Stereo Track into two Mono Tracks

You can instead choose to split a stereo track into two mono tracks.

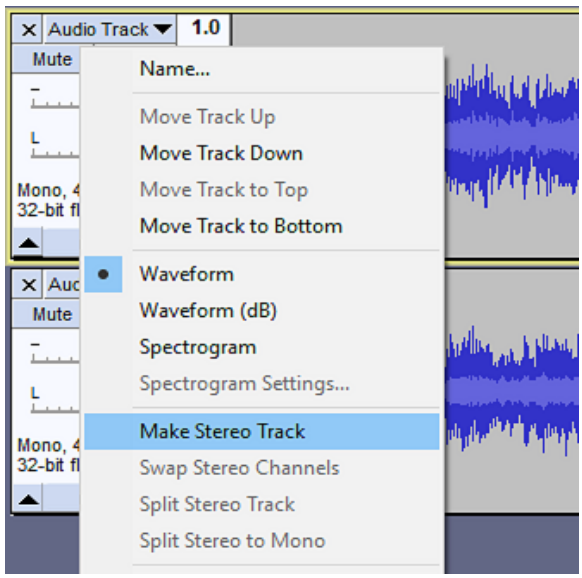
After choosing “Split Stereo to Mono” from the Track Dropdown Menu on the original stereo track, we get two separate mono tracks:



Note that in this case, both mono channels are center-panned (different from the hard left and right panning that you get when you make a simple split of a stereo track).

3. Joining tracks to Make a Stereo Track

Choosing “Make Stereo Track” from the Track Dropdown Menu of the upper track of a pair of mono, left, or right channel tracks (in any combination) will combine those two tracks into one stereo track. The upper track will become the left channel of the stereo track, and the lower track will become the right channel regardless of their current designation as mono, left, or right. In the example below, two mono tracks are about to be combined into one stereo track. The result of this operation will be to re-create the stereo track as shown in the first image on this page.



When joining two single-channel tracks into one stereo track, be aware that:

- The gain and pan settings of the two tracks will be ignored when making the new stereo track
    - the upper track will be treated as having a pan setting of *100% left* and a gain setting of *0 dB*
    - the lower track will be treated as having a pan setting of *100% right* and a gain setting of *0 dB*
- The gain setting of the upper track will be applied to the new stereo track
- The pan setting of the resulting stereo track will be set to 0.

Thus, the joint action may make the balanced sound different from your intentions or what you hear when playing the tracks.

- Envelopes will be retained for the left and right channels of the new stereo track, but any further envelope adjustments will be applied to both channels simultaneously, which may give unexpected results.

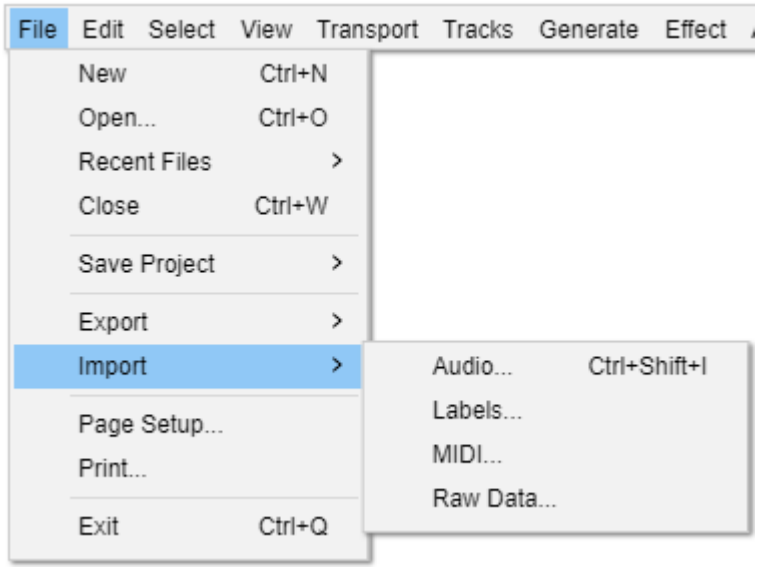
If you want to preview the result of the **Make Stereo Track** command, set the gain of each track to *0 dB*, set the pan of the upper track to *100% left,* and set the pan of the lower track to *100% right*.

If you wish to retain the gain, pan, and envelope settings of the two mono tracks when joining them into one stereo track, select the two tracks, then choose **Tracks > Mix > Mix and Render** *instead of* joining the tracks.

4) Import and Export

1. Import

It enables you to import audio files or label files into your project. Files in various audio formats can be imported into Audacity.



- **Audio (Ctrl +Shift + I)**

  Launches a file selection window where you can choose to import one or more audio files into the current Audacity project. The file(s) will always be added as a new track to the project. This lets you mix two or more files together.

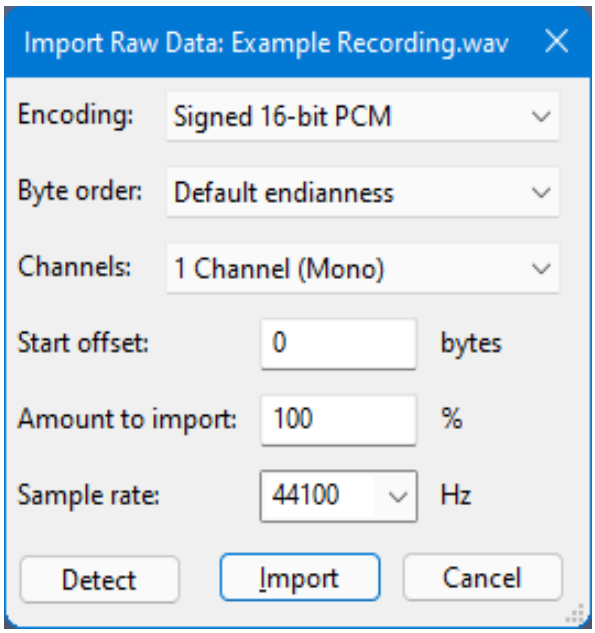
- **Labels**

  Launches a file selection window to import a single text file into the project containing point or region labels. For more information about the syntax for labels files.

- **MIDI**

  Imports a MIDI (MIDI or MID extension) or Allegro (GRO) file to a Note Track where the Note track can be played.

- **Raw Data**



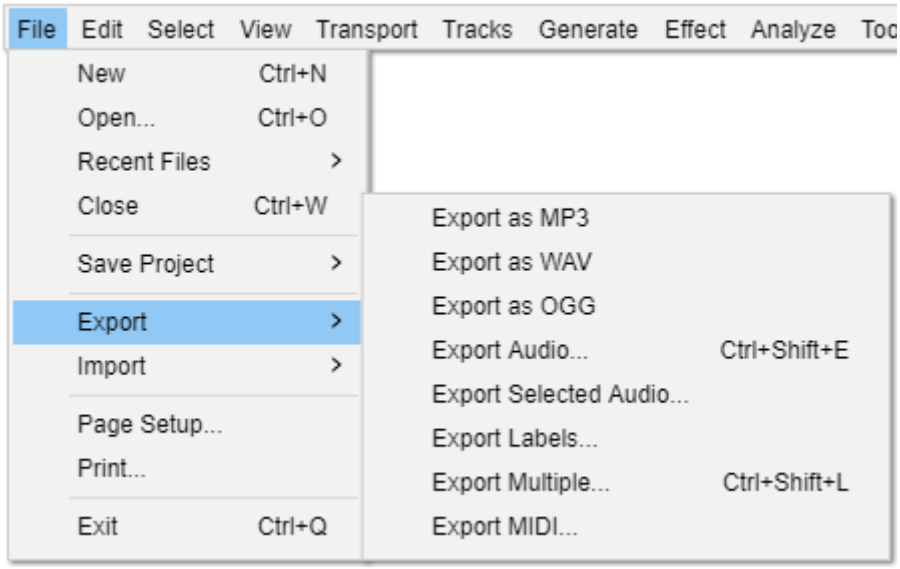
Attempts to import an uncompressed audio file that might be "raw" data without any headers to define its format, might have incorrect headers or be otherwise partially corrupted, or might be in a format that Audacity is unable to recognize. Raw data in textual format cannot be imported.

First, select the file in question in the "Select any uncompressed audio file" dialog. Then use the Detect button to let Audacity guess what kind of data your file is. If you know what kind of data you are dealing with, or if Audacity misidentified the format, you can set the following parameters yourself as well:

- Encoding (PCM, ADPCM, float...)
- Byte order (this is almost always Little-endian if the file was created on Windows)
- Number of channels (expected to be found in the file and created as a result)
- Start offset in bytes
- Percentage amount of the file to import
- Sample rate to be applied to the import (currently, rates between 100 Hz and 384,000 Hz are supported)

2. Export

This enables you to Export audio from Audacity into audio file formats that other applications can read and play. Additionally, you can export label files or MIDI or save a compressed copy of your project in a set of Ogg Vorbis formatted files.



For all types of audio export, including **Export Selected Audio** and **Export Multiple**, tracks that are muted are not exported.

So if you play a preview before you export, "what you hear is what you get" for the export.

- **Exports to Specific Audio File Formats**

  If there are multiple tracks in your project, they will be automatically mixed into the exported data. See Mix and Render on the Tracks Menu for more information about mixing.

- **Export as MP3**

  Exports the current Audacity project in compressed MP3 (lossy) audio file format.

- **Export as WAV**

  Exports the current Audacity project in uncompressed WAV (lossless) audio file format. The default Encoding is 16-bit which you can change from the Encoding dropdown menu. If you change it, Audacity will remember and re-use your previous setting for the next use.

- **Export as Ogg Vorbis**

  Exports the current Audacity project in compressed Ogg Vorbis (lossy) audio file format.

- **Export Audio (Ctrl + Shift + E)**

  Exports the current Audacity project as an audio file format that other applications can read. As with the exports to specific audio file formats, if there are multiple tracks in your project, they will be automatically mixed into the exported data.

- **Export Labels**

  If you have any Label Tracks, this command will export all their labels as a text file. The text in each label appears as one line in the exported file, prefaced by the label's start time and end time (in seconds). If you have multiple label tracks, the labels in the uppermost label track appear first in the file.

  Export Labels are commonly used in speech transcription or speech recognition research, after which the files can be manipulated in any application that accepts text files. Labels can also be modified after export for use as Cue Sheets for CD burning or movie subtitles.

Export Labels cannot export selected label tracks or selections within label tracks.

To export individual label tracks the workaround is to:

1. Temporarily delete all but one label, track and export that
2. Use Undo to restore the temporarily deleted label tracks
3. Repeat for each label track in turn

- **Export Multiple (Ctrl + Shift + L)**

  This allows you to do multiple exports from Audacity with one command. Export either multiple files based on the project's multiple tracks or the labels in a single audio track. It is an excellent timesaver for splitting long recordings into separate CD tracks or archiving multiple working tracks. See the Tutorial - Copying tapes, LPs, or MiniDiscs to CD for an example of how this is used. As with Export Audio, muted tracks are not exported.

- **Export MIDI**

  Export the currently selected Note Track as a MIDI or Allegro file (which is like a MIDI file except that the notes information is stored as plain text). In the Import/Export Preferences, you can choose whether to export Allegro files with times and durations represented in seconds (default) or in beats. Some applications that can play MIDI files may not be able to play Allegro files.

  Only one Note Track can be exported at a time. The entire Note Track will be exported regardless of any selection made in the track. If the Note Track has been time-shifted to start at a point other than zero, empty MIDI bars will be added at the start.

3.2.5. Audio Recording

1) Setting Up

1. Connect your input source to your computer and verify that you are getting sound into your computer using your computer's sound input control panel or the custom mixer application that came with your particular audio interface.
2. Tell Audacity which source you have selected to record from; use the Device Toolbar or Devices Preferences.
3. Set the recording level using the Mixer Toolbar's input slider while watching the Recording Meter's indications. Try to aim for a maximum peak of around \xe2\x80\x936.0 dB (or 0.5 if your meters are set to linear rather than dB). Tip: enlarging the Meter Toolbars by clicking and dragging them helps with this task.

To listen to what you are recording, you have two options.

1. If your computer's sound control panel supports sending the audio input to the computer's audio output, then make this setting there.
2. If that is not possible, click on **Transport ➔Transport Options ➔ Software Play** through (on/off) so that it is checked.

Alternatively, if you are using an external audio interface or mixer, you may be able to monitor the signal directly from that device.

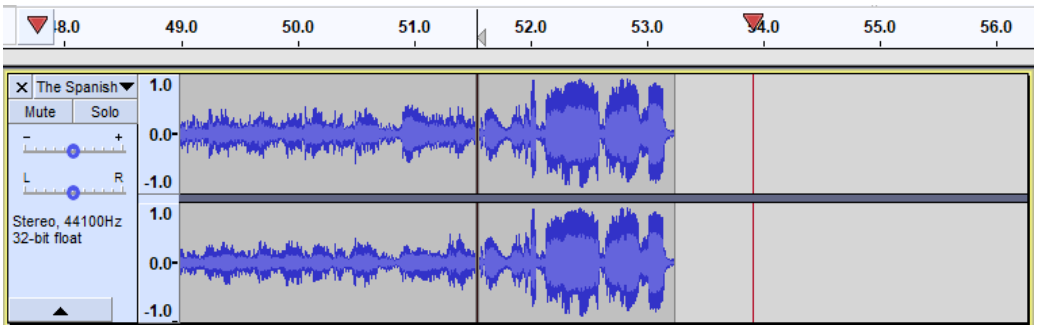
As soon as you have made a recording, it is strongly recommended to **File > Export > Export Audio...** it immediately to ***WAV*** or ***AIFF*** (ideally to an external drive) as a safety copy before you start editing the project.

2) Recording on the Same Track

This append recording is the default recording behaviour in Audacity. When you click the Record button on Transport Toolbar (or use the shortcut R), Audacity records at the end of the currently selected or only track or will create a new track if you currently have no tracks.

This requires that the number of recording channels (mono or stereo) matches the selected track. In other cases, it appends the first track (or adjacent tracks) that supports the number of channels being recorded.

When recording like this, at the end of an existing recording, Audacity will place a Clip line at the junction between the two recordings (as in the image below) to aid you in separating them later if required. You can remove the clip line, if not required, simply by clicking on it, joining the two clips.



A stereo track with appended recording showing a Split line at the end of the previous recording, here shown at 51.5 seconds

If you have your cursor positioned beyond the end of the existing track and then press Record, Audacity will start the recording from that cursor position and back-fill to the end of the existing audio with silence.

Alternatively, instead of stopping the recording, you can click the **Pause** button ⏸ to pause recording, or use the ***P*** shortcut.

To continue recording click ⏸ which releases the Pause button, or press ***P***.

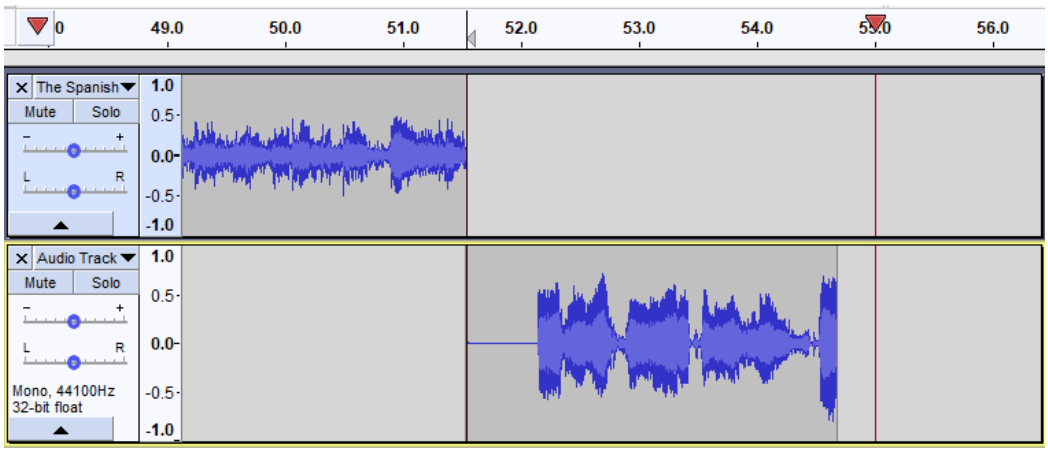
- **Recording Stereo into Mono, or Mono into Stereo**

  You cannot append record a mono recording to a stereo track. If you try to do this, Audacity will create a new mono track for you, and the recording will be a pseudo-appended recording, with the new mono audio start time being the end of the stereo audio (or the cursor position if that is set beyond the end of the stereo audio).

  Similarly, you cannot append a record of a stereo track into a mono track. Audacity will similarly create a new stereo track for the recording. However, if you have two mono tracks and try to append the record in stereo, Audacity will place one stereo channel in each mono channel. If you have mono tracks, you can select two of them and record the left channel in the first and the right channel in the second.

3) Recording a New Track

If you hold the Shift button down, the Record button in the Transport Toolbar will temporarily change to ⏺ Then clicking on this modified Record button or using the shortcut ***Shift* + *R*** will cause Audacity to create a new track and begin recording on that track from the current cursor position (or from the left edge of a region on the Timeline).



Mono track with new track being recorded on a new tack below starting at the end of the previous recording (as that is where the cursor was left)

There is no need to create a new track before starting to record. If you want recording to start from the beginning of the project, click the "Skip to Start" button ⏮ on Transport Toolbar or press the Home shortcut. Press the Stop button ■ (or use its shortcut Space) to Stop the recording.

- **Continuing recording in a new track**

  Instead of stopping the recording with the Stop button ■ or Space, you can stop the recording with the Play / Stop and Set Cursor shortcut X. When you record again using the Shift key modifier to get the ⏺ record below, recording will start in a new track at the end-position of the track above.

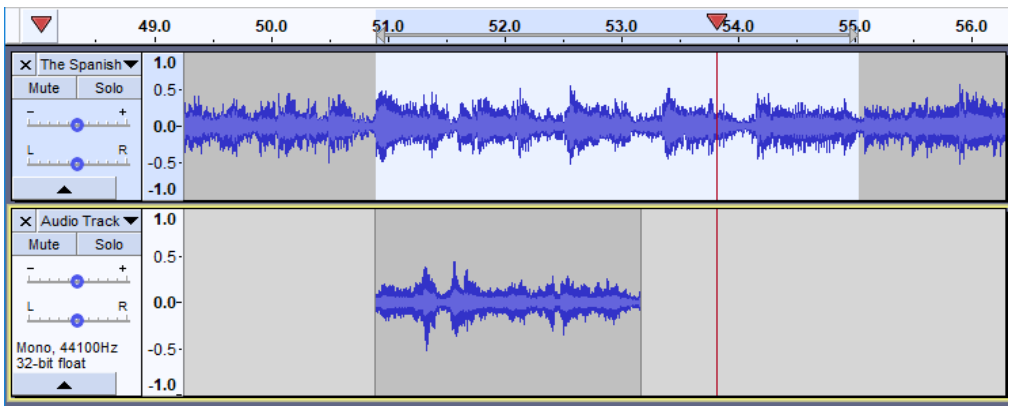
- **Recording a Region in a New Track**

  If there is no Timeline region or selection, Audacity records until you stop the recording.

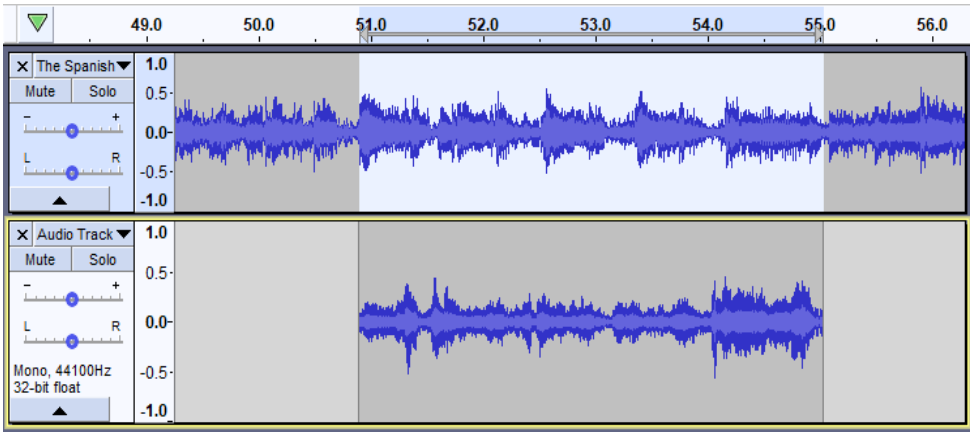
  To record only the Timeline region in a new track, select the region in any of the existing tracks or the Timeline - see Recording for a specific time below. There is no need for the track containing the region to be selected.

4) Recording for a Specific Length of Time

1. Drag-select a region in an existing audio track - or choose the time range to be recorded in Selection Toolbar.
2. Then hold down Shift and press the Record New Track button ⏺ (or use the shortcut ***Shift + R***) to record in a new track for the duration of the selection you made.



Mono recording on a new track below for a specific length of time



Recording for a specific length of time completed

If there is a selection that is entirely beyond the end of all selected tracks, then the recording will start at the beginning of the selection and stop at the end of the selection.

Ensure that you use the **Shift Modified Record** to make the recording.

If you use the ordinary Record, then the recording will append Record to the end of the track and ignore the selection. Or if you have an empty project and use the Selection Toolbar to make a selection, then, with plain Record, Audacity will create a new track starting at the selection start time, but it will carry on past the end of the selection until you Stop it.

5) Maximum Recording Length

Audacity does not restrict the maximum recording length beyond the practical limitation that recording takes space on your drive, so you can only record while the drive still has space available.

When you start to record, Audacity shows a “Disk space remains for recording” message in the Status Bar at the bottom left of the Audacity window giving the current recording time available.

With default Audacity settings, stereo recording takes 1.2 GB of space per hour.

After recording, you will still need space to export the recording as an audio file for your computer. Editing the recording before export takes extra space. Each edit of a region requires as much extra disk space as was required to record that section initially.

To get more recording time:

- Delete your old files and folders (especially your old Audacity Project files when you have finished with them)
- Select an alternative drive that has more space in the Directories Preferences (but do not record to an external USB or FireWire disk because recording needs disk access to be as fast as possible)
- Record in mono instead of stereo (settable at "Recording Channels" in Device Toolbar or in Devices Preferences)
- Set the "Default Sample Format" in Quality Preferences to 16-bit instead of 32-bit (this is a good choice for a "quick recording," which you export at once without editing).
- See recording length for more details.

6) Punch and Roll Recording

- This enables you to correct errors easily during the course of a recording session.
- You can stop, back up over a mistake, and continue recording, resulting in one track that eliminates the errors and is properly timed without the use of cutting, pasting, and clip-moving commands or mixing multiple tracks.
- You can do rough editing as you go, with minimal interruption of your performance (saving you the trouble and extra work of having to come back later and make the edits).

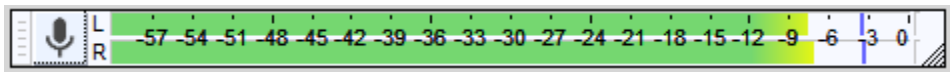
7) Arming Audacity for Recording

Arming Audacity simply means that you are preparing it for recording, readying it without the recording actually starting

To arm Audacity:

1. Click the Pause button ⏸ or its shortcut **P**
2. Click the Record button ● or use the shortcut **R**

Audacity is now armed and ready to record. Note that monitoring in the Recording Meter will have become active, monitoring your input signal:



Once you are ready to start recording simply click the Pause button ⏸ again, or its shortcut **P** (or the Record button ● or its shortcut **R**) and recording will commence immediately.

8) Dropouts (small skips) in Recording

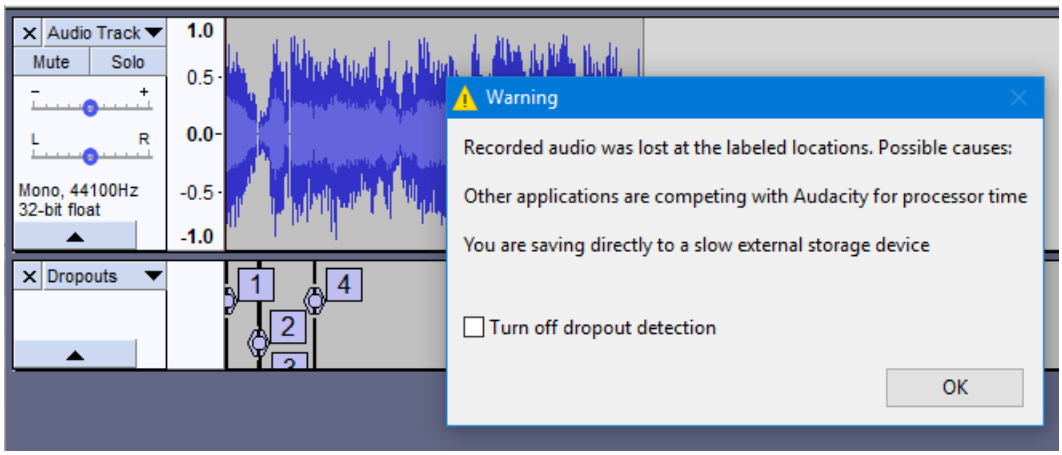
Audacity now has dropout detection, which is enabled by default. This is controlled from a setting in Recording Preferences called “Detect dropouts.”

Dropouts may be caused by a disk drive that cannot keep up with the recording. This can happen, for example, with a slow USB or network drive, if antivirus software is slowing writing to disk, or if another activity on the computer is slowing the computer down.

You may have been experiencing dropouts and not noticing. They are not discernible while recording only on playback. So Audacity could now appear much worse than previous releases when in fact, Audacity is just alerting you to a problem that you previously would not have been aware of - or might have put down to a bad microphone or poor recording technique.

When this setting is “on” (default setting), Audacity will detect dropouts (brief gaps in the recording) and will insert zeroes into the recording to keep the other good parts synchronized.

When recording stops, a message box alerts the user, and a label track, called “Dropouts” is added, showing the lost parts labeled with consecutive numbers. If you already have a label track or tracks, this will be an additional new label track.



- If you are certain that your recordings do not suffer from dropouts, you may wish to turn this option “**off**.”
- Audacity makes its best effort to detect dropouts as they occur, but detection may be incomplete for some operating systems and audio hosts.

Summary

In this chapter, you have learned:

Video editing is the manipulation and arrangement of video shots. Video editing is used to structure and present all video information, including films and television shows, video advertisements, and video essays. Video editing has been dramatically democratized in recent years by editing software available for personal computers. Editing video can be difficult and tedious, so several technologies have been produced to aid people in this task. Pen-based video editing software was developed to give people a more intuitive and fast way to edit video.

OpenShot Video Editor is an award-winning, open-source video editor available on Linux, Mac, and Windows. OpenShot can create stunning videos, films, and animations with an easy-to-use interface and rich feature set.

Audio editing software is any software or computer program that allows audio data editing and generating. Audio editing software can be implemented completely or partly as a library, as a computer application, as a web application, or as a loadable kernel module. Wave editors are digital audio editors. There are many sources of software available to perform this function. Most can edit music, apply effects and filters, adjust stereo channels, etc.

Audacity is the default software for many multimedia content creators because not only is it free, but it is also relatively easy to use. Unlike other digital audio workstations (DAWs), which are much more expensive and reserved for professional audio engineers, Audacity's minimal approach to audio editing simplifies the whole experience.

Questions

1) What is video editing?
2) What is OpenShot?
3) What are the features of OpenShot?
4) List five main parts of the OpenShot video editor.
5) What file types does OpenShot support?
6) What is audio editing software?
7) What is Audacity, and how does it work?
8) What are the features of Audacity?
9) What are the advantages of Audacity?
10) What file types does Audacity support?

Exercises

1) **Exercise 1:** Create a video containing pictures and clips of your friend on his/her birthday and add music and transition to the video using OpenShot.
2) **Exercise 2:** Make a song cover using the karaoke music you downloaded. Use Audacity to record a member's voice singing a song.

Additional Reading:

1) https://www.openshot.org/
2) https://support.audacityteam.org/

Chapter 04

Introduction to Adobe Photoshop

Learning Objective:

The objective of this chapter is to introduce Adobe Photoshop. It provides a basic understanding of Adobe Photoshop. This chapter explains how to get started with Adobe Photoshop 2021.

After completing this chapter, students should be able to:

- Explain what Adobe Photoshop is
- Describe the history and version of Adobe Photoshop
- Understand Photoshop system requirements
- Implement Adobe Photoshop 2021

In this chapter, you will learn about:

4.1. What is Adobe Photoshop?

Adobe Photoshop is a raster graphics editor developed and published by Adobe Inc. for **Windows** and **macOS.** It was created in 1988 by *Thomas and John Knoll*. Since then, the software has become the industry standard not only in raster graphics editing but in digital art as a whole. Photoshop can edit and compose raster images in multiple layers and supports masks, alpha compositing, and several color models, including RGB, CMYK, CIELAB, spot color, and duotone. Photoshop uses its own PSD and PSB file formats to support these features. In addition to raster graphics, Photoshop has limited abilities to edit or render text and vector graphics (particularly through clipping path for the latter), as well as 3D graphics and video. Plug-ins can expand its feature set, programs developed and distributed independently of Photoshop that run inside it and offer new or enhanced features.

Note:

A raster graphics editor is a computer program that allows users to create and edit images interactively on the computer screen and save them in one of many raster graphics file formats (also known as bitmap images) such as JPEG, PNG, and GIF**.**

4.2. Early History

Photoshop was developed in 1987 by two brothers, Thomas and John Knoll, who sold the distribution license to Adobe Systems Incorporated in 1988. Thomas Knoll, a Ph.D. student at the University of Michigan, began writing a program on his Macintosh Plus to display grayscale images on a monochrome display. This program (at that time called Display) caught the attention of his brother John, an Industrial Light & Magic employee, who recommended that Thomas turn it into a full-fledged image editing program. Thomas took a six-month break from his studies in 1988 to collaborate with his brother on the program. Thomas renamed the program ImagePro, but the name was already taken. Later that year, Thomas renamed his program Photoshop and worked out a short-term deal with scanner manufacturer Barneyscan to distribute copies of the program with a slide scanner; a “total of about 200 copies of Photoshop were shipped” this way.

During this time, John traveled to Silicon Valley and demonstrated the program to engineers at Apple and Russell Brown, art director at Adobe. Both showings were successful, and Adobe decided to purchase the license to distribute in September 1988. While John worked on plug-ins in California, Thomas remained in Ann Arbor writing code. Photoshop 1.0 was released on February 19, 1990, for Macintosh exclusively. The Barneyscan version included advanced color editing features stripped from the first Adobe shipped version. Handling color slowly improved with each release from Adobe, and Photoshop quickly became the industry standard in digital color editing. When Photoshop 1.0 was released, digital retouching on dedicated high-end systems (such as the Scitex) cost around $300 an hour for basic photo retouching. The list price of Photoshop 1.0 for Macintosh in 1990 was $895. Photoshop was initially only available on Macintosh. In 1993, Adobe chief architect Seetharaman Narayanan ported Photoshop to Microsoft Windows. The Windows port led to Photoshop reaching a wider mass market audience as Microsoft's global reach expanded within the next few years. On March 31, 1995, Adobe purchased the rights for Photoshop from Thomas and John Knoll for $34.5 million, so Adobe would no longer need to pay a royalty for each copy sold.

4.3. Version History

4.3.1. Older Versions

Photoshop's naming scheme was initially based on version numbers, from version 0.07 (codename "Bond"; double-oh-seven), through version 0.87 (codename "Seurat" which was the first commercial version, sold as "Barneyscan XP"), version 1.0 (February 1990) all the way to version 7.0.1. Adobe published seven major and many minor versions before the October 2003 introduction of version 8.0, which brought with it the Creative Suite branding.

Notable milestone features would be: Filters, Colour Separation, Virtual Memory (1.0), Paths, CMYK color (2.0), 16-bits-per-channel support, availability on Microsoft Windows (2.5), Layers, tabbed Palettes (3.0), Adjustments, Actions, Freeform Transform, PNG support (4.0), Editable Type, Magnetic Lasso and Pen, Freeform Pen, Multiple Undo, Layer Effects (5.0), Save For Web (5.5), Vector Shapes, revised User Interface (6.0), Vector Text, Healing Brush, Spell Check (7.0), Camera RAW (7.0.1).

4.3.2. CS (version 8)

The first Photoshop CS was commercially released in October 2003 as the eighth major version of Photoshop. Photoshop CS increased user control with a reworked file browser augmenting search versatility, sorting and sharing capabilities, and the Histogram Palette, which monitors changes in the image as they are made to the document. Match Color was also introduced in CS, which reads color data to achieve a uniform expression throughout a series of pictures.

4.3.3. CS2 (version 9)

Photoshop CS2, released in May 2005, expanded on its predecessor with a new set of tools and features. It included an upgraded Spot Healing Brush, mainly used for handling common photographic problems such as blemishes, red-eye, noise, blurring, and lens distortion. One of the most significant inclusions in CS2 was the implementation of Smart Objects, which allows users to scale and transform images and vector illustrations without losing image quality and create linked duplicates of embedded graphics so that a single edit updates across multiple iterations.

Adobe responded to feedback from the professional media industry by implementing non-destructive editing and producing and modifying 32-Bit High Dynamic Range (HDR) images, which are optimal for 3D rendering and advanced compositing. FireWire Previews could also be viewed on a monitor via a direct export feature.

Photoshop CS2 brought the Vanishing Point and Image Warping tools. Vanishing Point makes tedious graphic and photo retouching endeavors much simpler by letting users clone, paint and transform image objects while maintaining visual perspective. Image Warping makes it easy to digitally distort an image into a shape by choosing on-demand presets or dragging control points.

The File Browser was upgraded to Adobe Bridge, which functioned as a hub for productivity, imagery, and creativity, providing multi-view file browsing and smooth cross-product integration across Adobe Creative Suite 2 software. Adobe Bridge also provided access to Adobe Stock Photos. This new stock photography service offered users one-stop shopping across five elite stock image providers to deliver high-quality, royalty-free images for layout and design.

Camera Raw version 3.0 was a new addition in CS2, allowing settings for multiple raw files to be modified simultaneously. In addition, processing multiple raw files in other formats, including JPEG, TIFF, DNG, or PSD, could be done in the background without executing Photoshop itself.

Photoshop CS2 brought a streamlined interface, making accessing features for specific instances easier. In CS2, users could also create their own custom presets, which was meant to save time and increase productivity.

CS2 activation servers' shutdown: In January 2013, Adobe Photoshop CS2 (9.0), with some other CS2 products, was released with an official serial number due to a technical glitch in Adobe's CS2 activation servers.

4.3.4. CS3 (version 10)

CS3 improves on features from previous versions of Photoshop and introduces new tools. One of the most significant is the streamlined interface which allows increased performance, speed, and efficiency. There is also improved support for Camera RAW files, which allows users to process images with higher speed and conversion quality. CS3 supports over 150 RAW formats, as well as JPEG, TIFF, and PDF. Enhancements were made to the Black and White Conversion, Brightness and Contrast Adjustment, and Vanishing Point Module tools. The Black and White adjustment option improves control over manual grayscale conversions with a dialog box similar to Channel Mixer. There is more control over print options and better management with Adobe BridgeCS2 activation servers' shutdown: In January 2013, Adobe Photoshop CS2 (9.0), with some other CS2 products, was released with an official serial number due to a technical glitch in Adobe's CS2 activation servers.

The Clone Source palette was introduced, adding more options to the clone stamp tool. Other features include the nondestructive Smart Filters, optimizing graphics for mobile devices, and Fill Light and Dust Busting tools. Compositing is assisted with Photoshop's new Quick Selection and Refine Edge tools and improved image stitching technology.

CS3 Extended includes everything in CS3 and additional features. There are tools for 3D graphic file formats, video enhancement and animation, and comprehensive image

measurement and analysis tools with DICOM file support. The 3D graphic formats allow 3D content to be incorporated into 2D compositions. As for video editing, CS3 supports layers and video formatting so that users can edit video files per frame.

CS3 and CS3 Extended were released in April 2007 in the United States and Canada. They were also made available through Adobe's online store and Adobe Authorized Resellers. CS3 and CS3 Extended are offered as stand-alone applications or a feature of Adobe Creative Suite. Both products are compatible with Intel-based Macs and PowerPCs, supporting Windows XP and Windows Vista. CS3 is the first release of Photoshop that will run natively on Macs with Intel processors: previous versions can only run through the translation layer Rosetta and will not run at all on Macs running Mac OS X 10.7 or later.

4.3.5. CS4 (version 11)

CS4 features smoother panning and zooming, allowing faster image editing at high magnification. The interface is more simplified with its tab-based interface, making it cleaner to work with. Photoshop CS4 features a new 3D engine that converts gradient maps to 3D objects, adds depth to layers and text, and gets print-quality output with the new ray-tracing rendering engine. It supports common 3D formats, the new Adjustment and Mask panels, content-aware scaling (seam carving), fluid canvas rotation, and File display options. The content-aware scaling allows users to intelligently size and scale images, and the canvas rotation tool makes it easier to rotate and edit images from any angle.

Adobe released Photoshop CS4 Extended, which has the features of Adobe Photoshop CS4, plus capabilities for scientific imaging, 3D, motion graphics, accurate image analysis, and high-end film and video users. The faster 3D engine allows users to paint directly on 3D models, wrap 2D images around 3D shapes, and animate 3D objects. As the successor to Photoshop CS3, Photoshop CS4 is the first x64 edition of Photoshop on consumer computers for Windows. The color correction tool has also been improved significantly.

CS4 and CS4 Extended were released on October 15, 2008. They were also made available through Adobe's online store and Adobe Authorized Resellers. Both CS4 and CS4 Extended are offered as either a stand-alone application or a feature of Adobe Creative Suite. Both products are compatible with Intel-based Mac OS X and PowerPCs, supporting Windows XP and Windows Vista.

4.3.6. CS5 (version 12)

Photoshop CS5 was launched on April 12, 2010. In a video posted on its official Facebook page, the development team revealed the new technologies under development, including three-dimensional brushes and warping tools.

In May 2011, Adobe Creative Suite 5.5 (CS5.5) was released, with some applications' new versions. Its version of Photoshop, 12.1, is identical to the concurrently released update for Photoshop CS5, version 12.0.4, except for support for the new subscription pricing introduced with CS5.5.

CS5 introduces new tools such as the Content-Aware Fill, Refine Edge, Mixer Brush, Bristle Tips, and Puppet Warp. The community also had a hand in the additions made to CS5, as 30 new features and improvements were included by request. These include automatic image straightening, the Rule-of-Thirds cropping tool, color pickup, and saving a 16-bit image as a JPEG. Another feature includes the Adobe Mini Bridge, which allows for efficient file browsing and management.

CS5 Extended includes everything in CS5 plus features in 3D and video editing. A new materials library was added, providing more options such as Chrome, Glass, and Cork. The new Shadow Catcher tool can be used to enhance 3D objects further. For motion graphics, the tools can be applied to more than one video sequence frame.

CS5 and CS5 Extended were made available through Adobe's online store, Adobe Authorized Resellers, and Adobe direct sales. Both CS5 and CS5 Extended are offered as either a stand-alone application or a feature of Adobe Creative Suite 5. Likewise, both products are compatible with Intel-based Mac OS X and Windows XP, Windows Vista, and Windows 7.

4.3.7. CS6 (version 13)

Photoshop CS6, released in May 2012, added new creative design tools and provided a redesigned interface focused on enhanced performance. New features have been added to the Content-Aware tool, such as the Content-Aware Patch and Content-Aware Move.

Adobe Photoshop CS6 brought a suite of tools for video editing. Color and exposure adjustments, as well as layers, are among a few things that are featured in this new editor. Upon completion of editing, the user is presented with a handful of options for exporting into a few popular formats.

CS6 brings the "straighten" tool to Photoshop, where a user simply draws a line anywhere on an image. The canvas will reorient itself so that the line drawn becomes horizontal and adjusts the media accordingly. This was created with the intention that users would draw a line parallel to a plane in the image and reorient the image to that plane to more easily achieve certain perspectives.

CS6 allows background saving, which means that while another document is compiling and archiving itself, it is possible to edit an image simultaneously. CS6 also features a customizable auto-save feature, preventing any work from being lost. With version 13.1.3, Adobe dropped support for Windows XP (including Windows XP Professional x64 Edition); thus, the last version that works on Windows XP is 13.0.1. Adobe also announced that CS6 would be the last suite sold with perpetual licenses in favor of the new Creative Cloud subscriptions. However, they will continue to provide OS compatibility support, bug fixes, and security updates as necessary.

Starting January 9, 2017, CS6 is no longer available for purchase, making a Creative Cloud license the only purchase option going forward. No more updates will be available for all CS6 software either.

4.3.8. CC (version 14)

Photoshop CC (14.0) was launched on June 18, 2013. As the next major version after CS6, it is only available as part of a Creative Cloud subscription. Significant features in

this version include a new Smart Sharpen, Intelligent Up sampling, and Camera Shake Reduction for reducing blur caused by camera shake. Editable Rounded Rectangles and an update to Adobe Camera Raw (8.0) were also included.

Since the initial launch, Adobe has released two additional feature-bearing updates. The first, version 14.1, was launched on September 9, 2013. The significant features in this version were Adobe Generator, a Node.js-based platform for creating plug-ins for Photoshop. Photoshop 14.1 shipped with two plug-ins, one to automatically generate image assets based on an extension in the layer name and another to automatically generate assets for Adobe Edge Reflow.

Version 14.2 was released on January 15, 2014. Major features include Perspective Warp, Linked Smart Objects, and 3D Printing support.

4.3.9. CC 2014 (version 15)

Photoshop CC 2014 (15.0) was released on June 18, 2014. CC 2014 features improvements to content-aware tools, two new blur tools (spin blur and path blur), and a new focus mask feature that enables the user to select parts of an image based on whether they are in focus. Other minor improvements have been made, including speed increases for specific tasks.

4.3.10. CC 2015 (version 16 and version 17)

Photoshop CC 2015 was released on June 15, 2015. Adobe added various creative features, including Adobe Stock, a library of custom stock images. It also includes and has the ability to have more than one layer style. For example, in the older versions of Photoshop, only one shadow could be used for a layer, but in CC 2015, up to ten are available. Other minor features like Export As, which is a form of the Save For Web in CC 2014, were also added. As of November 30, 2015, the updated UI delivers a cleaner and more consistent look throughout Photoshop. The user can quickly perform common tasks using a new set of gestures on touch-enabled devices like Microsoft Surface Pro. CC 2015 also marks the 25th anniversary of Photoshop.

4.3.11. CC 2017 (version 18)

Photoshop CC 2017 was released on November 2, 2016. It introduced a new template selector when creating new documents, the ability to search for tools, panels, and help articles for Photoshop, support for SVG OpenType fonts, and other small improvements. In December 2016, a minor update was released to include support for the MacBook Pro Touch Bar.

4.3.12. CC 2018 (version 19)

Photoshop CC 2018 (version 19) was released on October 18, 2017. It featured an overhaul to the brush organization system, allowing for more properties (such as color and opacity) to be saved per brush and for brushes to be categorized in folders and sub-folders. It also added brush stroke smoothing and over 1000 brushes created by Kyle T. Webster (following Adobe's acquisition of his website, KyleBrush.com). A Curvature Pen tool, similar to the one in Illustrator, was added, allowing for faster creation of Bézier paths. Other additions were Lightroom Photo access, Variable font support, select subject, copy-paste layers, enhanced tooltips, 360 panoramas and HEIF support, PNG compression, increased maximum zoom level, symmetry mode, algorithm improvements to Face-aware and selection tools, color and luminance range masking, improved image resizing, and performance improvements to file opening, filters, and brush strokes.

4.3.13. CC 2019 (version 20)

Photoshop CC 2019 was released on October 15, 2018. Beginning with Photoshop CC 2019 (version 20.0), the 32-bit version of Windows is no longer supported. This version introduced a new tool called Frame Tool to create placeholder frames for images. It also added multiple undo modes and auto-commitment, preventing accidental panel moves with lock workspace. Live blend mode previews were added, allowing faster scrolling over different blend mode options in the layers panel. Other additions were Color Wheel, Transform proportionally without Shift key, Distribute spacing like in Illustrator, the ability to see longer layer names, match font with Japanese fonts, flip document view, scale UI to font, reference point hidden by default, new compositing engine, which provides a more modern compositing architecture is added which is easier to optimize on all platforms.

4.3.14. 2020 (version 21)

Photoshop 2020 was released on November 4, 2019. Version 21 has many new and enhanced features like the new object selection tool for better automating complex selections, new properties panel, enhanced transform warp, new keyboard shortcuts for Paint & Brush, and a background image removal option. It added several improvements to the new content-aware fill and the new document tab. Also added were animated GIF support, improved lens blur performance, and one-click zoom to a layer's contents. It introduced new swatches, gradients, patterns, shapes, and stylistic sets for OpenType fonts. This version allows users to easily convert smart objects to layers and adjust 32-bit layers for brightness/contrast and curves. Presets are now more intuitive to use and easier to organize.

With the February 2020 update (version 21.1), Photoshop can now iteratively fill multiple areas of an image without leaving a content-aware fill workspace. This version improved GPU-based lens blur quality and provided performance improvements, such as accelerating workflows with smoother panning, zooming, and navigation of documents.

Version 21 was the first version where the iPad version was released. With Photoshop on the iPad, combined with the new Cloud PSD file format, a user can save cloud documents and work across Windows, Mac, and iPad. Photoshop on the iPad does not have all the features of desktop Photoshop. Adobe promises to update Photoshop on the iPad at "a much more aggressive pace than it has with its current Creative Cloud apps for the desktop." Adobe has provided a timeline for enhancing Photoshop on the iPad to have more desktop Photoshop features.

Version 21.2 of the desktop version was released in June 2020. It introduced faster portrait selection, Adobe Camera Raw improvements, auto-activated Adobe Fonts, rotatable patterns, and improved Match Font.

4.3.15. 2021 (version 22)

- Version 22.0.0 was released in October 2020.
- Version 22.0.1 was released in November 2020.
- Version 22.1.0 was released in December 2020.
- Version 22.1.1 was released in January 2021.
- Version 22.2 was released in February 2021.
- Version 22.3 was released in March 2021. This is the first macOS release to run natively on Apple silicon.[82]
- Version 22.3.1 was released in April 2021.
- Version 22.4 was released in May 2021.
- Version 22.4.1 was released in May 2021.
- Version 22.4.2 was released in June 2021.
- Version 22.4.3 was released in July 2021.
- Version 22.5 was released in August 2021.
- Version 22.5.1 was released in September 2021.

4.3.16. 2022 (version 23)

- Version 23.0 was released in October 2021.
- Version 23.0.1 was released in November 2021.
- Version 23.0.2 was released in November 2021.
- Version 23.1 was released in December 2021.
- Version 23.1.1 was released in January 2022.
- Version 23.2 was released in February 2022.

4.4. Photoshop System Requirements

Minimum and recommended system requirements for Photoshop

Table 4.1: Photoshop System Requirements for Window

Name	Minimum	Recommended
Processor	Intel® or AMD processor with 64-bit support; 2 GHz or faster processor with SSE 4.2 or later	
Operating System	Windows 10 64-bit (version 1909) or later; LTSC versions are not supported	
RAM	8 GB	16 GB or more
Graphics card	• GPU with DirectX 12 support • 1.5 GB of GPU memory	• GPU with DirectX 12 support • 4 GB of GPU memory for 4k displays and greater
Monitor resolution	1280 x 800 display at 100% UI scaling	1920 x 1080 display or greater at 100% UI scaling
Hard disk space	4 GB of available hard-disk space; additional space is required for installation	16 GB of available hard-disk space; additional space is required for installation • Fast internal SSD for app installation • Separate internal drive for scratch disks
Internet	Internet connection and registration are necessary for required software activation, validation of subscriptions, and access to online services.	

Table 4.2: Photoshop System Requirements for macOS

Name	Minimum	Recommended
Processor	Intel processor with 64-bit support; 2 GHz or faster processor with SSE 4.2 or later	
Operating system	macOS Catalina (version 10.15) or later	macOS Big Sur (version 11) macOS Catalina (version 10.15)
RAM	8 GB	16 GB or more
Graphics card	• GPU with Metal support • 1.5 GB of GPU memory	• GPU with Metal support • 4 GB of GPU memory for 4k displays and greater
Monitor resolution	1280 x 800 display at 100% UI scaling	1920 x 1080 display or greater at 100% UI scaling
Hard disk space	4 GB of available hard-disk space; additional space is required for installation	16 GB of available hard-disk space; additional space is required for installation • Fast internal SSD for app installation • Additional high-speed drive(s) or SSD to set up scratch disks
Internet	Internet connection and registration are necessary for required software activation, membership validation, and access to online services.	

4.5. Getting Start with Adobe Photoshop 2021

Begin by opening Adobe Photoshop 2021

- On a Mac (macOS), click **Go ➔ Applications ➔ Adobe Photoshop 2021**, or click the icon in the Dock.
- On a PC (Windows), click **Start ➔ All Programs ➔ Adobe Photoshop 2021,** shown in Figure 4.1, or click on the shortcut on the desktop.

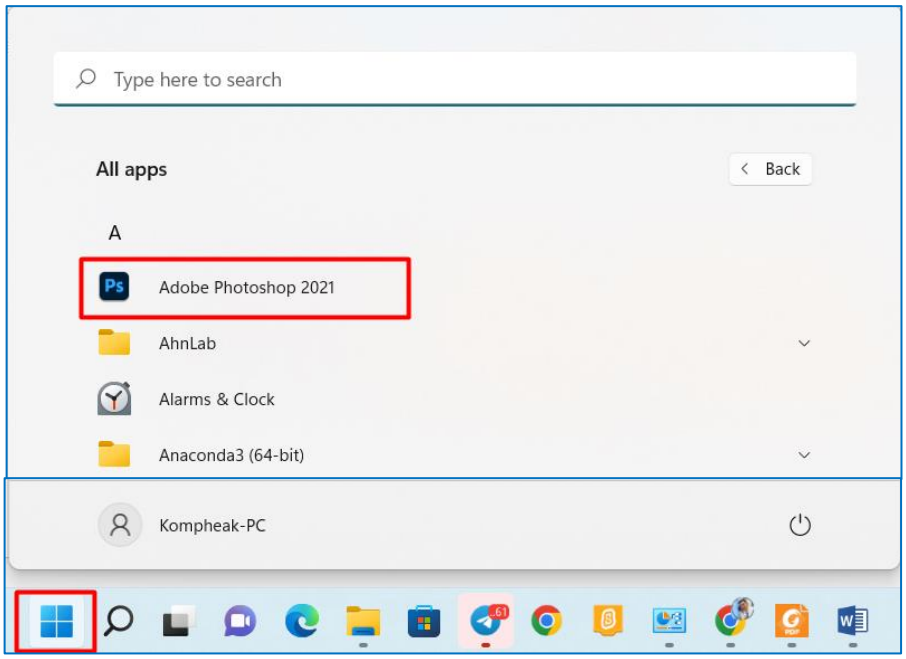


Figure 4.1: Opening Adobe Photoshop 2021 on a PC

When you launch Photoshop, the **Home screen** appears, which includes the following:

- Information about new features.
- A wide range of tutorials to help you quickly learn and understand the concepts, workflow, tips, and tricks.
- Display and access your recent documents: Cloud documents owned by you and accessed or shared with you recently will also appear under Recent on the home screen. Also, you can filter cloud documents with a keyword. When offline, you can still filter cloud documents using a keyword, but the cloud documents available online only will appear to be grayed out.
- If necessary, customize the number of recent files displayed. Select **Preferences ➔ File Handling** and then specify the desired value (0-100) in the **Recent File List Contains** field.

The contents of the Home screen are tailored based on your familiarity with Photoshop and your Creative Cloud membership plan.

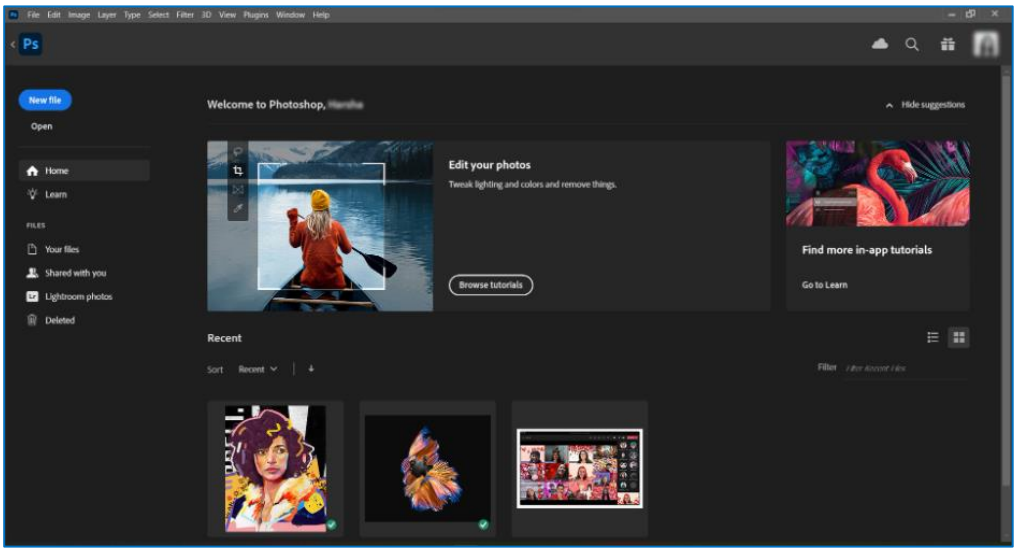


Figure 4.2: Photoshop Home Screen

To access the Home screen at any point while working on a Photoshop document, click the Home icon in the Options bar. To exit the Home screen, simply press the Esc key.

The Home screen shows the following tabs and buttons on the left:

- **New file**: Click this button to create a new document. You can create a document by selecting one of the numerous templates and presets available in Photoshop.
- **Open:** Click this button to open an existing document in Photoshop.
- **Home:** Click this tab to open the Home screen.
- **Learn:** Click this tab to open a list of basic and advanced tutorials on Photoshop to get started with the application.
- **Files:** Files section shows you all your files
  - **Lightroom photos:** Click this tab to access your synced Lightroom photos and import them into a Photoshop document.
  - **Your files:** View a list of all saved cloud documents in Photoshop, whether created in Photoshop on your desktop, iPad, or web. You can easily toggle between the tile and the list view.
  - **Shared with you:** View a list of the cloud documents that have been shared with you in Photoshop.
- **Deleted:** Find a complete list of cloud documents that you have deleted here. You can choose to restore the documents or permanently delete them.

Setting up the Document

Setting up your document correctly from the start will make your job much easier as you work through your project. This will require some advanced planning. For example, if your final output will be a brochure, you may need to set up your document to be horizontal and double-sided.

To create a new document, click **File ➔ New**. This will open the Document Setup dialog box (*See Figure 4.4*).

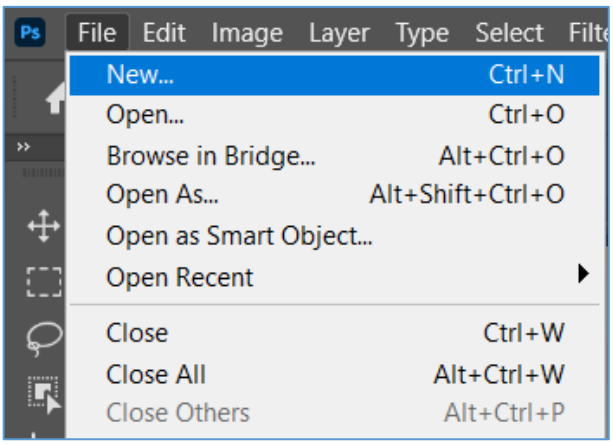


Figure 4.3: Create a New Document

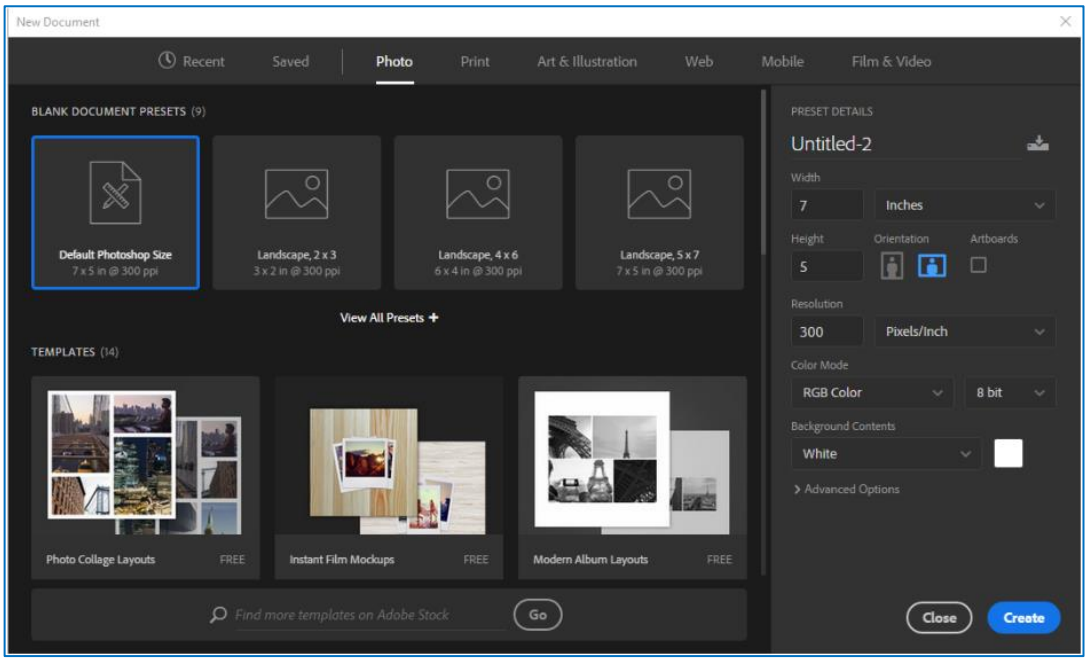


Figure 4.4: New Document Dialog Box

The new document dialog window lets you:

- Create documents using selected templates from Adobe Stock across several categories: **Photo**, **Print**, **Art & Illustration**, **Web**, **Mobile**, and **Film & Video**.
- Find more templates and create documents using them.
- Quickly access files, templates, and items you have recently accessed (**Recent** tab).
- Save your own custom presets for reuse and quickly access them later (**Saved** tab).
- Create documents using **Blank Document Presets** for multiple categories and device form factors. Before opening the presets, you can modify their settings.

Create documents using presents

1. In the **New Document** dialog box, click a category tab: **Photo**, **Print**, **Art & Illustration**, **Web**, **Mobile**, and **Film** & **Video**.
2. Select a preset.
3. Optionally, change the settings for the selected preset in the **Preset Details** pane on the right.
4. Click **Create**. Photoshop opens a new document based on the preset.

Modify Presets

Before opening a document using the preset, you can modify its settings in the right pane.

1. Specify a file name for the new document.

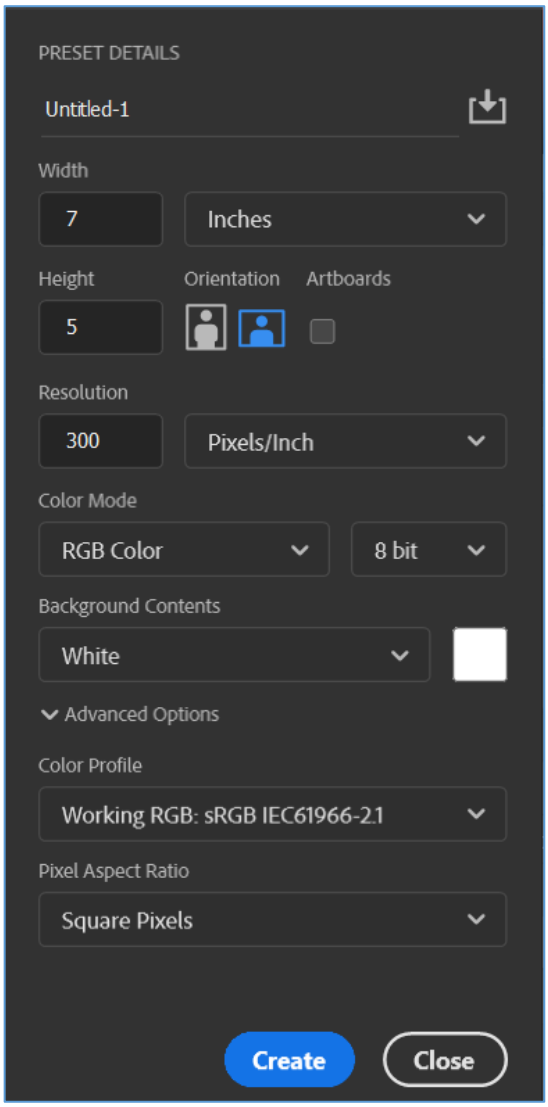
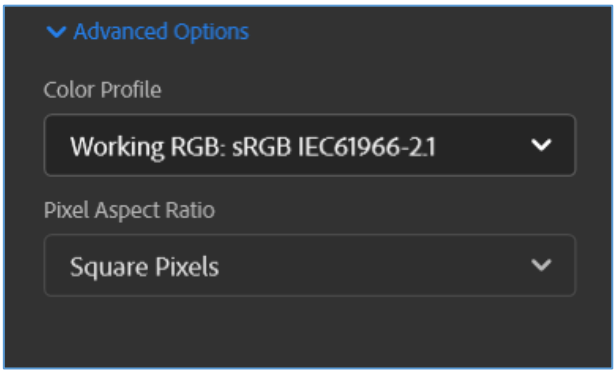


Figure 4.5: The Preset Detail Pane

2. Specify the following options for the selected preset:
   - **Width** and **Height**: Specify the size of the document. Select the unit from the pop-up menu.
   - **Orientation:** Specify a page orientation for the document: Landscape or Portrait.
   - **Artboards**: Select this option if you want your document to have artboards. Photoshop adds an artboard while creating the document.

- **Color Mode**: Specify a color mode for the document. Changing the color mode converts the default contents of the selected new document profile to a new color.
- **Resolution**: Specify the fineness of detail in a bitmap image measured in pixels/inch or pixels/centimeter.
- **Background contents**: Specify a background color for the document.

3. To specify the following extra options, click **Advanced Options**.



- **Color Profile:** Specify the color profile for your document from a wide range of options.
- **Pixel Aspect Ratio**: Specify the ratio of width to height of a single pixel in a frame.

4. Click **Create** to open a document with the preset settings.

Save your own presets

The **Preset Details** pane lets you modify an existing preset or specify fresh settings for a new one. To save your custom settings as a new preset, follow these steps:

1. After you're done specifying the settings, click the  icon in the **Preset Details** pane.
2. Specify a name for the new preset.
3. Click **Save Preset**.

You can later access the new preset from the **Saved** tab of the New Document dialog.

4.6. Interface Layout

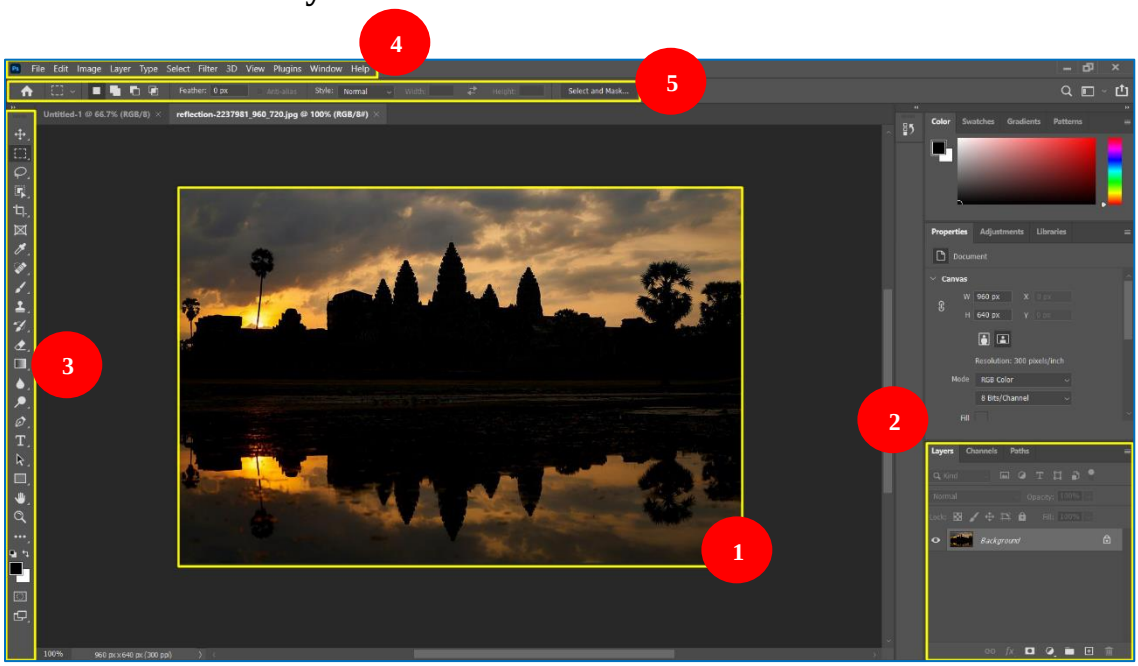


Figure 4.6: Photoshop Interface Layout

1. **The Canvas**

   The most important part of Photoshop's interface is the canvas, where everything happens. This is where you draw, paint, or design, and it's where you should focus 90% of the time. All your images in Photoshop will show up here, and you can do all sorts of image editing.

2. **The Layers Panel**

   Directly related to the canvas, we have the Layers panel. You can see it on the right side of your screen, but if you don't have it there, check **Window in the main menu ➔ Layers**. Everything you place on the canvas will show up in the Layers panel. Currently, we have a single layer called Background laid out on the canvas. These two elements are connected, and you can't use one without the other.

3. **The Toolbar**

   On the left side of your workspace, you have your toolbar. This is where you find things like the brush tool, the crop tool, the move tool, the zoom tool, the type tool, the eyedropper, the eraser, and so on.

4. **The Main Menu**

   At the top of Adobe Photoshop, we have the main menu system which contains all sorts of options and features. In your everyday projects, you'll

use it from time to time, but the most important actions have hotkeys, and it's faster to use those rather than the menus. Your version of Photoshop doesn't matter, as this menu bar has always been at the top of the program.

5. **The Options Bar**

   Directly underneath the main menu, we have the options bar, which changes constantly depending on what tool you have selected. In this case, we have the move tool active, so the options bar shows us related move settings.

Summary

In this chapter, you have learned:

Adobe Photoshop is a raster graphics editor developed and published by Adobe Inc. for Windows and macOS. Adobe Photoshop was initially created in 1988 by Thomas and John Knoll. It can edit and compose raster images in multiple layers and supports masks, alpha compositing, and several color models. In addition to raster graphics, Photoshop has limited abilities to edit or render text and vector graphics.

The most basic use of Photoshop is photo editing, graphic editing, website theme designing, and poster designing.

1) **Photo Editing:** Almost every photographer needs software for editing photos. Editing the photo involves actions,
    - To adjust the color levels of the photo.
    - Resize and Crop the photos.
    - Touch-up photos, by erasing and changing the objects in the photo.
    - Applying filters.
    - Change the format of the photo.
    - A designer can use their skills and transform the image.
2) **UI Content Designing:** Designing the User Interface content, for example, Logo, Buttons, Task Bar Design, GIFs, etc.,
3) **Graphics Design:** Using paintbrushes, effects like drop shadows, water, fire, and many more effects. The graphic designer can produce high-quality graphics.
4) **Social Media Content:** Social media handler designs high-quality, attractive posts and stories for their public engagement using various tools available in Photoshop.
5) **Animation:** Using Photoshop, we can make simple graphics animation. We have to create a set of layers and then activate the animation panel from the timeline. We can export our animation in the form of a GIF.

Questions

1) Explain what Adobe Photoshop is.
2) Who created Photoshop, and when did Photoshop start?
3) Summarize the Adobe Photoshop versions.
4) What are the minimum system requirements to run Photoshop?
5) What are the features of Photoshop?
6) Explain how to open Photoshop 2021 on Windows and macOS.
7) Explain how to create a new document in Photoshop 2021.
8) Explain the Photoshop 2021 interface layout.
9) What is File Extension in Photoshop?

Exercises

1) **Exercise 1:** Run Photoshop 2021 to create the following documents:
   - Name: ps2021-ex-1
     - Document Type: Web
     - Width: 600 (Pixels)
     - Height: 500 (Pixels)
     - Resolution: 72 (Pixels/Inch)
     - Background Contents: White
   - Name: ps2021-ex-2
     - Document Type: Mobile App Design (320, 1024)
     - Width: 320 (Pixels)
     - Height: 1024 (Pixels)
     - Resolution: 72 (Pixels/Inch)
     - Background Contents: White
2) **Exercise 2:** Run Photoshop 2021 to create the following documents and then Save the document preset:
   - Name: Facebook
     - Width: 1920 (Pixels)
     - Height: 1005 (Pixels)
     - Resolution: 72 (Pixels/Inch)
     - Background Contents: White
3) **Exercise 3:** Run Photoshop 2021 and then open an image from your computer.

Additional Reading:

1) https://helpx.adobe.com/photoshop/user-guide.html
2) https://en.wikipedia.org/wiki/Adobe_Photoshop

Chapter 05

Using Adobe Photoshop 2021 (1)

Learning Objective:

The objective of this chapter is to introduce the fundamental use of Adobe Photoshop 2021. It provides an understanding of palettes, toolboxes, and Photoshop tools.

After completing this chapter, students should be able to:

- Implement palettes
- Implement toolbox
- Implement Photoshop tools

In this chapter, you will learn about:

5.1. Palettes

5.2. Toolbox

5.3. Photoshop Tools

5.1. Palettes

Palettes contain functions that help you monitor and modify an image. By default, palettes are stacked together in groups. These are the palettes that are usually visible: **Color**, **Adjustments**, and **Layers**. If none of the palettes are visible, go to **Window** in the **Menu** bar and choose the palettes you need.

Below is the description of the most commonly used palettes in Adobe Photoshop 2021.

Color, Swatches, Style, Adjustments, History, and Layers

The **Color** palettes (*Figure 5.1*) display the current foreground and background colors and the RGB value for these colors. You can use the sliders to change the foreground and background colors in different color modes. You can also choose a color from the spectrum of colors displayed in the color ramp at the bottom of the palettes.

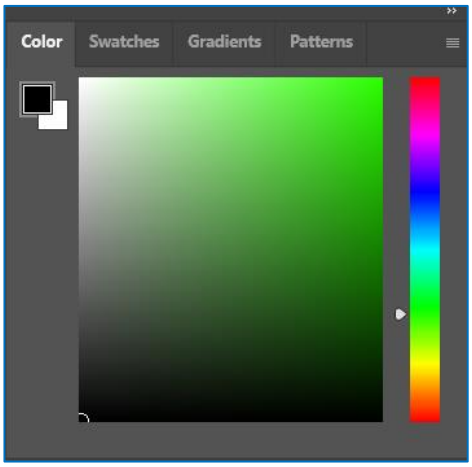


Figure 5.1: Color Palette

In the **Swatches** palette (*Figure 5.2*), you can choose a foreground or background color and add a customized color to the library.

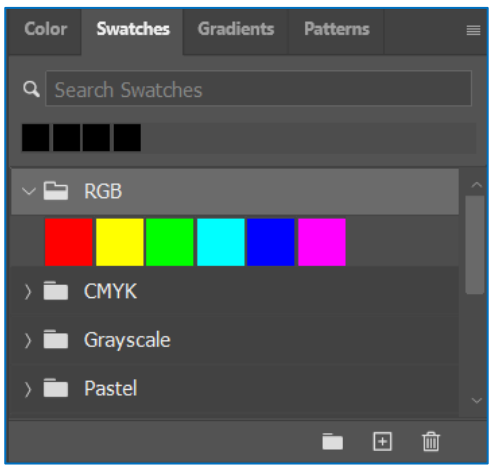


Figure 5.2: Swatches Palette

The **Styles** palette (*Figure 5.3*) allows you to view, select, and apply preset layer styles. By default, a preset style replaces the current layer style. You can use the styles in the palette or add your own using the **Create New Style** icon.

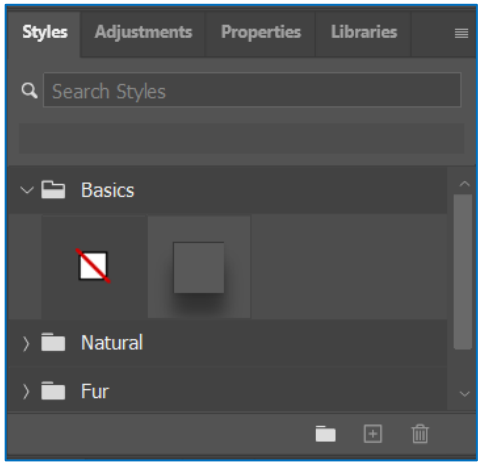


Figure 5.3: Styles Palette

The **Adjustment** layers palette (*Figure 5.4*) gives you the ability to apply an effect to a group of layers in Photoshop, and then you can edit that effect later while preserving the original layers.

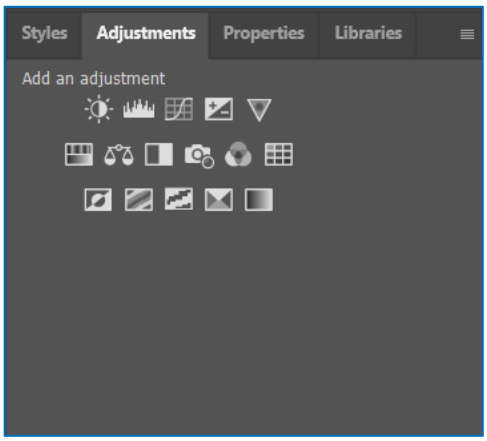


Figure 5.4: Adjustment Palette

The **History** palette (*Figure 5.5*) stores the displays of each action performed, allowing you to jump to any recent stage of the image alteration. The alterations should be created during the current working session. After saving or closing the document, the History palette clears all the contents. Each time you apply a change to an image, the new state of that image is added to the palette. It is significant to know that once you click on any of the previous stages, all the changes that were made after it will be lost.

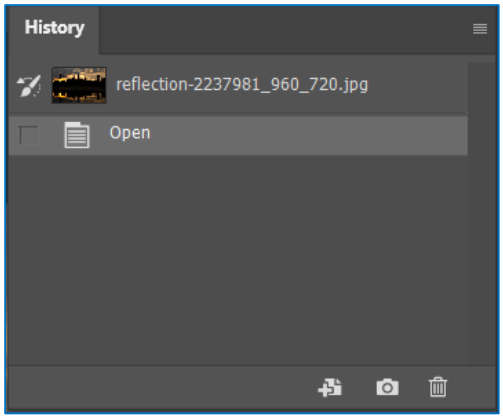


Figure 5.5: History Palette

Layers let you organize your work into distinct levels that can be edited and viewed as individual units. Every Photoshop 2021 document contains at least one layer. Multiple layers let you easily control how your artwork is printed, displayed, and edited.

You will use the **Layers** palette (*Figure 5.6*) often while creating a document, so it is crucial to understand what it does and how to use it.

1) **Layer Visibility** –The eye shows that the selected layer is visible. Click on or off to see or hide a layer.
2) **Layer Locking Option** –Click the checkered square icon to lock Transparency, click the brush icon to lock the image, click the arrow icon to lock the Position, and click the lock icon to lock all options.
3) **Layer Blending Mode** –Defines how the layer's pixels blend with underlying pixels in the image. By choosing a particular blending mode from the drop-down menu, you can create various special effects.
4) **Fill** –By typing in the value or dragging the slider, you can specify the transparency.
5) **Opacity** –By typing in a value or dragging the slider, you can specify the transparency of the entire lay
6) **Layer Styles** –If a layer has a style, an "F" icon shows at the bottom of the **Layer** palette. Click the little black triangle to see the style option
7) **Layer Mask** –This allows you to hide certain parts of the layer, which can then be revealed by using the paintbrush and the white paint color to expose portions of the layer.
8) **Layer Set** –This option helps to organize images with multiple layers. Click the icon to create a folder for several layers.

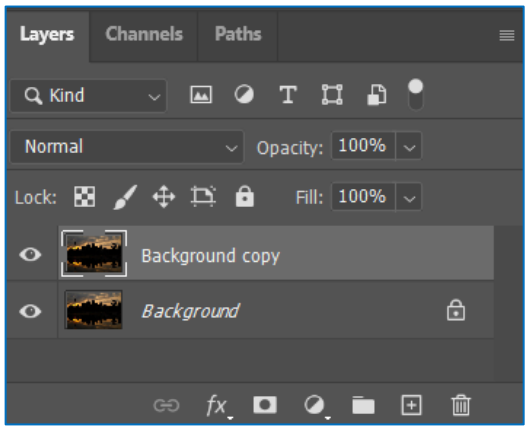


Figure 5.6: Layer Palette

9) **Create New Fill or Adjustment Layer** –Have the same opacity and blending mode options as image layers and can be rearranged, deleted, hidden, and duplicated in the same manner as image layers. Click the icon and select an option to create a new fill or adjustment layer.
10) **Create New Layer** –Click the icon to create a new layer.
11) **Delete Layer** –To delete a layer, select a layer in the **Layers** palette and drag it to the **trash can** icon, or select a layer and click the icon.

5.2. Toolbox

If you used other Adobe products, such as Illustrator or InDesign, you should be familiar with the toolbox in Adobe Photoshop as it shares some of the tools from these applications. If you are a new user of Adobe products, remember that you might only need to use some of the tools. In this tutorial, only the fundamental tools will be discussed in-depth.

Some tools in the toolbar have additional "hidden" tools. These tools have small black triangles in the right-hand corner. To view the "hidden" tools, click and hold down on any tool that has a gray triangle in the corner (*Figure 5.7*)

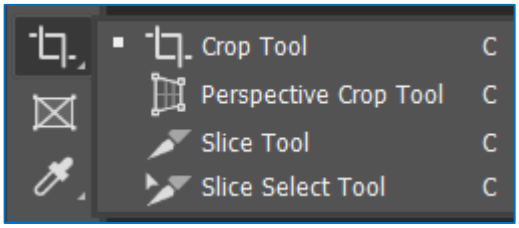


Figure 5.7: "Hidden" Tools

5.3. Photoshop Tools

5.3.1. Move Tool

Use the **Move tool** to move elements in a document. The **Move tool** helps you position selected content or layers when customizing your work.

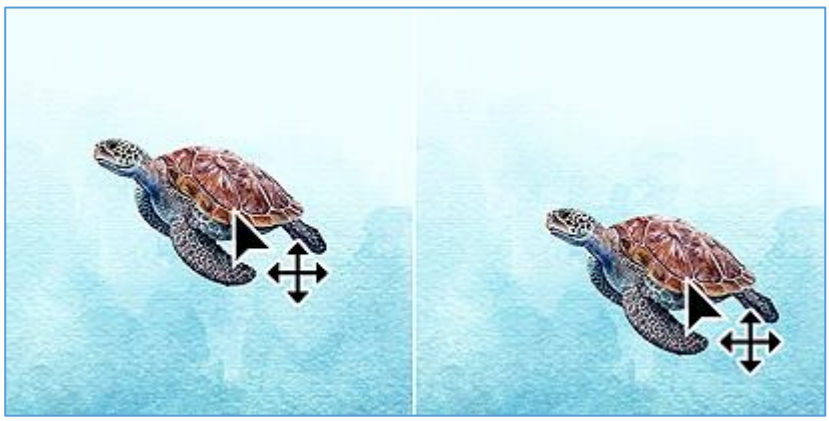


Figure 5.8: Move Tool

How to move the tool:

1. Select the **Move tool (V)** 
2. Use the **Options bar** to customize tool settings, like Alignment and Distribution, to get the desired effect.
3. Click on an element –like a layer, selection, or artboard –to move it.

5.3.2. Rectangular Marquee Tool

Make selections with the **Rectangular Marquee tool**. The **Rectangular Marquee tool** makes a selection in the shape of a rectangle.

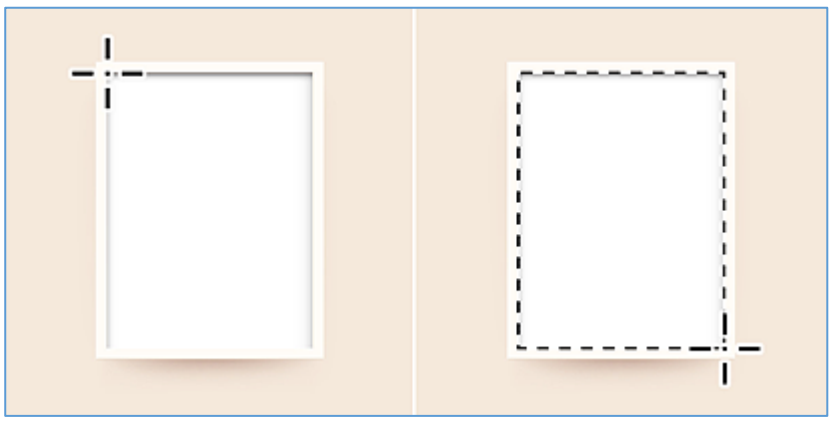


Figure 5.9: Rectangular Marquee Tool

How to use the Rectangular Marquee tool:

1. Select the **Rectangular Marquee tool (M)**
2. Use the **Options bar** to customize tool settings, like Add to selection or Subtract from selection, to get the selection you want.
3. Draw the selection area.
    - **Rectangular:** Drag over the area you want to select.
    - **Square:** Hold down the **Shift** key and drag diagonally in any direction.
    - **Draw from the center out:** Hold down **Alt** (**Windows**) or **Option** (**macOS**) as you drag.

5.3.3. Lasso Tool

Make freehand selections with the **Lasso tool.** The **Lasso tool** allows you to draw a freehand selection border around the objects you want to select in your image.

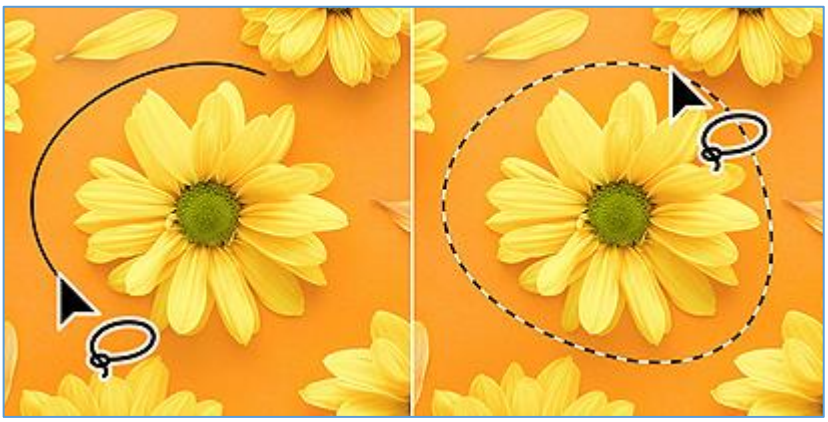


Figure 5.10: Lasso Tool

How to use the Lasso tool:

1. Select the **Lasso tool (L)**
2. Use the **Options bar** to customize tool settings, like Add to selection, subtract from a selection, and Select and Mask, to get the desired effect.
3. Drag to draw a selection border around the object.
4. Release the mouse (without holding down **Alt** or **Option**) to close the selection border.

5.3.4. Object Selection Tool

Selection of an object. The **Object Selection tool** is useful when an image contains multiple objects, and you only need to select one object or part of an object.

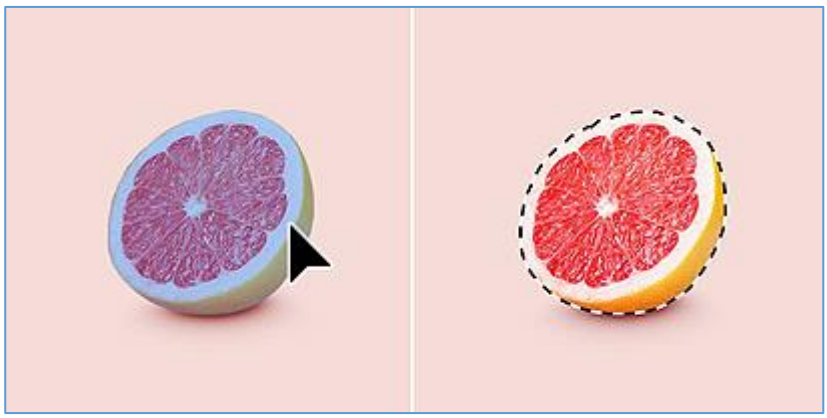


Figure 5.11: Object Selection Tool

How to use the Object Selection tool:

1. Select the **Object Selection tool (W)**  from the toolbar in the workspace.
2. In the **Option bar** at the top of the workspace, choose a selection Mode – **Rectangle** or **Lasso**.
3. Hover the mouse pointer over the object in your image that you want to select and click to automatically select the object for you.
4. In the **Option bar**, choose any of these settings –add to, subtract, or intersect for further refinement of your selection.
5. To make multiple selections, you can press the **Shift** (**masOS**)/ **Ctrl** (**Windows**) key on your keyboard and continue making selections.

5.3.5. Crop Tool

Crop a photo using the **Crop tool**. The **Crop tool** allows you to select an area of a photo and remove or crop everything outside the selected area.

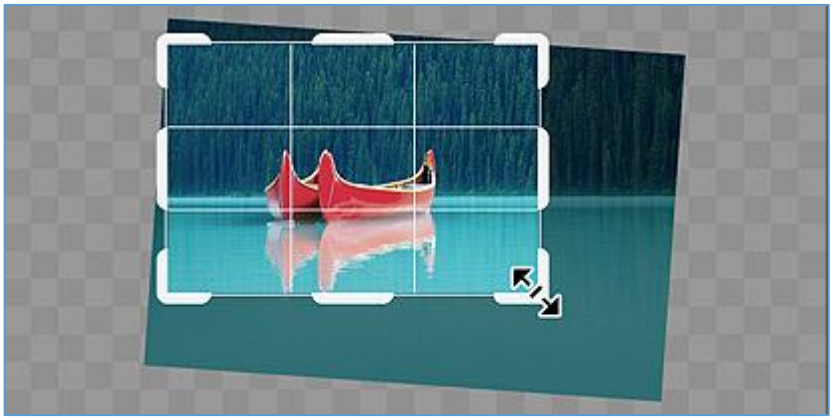


Figure 5.12: Crop Tool

How to Crop tool:

1. Select the **Crop tool (C)** 
2. Use the **Option bar** to customize tool settings, like setting the aspect ratio or width and height values, to get the desired effect.
3. Click inside the crop border and drag to reposition the image.
4. Drag the corner or edge handles of the crop border that appears on your photo to specify the crop boundaries.
5. Press **Enter** (**Windows**) or **Return** (**masOS**) to crop the photo.

5.3.6. Frame Tool

Create placeholder frames with the **Frame tool.** The **Frame tool** allows you to draw placeholder frames that you can fill with images.

Figure 5.13: Frame Tool

How to use the Frame tool:

1. Select the **Frame tool (K)**
2. Select the **Rectangular** or **Elliptical** frame icon in the **Option bar**.
3. Draw a frame on the canvas.
4. Drag an image from the Libraries panel or from your computer's local disk into the frame.

The placed image automatically scales to fit the frame. The boundary of the frame masks the placed image.

5.3.7. Eyedropper Tool

Sample image colors with the **Eyedropper tool**. The **Eyedropper tool** can sample colors from anywhere in an image and add them to your **Swatches panel**.

Figure 5.14: Eyedropper tool

How to use the Eyedropper tool:

1. Select the **Eyedropper tool (I)**
2. Use the **Options bar** to customize tool settings, like Sample Size and Sample, to get the desired effect.
3. Click on the color you want to sample.
4. The sampled color will become the foreground color and be added to your **Swatches panel**.

5.3.8. Spot Healing Brush Tool

Remove marks with the **Spot Healing Brush tool**. The **Spot Healing Brush tool** quickly repairs image imperfections.

Figure 5.15: Spot Healing Brush Tool

How to use the Spot Healing Brush tool:

1. Select the **Spot Healing Brush tool (J)**
2. Use the **Options bar** to customize tool settings, like Size, Hardness, and Pressure, to get the desired effect.
3. **For smaller areas:** Simply click the area you want to fix.
4. **For larger areas:** Click and drag to smooth over imperfections across the area you want to fix.

5.3.9. Brush Tool

Paint images using the **Brush tool**. Use the **Brush tool** to paint brush strokes.

Figure 5.16: Brush Tool

How to use the Brush tool:

1. Select the **Brush tool (B)** in the toolbar
2. Open the **Brush** picker in the **Options bar** and use the Size and Hardness sliders to define the brush tip.
3. Click and drag the brush across the area you want to paint.

5.3.10. Clone Stamp Tool

Retouch images with the **Clone Stamp tool**. The **Clone Stamp tool** copies pixels from one part of an image to another.

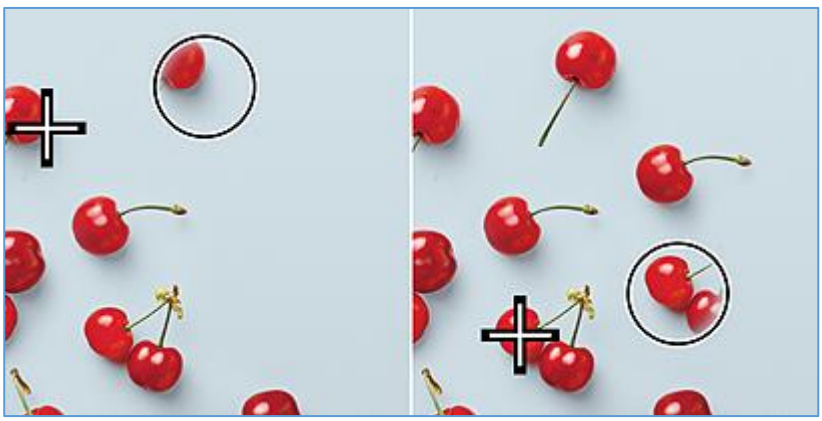


Figure 5.17: Clone Stamp Tool

How to use the Clone Stamp tool:

1. Select the **Clone Stamp tool (S)**
2. Use the **Options bar** to customize tool settings, like Size, Hardness, and Blending mode, to get the desired effect.
3. Press the **Alt** key (**Windows**) or the **Option** key (**masOS**) and click the area of the image that you want to copy.

This sets a starting point from which the tool will begin copying.

4. Release the **Alt** or **Option** key and drag over the new area where you want to place your copied content.
5. The **Clone Stamp tool** will copy content from the source and paint it into the new area.

5.3.11. History Brush Tool

Restore parts of an image with the **History Brush tool**. The **History Brush tool** allows you to restore parts of an image to an earlier historical state by painting over them.

Figure 5.18: History Brush Tool

How to use the History Brush tool:

1. Choose **Window** ➔ **History** to open the **History panel**.
2. In the **History panel**, click the far-left column of the state you want to use as the source for the **History Brush tool**. A brush icon will appear next to the selected history state.
3. Select the **History Brush tool (Y)** 
4. Use the **Options bar** to customize tool settings, like Size and Hardness, to get the desired effect.
5. Drag over the parts of the image you want to restore.

5.3.12. Eraser Tool

Remove part of an image with the **Eraser tool**. The **Eraser tool** can make pixels transparent or match them to the image's background color.

Figure 5.19: Eraser Tool

How to use the Eraser tool:

1. Select the **Eraser tool (E)** 
2. Use the **Options bar** to customize tool settings, like Size and Hardness, to get the desired effect.
3. Drag over the parts of the image you want to erase.

5.3.13. Gradient Tool

Create smooth color blending effects with the **Gradient tool**. The **Gradient tool** creates a gradual blend between colors using preset, or custom gradient fills.

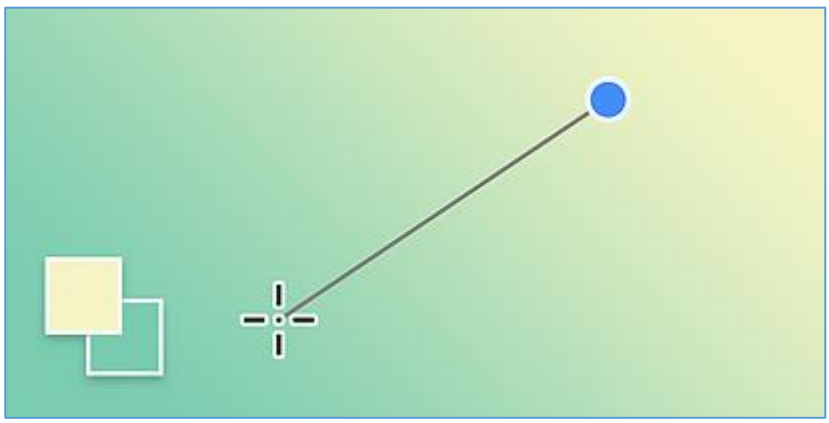


Figure 5.20: Gradient Tool

How to use the Gradient tool:

1. Select the area you want to fill with a gradient.
2. Select the **Gradient tool (G)** 
3. Use the **Options bar** to customize tool settings, like Gradient Type and Opacity, to get the desired effect.
4. Drag the cursor across the selected area to fill it with a gradient.

5.3.14. Blur Tool

Blur areas in an image with the **Blur tool**. The **Blur tool** allows you to paint a blur effect on specific areas of an image.

Figure 5.21: Blur Tool

How to use the Blur tool:

1. Select the **Blur tool** 
2. Use the **Options bar** to customize tool settings, like Size, Hardness, and Strength, to get the desired effect.
3. Click and drag over the part of the image you want to blur.

5.3.15. Dodge Tool

Lighten areas in an image with the **Dodge tool**. The **Dodge tool** allows you to lighten specific areas of your image without affecting hue or saturation.

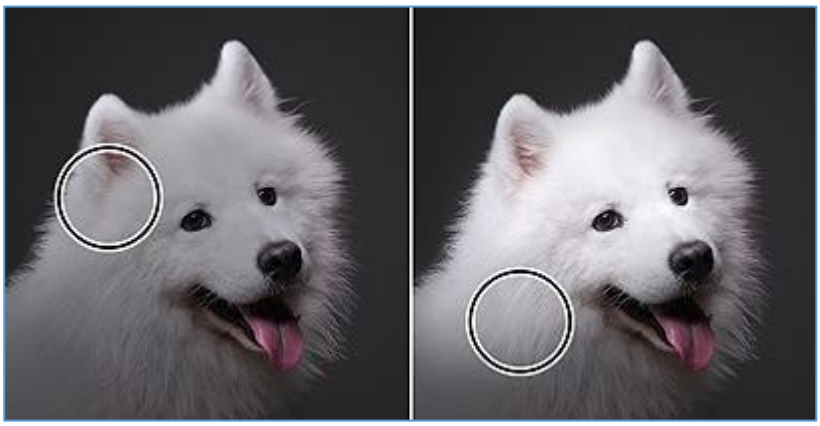


Figure 5.22: Dodge Tool

How to use the Dodge tool:

1. Select the **Dodge tool (O)** 
2. Use the **Options bar** to customize tool settings, like brush size, range, and exposure, to get the desired effect.
3. Drag over the part of the image you want to lighten.

5.3.16. Pen Tool

Draw shapes and paths with the **Pen tool**. The **Pen tool** allows you to draw smooth-edged paths with anchor points and handles.

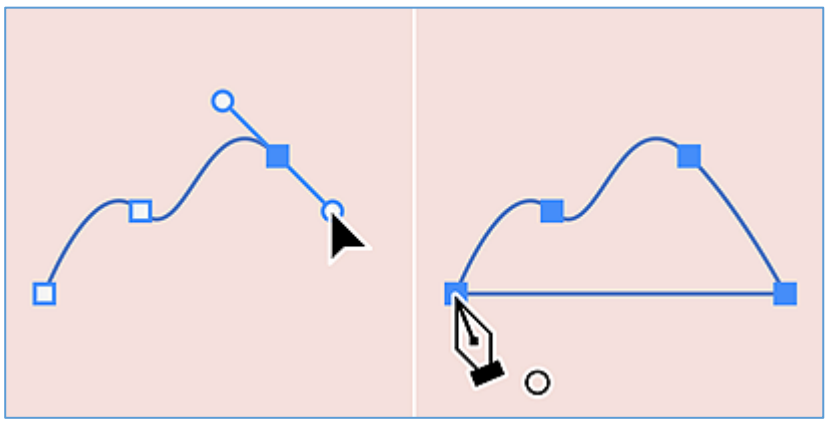


Figure 5.23: Pen Tool

How to use the Pen tool:

1. Select the **Pen tool (P)** 
2. Use the **Options bar** to customize tool settings, like Drawing Mode and Add/Delete anchor points, to get the desired effect.
3. Draw a path with anchor points and handles.
4. Finish drawing the path by closing it or leaving it open.
   - **Close the path:** Position the tool over the first (hollow) anchor point and click or drag.
   - **Leaving the path open: Ctrl**-click (**Windows**) or **Command**-click (**macOS**) anywhere away from all objects.

5.3.17. Horizontal Type Tool

Add text with the **Horizontal Type tool**. The **Horizontal Type tool** allows you to add horizontal text to your image.

Figure 5.24: Horizontal Type Tool

How to use the Horizontal Type tool:

1. Select the **Horizontal Type tool (T)** 
2. Use the Options bar to customize tool settings, like Font Style, Font Size, and Text Color, to get the desired effect.
3. Add point text (a few words like a heading or title) or paragraph text.
   - **Point text**: Click anywhere on the canvas and type the text.
   - **Paragraph text**: Drag the cursor on the canvas to create a bounding box and type your paragraph.

4. Click  in the Options bar or press **Ctrl + Enter** (**Windows**) or **Command + Return** (**macOS**) to save your changes.

5.3.18. Path Selection Tool

Select and move paths with the **Path Selection tool**. The **Path Selection too**l lets you quickly select paths, giving you the versatility to move or edit the object.

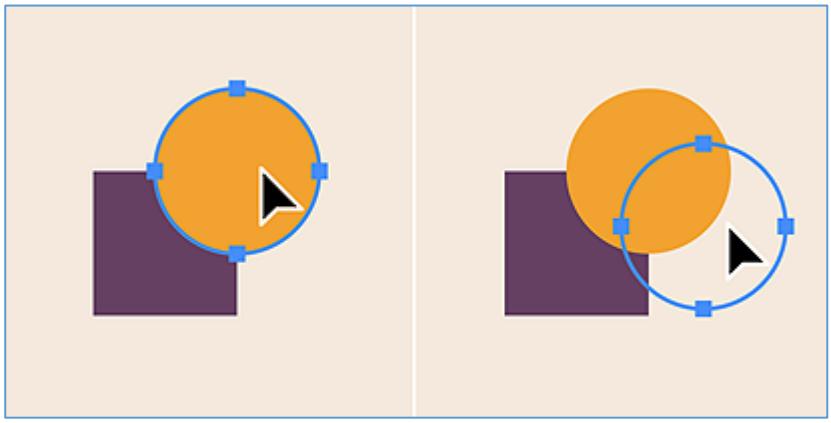


Figure 5.25: Path Selection Tool

How to use the Path Selection tool:

1. Select the **Path Selection tool (A)** 
2. Use the **Options bar** to customize tool settings, like Path Operations, Path Alignment, and Arrangement, to get the effect you want.
3. Select one or more paths
   - **Single path:** Click a path to select it.
   - **Multiple paths: Shift**-click the paths to select them.
4. Drag to move the selected paths.

5.3.19. Rectangle Tool

Draw rectangular shapes with the **Rectangle tool.** The **Rectangle tool** allows you to draw rectangular shapes (vector and pixel-based) and paths (shape outlines).

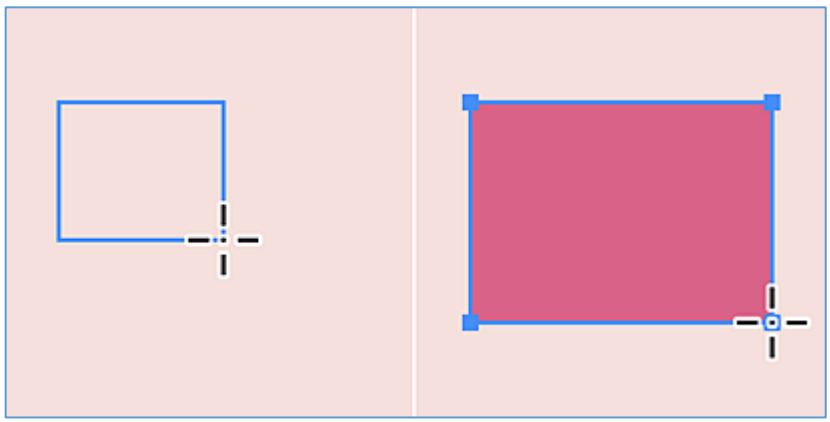


Figure 5.26: Rectangle Tool

How to use the Rectangle tool:

1. Select the **Rectangle tool (U)** 
2. Use the **Options bar** to customize tool settings, like Fill, Stroke, Width, and Height, to get the desired effect.
3. Draw shapes or paths on the canvas.
   - **Draw a rectangle:** Drag diagonally in any direction.
   - **Draw a square:** Hold down the **Shift** key and then drag diagonally in any direction.
   - **Draw from the center out:** Position the crosshairs where you want the center of the shape or the path to be, hold down **Alt** (**Windows**) or **Option** (**macOS**) and then drag diagonally to any corner.

5.3.20. Hand Tool

Use the **Hand tool** to view a different area of an image. The **Hand tool** allows you to move your image while you're zoomed in to more than 100% and part of the image is out of view.

Figure 5.27: Hand Tool

How to use the Hand tool:

1. Select the **Hand tool (H)**  from the toolbar or press and hold the **spacebar** key to temporarily switch to the **Hand tool.**
2. Drag in any direction to move the image around and view different parts of the image.

5.3.21. Zoom Tool

View images with the **Zoom tool**. Magnify or reduce the view of your image with the **Zoom tool.**

Figure 5.28: Zoom Tool

How to use the Zoom tool:

1. Select the **Zoom tool**  from the toolbar.
2. In the tool options bar, choose the **Zoom In**  option to magnify your view or the **Zoom Out**  option to reduce the image view.
3. Click the area you want to zoom in or out in your image. Each click magnifies or reduces the image to the next preset percentage and centers the display around the point you click.
4. In the tool options bar, you can select from these zoom options and set a zoom percentage: **Resize Windows to Fit, Zoom All Windows, Scrubby Zoom, Fit Screen**, and **Fill Screen**.

Summary

In this chapter, you have learned:

Palettes contain functions that help you monitor and modify an image. By default, palettes are stacked together in groups. These are the palettes that are usually visible: **Color**, **Adjustments**, and **Layers**. If none of the palettes are visible, go to **Window** in the **Menu** bar and choose the palettes you need.

The toolbox contains the main tools for working on images. Click any tool to select and use it. A small arrow next to a tool in the toolbox indicates that the tool also has additional options available. In Photoshop, click and hold your mouse on a tool to see its options.

Photoshop tools:

- Move and selection tools
- Crop and slice tools
- Measurement tools
- Retouching and painting tools
- Drawing and type tools
- Navigation tools

Questions

1) Explain what color, swatches, style, adjustments, history, and layers palettes are.
2) List some important tools in Adobe Photoshop.
3) How can you select the exact color to match the image?
4) In Photoshop, what is a smart object?
5) How do you organize layers in Photoshop?
6) How can you unlock the background in Photoshop?

Exercises

1) **Exercises 1:** Create a student card by using tools in Photoshop.
2) **Exercises 2:** Design a photo frame using custom shapes in Photoshop.
3) **Exercises 3:** Create a cover page for a textbook.

Additional Reading:

1) https://helpx.adobe.com/photoshop/user-guide.html
2) https://www.youtube.com/channel/UClH-KpveOLJszChWRfFmPfQ

Chapter 06

Using Adobe Photoshop 2021 (2)

Learning Objective:

The objective of this chapter is to introduce the basic usage of Adobe Photoshop 2021. It provides an understanding of draw, and paint tools and how to use text tools to create text in Photoshop.

After completing this chapter, students should be able to:

- Design a document by using draw and paint tools
- Create a document by using text tools

In this chapter, you will learn about:

6.1. Drawing and Painting

6.2. Text

6.1. Drawing and Painting

6.1.1. Draw Rectangles and Modify Stroke Options

Learn how to work with the **Rectangle tool** in Photoshop.

Draw a Rectangle

The **Rectangle tool** allows you to draw rectangles and rounded rectangles on your canvas:

1. Select the **Rectangle tool**

   From the toolbar, click and hold the **Shape tool** ( ) group icon to bring up the various shape tool choices. Select the **Rectangle tool**.

2. Adjust the shape properties of the **Rectangle tool**

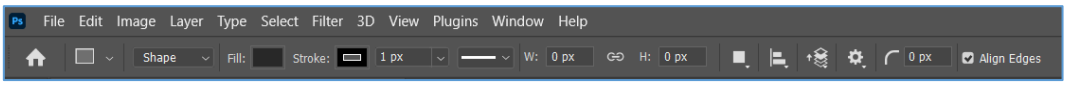


Figure 6.1: Set the Rectangle Properties

In the **Shape tool** options bar, you can set the following:

- **Mode:** Set a mode for your **Rectangle tool** — Shape, Path, and Pixels.
- **Fill:** Choose a color to fill your rectangle shape.
- **Stroke:** Choose the color, width, and type of your shape stroke.
- **Stroke width:** Manually set the width for your rectangle stroke.
- **Stroke type:** Select the stroke type for drawing a rectangle.
- **Shape W&H:** Manually set the width and height of your shape.
- **Path operations:** Use path operations to set the way your drawn rectangles interact with each other.
- **Path alignment:** Use path alignment to align and distribute your rectangles.
- **Path arrangement:** Use path arrangement to set the stacking order of rectangles you create.
- **Additional shape and path options:** Click the gear ( ) icon to access additional rectangle shape and path options to set attributes such as width and color of the on-screen display of your path and constrain options while drawing rectangles.
- **The Radius of rounded corners:** Manually set the radius for rounding the corners of your rectangle.

3. Draw a rectangle

Click on the canvas to bring up the **Create Rectangle dialog**. You can use this dialog to manually set your rectangle's dimensions and corner radii and choose to align from the centre. Click **OK** to enable changes. Position your pointer and drag it on the canvas to draw a rectangle. This automatically creates a new layer in the **Layers panel**.

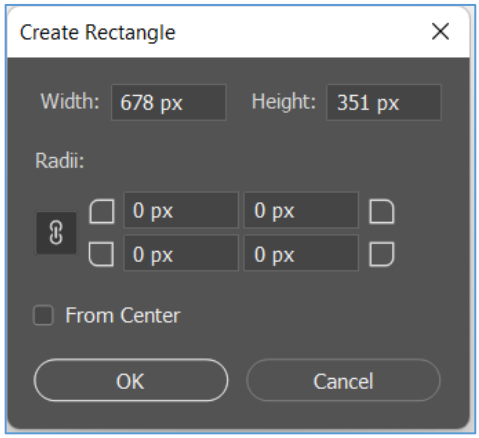


Figure 6.2: Create Rectangle Dialog

4. Edit rectangle shape properties

You can easily edit your shape properties directly using on-canvas controls or accessing **Shape Properties** under the **Properties panel.**

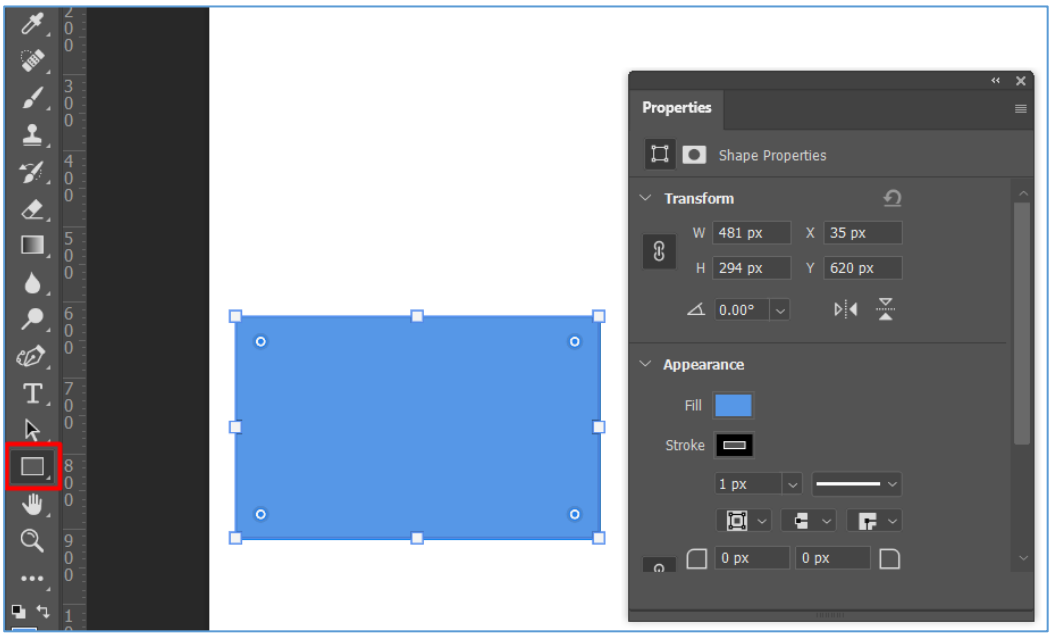


Figure 6.3: Properties Panel

Set shape stroke options

1. Use the **Path Selection tool** to select the shape whose path you want to modify.
2. In the **Properties panel** or the tool options bar, click the **Set Shape Stroke Type** menu icon to open the **Stroke Options panel**.
3. In the **Stroke Options panel**, do any of the following:
    - Choose the type of stroke you want.
    - Click the **Align** icon and choose an option to specify the position of the stroke relative to its path.
    - Click the **Caps** icon and choose a cap style to specify the appearance of both ends of a path:
        - **Butt cap:** Creates squared ends that abut (stop at) the endpoints.
        - **Round cap:** Creates semicircular ends that extend half the stroke width beyond the endpoints.
        - **Projecting cap:** Creates squared ends that extend half the stroke width beyond the endpoints. This option makes the stroke weight extend evenly in all directions around the path.

Note:

Keep in mind that the caps are not visible unless the path is opened. Also, cap styles are easier to see at thicker stroke weights, such as JPEG, PNG, and GIF.

- Click the **Corner** icon to see the appearance of the stroke at corner points:
    - **Miter join:** Creates pointed corners that extend beyond the endpoint when the miter's length is within the miter limit.
    - **Round join:** Creates rounded corners that extend half the stroke width beyond the endpoints.
    - **Bevel join:** Creates squared corners that abut the endpoints.

Note:

Like caps, miters are easier to see at thicker stroke weights.

Save stroke settings

After specifying the shape stroke options in the **Stroke Options** panel, you can save your newly created stroke type for reuse.

Click the gear icon in the upper-right corner of the **Stroke Options** panel and choose **Save Stroke**.

Copy and paste shape stroke settings

After specifying shape stroke options, you can copy and paste the settings to another shape.

1. Click the gear icon in the upper-right corner of the Stroke Options panel and choose Copy Stroke Details.
2. Select the shape you want to modify.
3. In the **Properties** panel or tool options bar, click the **Set Shape Stroke Type** menu icon to open the **Stroke Options** panel.
4. Click the gear icon in the upper-right corner of the **Stroke Options** panel and choose **Paste Stroke Details**.

6.1.2. Paint Symmetrical Patterns

Paint your brush strokes in a perfectly symmetrical pattern. Symmetry mode lets you define an axis or axes and then choose from preset types, including circular, radial, spiral, and mandala.

Choose Symmetry Options While Painting

Photoshop lets you paint symmetrically while using the **Paint Brush**, **Pencil**, and **Eraser** tools. While using these tools, click the butterfly icon  in the Options bar. Choose from the several available types of symmetry - **Vertical**, **Horizontal**, **Dual Axis**, **Diagonal**, **Wavy**, **Circle**, **Spiral**, **Parallel Lines**, **Radial**, and **Mandala**.

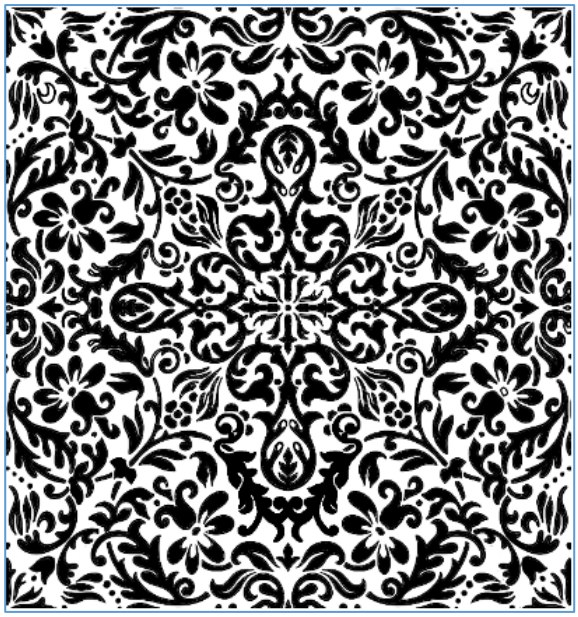


Figure 6.4: Symmetrical Pattern

Paint strokes are reflected across the line of symmetry, allowing for easier sketching of faces, cars, animals, and more.

You can also set any path as a symmetry path. Right-click the path in the Paths panel and select **Make Symmetry Path**. To modify a symmetry path, select it and then choose ➔ **Transform Symmetry.**

Paint with Radial and Mandala Symmetry

1. Select the **Paint Brush**, **Pencil**, or **Eraser** tool.
2. In the **Options** bar, click the butterfly icon and choose **Radial** or **Mandala** symmetry from the menu.
3. In the **Radial Symmetry** or **Mandala Symmetry** dialog, specify the desired **Segment Count** and click **OK**.
   - For Radial Symmetry, you can specify any Segment Count from 2 (minimum) through 12 (maximum).
   - For Mandala Symmetry, you can specify any Segment Count from 3 (minimum) through 10 (maximum).
4. Photoshop now displays the default Symmetry Path over your document. Transform the path as necessary. Press the **Enter** key (**Win**) / **Return** key (**Mac**) to commit the transformation.

To modify the symmetry path later, select it and then choose ➔ **Transform Symmetry.**

5. Paint your document using the symmetry guide as a reference.

- **Radial Symmetry:** Photoshop repeats a single brush stroke around a center point or radial axis as you paint with Radial Symmetry. For example, setting the Segment Count for Radial Symmetry to six results in a single brush stroke repeated six times around the center point.

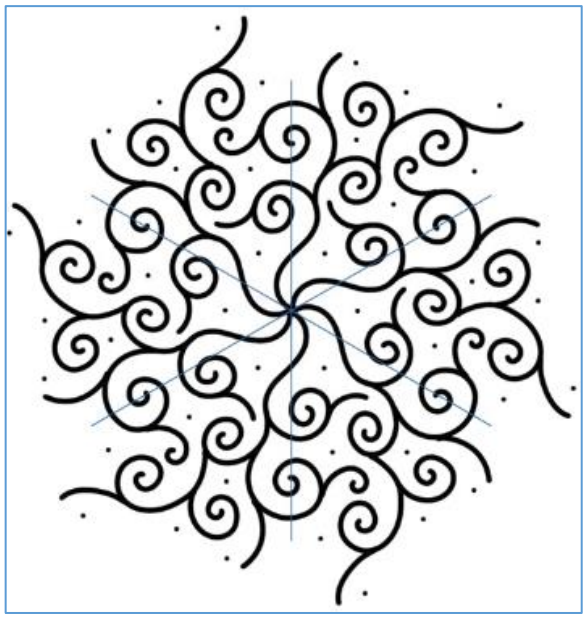


Figure 6.5: Using Redial Symmetry with Paint Brush Tool

- **Mandala Symmetry:** When you paint with Mandala Symmetry, Photoshop first mirrors and then repeats a single brush stroke around the center point or radial axis. For example, setting the Segment Count for Mandala Symmetry to six results in a single brush stroke mirrored and repeated six times around the center point.

Figure 6.6: Using Mandala Symmetry with Paint Brush Tool

Assign Keyboard Shortcuts to the Symmetry Options

You can assign keyboard shortcuts to the following options in the symmetry menu .

- Toggle between **Symmetry Off** and **Last Used Symmetry**
- Toggle between **Hide Symmetry** and **Show Symmetry**

By default, these options are not pre-bound to any keyboard shortcut.

1. Do one of the following:
   - Choose **Edit ➔ Keyboard Shortcuts**.
   - Choose **Window ➔ Workspace ➔ Keyboard Shortcuts & Menus**, and click the **Keyboard Shortcuts** tab.

2. From the **Shortcuts For** menu, choose **Tools**.
   In the **Tool Panel Command** column of the list, scroll to the bottom to find **Toggle Symmetry Off/Last** and **Toggle Symmetry Visibility.**

3. Select and assign the desired keyboard shortcut. Click **OK**.

6.1.3. About Drawing

Understanding Shapes and Paths

Drawing in Adobe Photoshop involves creating vector shapes and paths. In Photoshop, you can draw with any shape tool, Pen tool, or Freeform Pen tool. Options for each tool are available in the options bar.

Before you begin drawing in Photoshop, choose a drawing mode from the options bar. The mode you choose to draw determines whether you create a vector shape on its layer, a work path on an existing layer, or a rasterized shape on an existing layer.

Vector Shapes are lines and curves you draw using the shape or pen tools. Vector shapes are resolution-independent—they maintain crisp edges when resized, printed to a PostScript printer, saved in a PDF file, or imported into a vector-based graphics application. You can create libraries of custom shapes and edit a shape's outline (called a path) and attributes (such as stroke, fill color, and style).

Paths are outlines you can turn into selections or fill and stroke with color. You can easily change the shape of a path by editing its anchor points.

A work path is a temporary path that appears in the Paths panel and defines the outline of a shape.

You can use paths in several ways:

- Use a path as a vector mask to hide areas of a layer
- Convert a path to a selection.
- Fill or stroke a path with color.

Drawing Modes

You can draw in three different modes when working with the shape or pen tools. You choose a mode by selecting an icon in the options bar when a shape or pen tool is selected.

Shape Layers: This creates a shape on a separate layer. You can use either the shape tools or the pen tools to create shape layers. Because they are easily moved, resized, aligned, and distributed, shape layers are ideal for making graphics for web pages. You can choose to draw multiple shapes on a layer. A shape layer consists

of a fill layer that defines the shape color and a linked vector mask that defines the shape outline. The outline of a shape is a path, which appears in the Paths panel.

Paths: Draws a work path on the current layer that you can then use to make a selection, create a vector mask, or fill and stroke with color to create raster graphics (much as you would using a painting tool). A work path is temporary unless you save it. Paths appear in the Paths panel.

Fill Pixels: Paints directly on a layer—much as a painting tool does. When you work in this mode, you create raster images—not vector graphics. You work with the shapes you paint just like any raster image. Only the shape tools work in this mode.

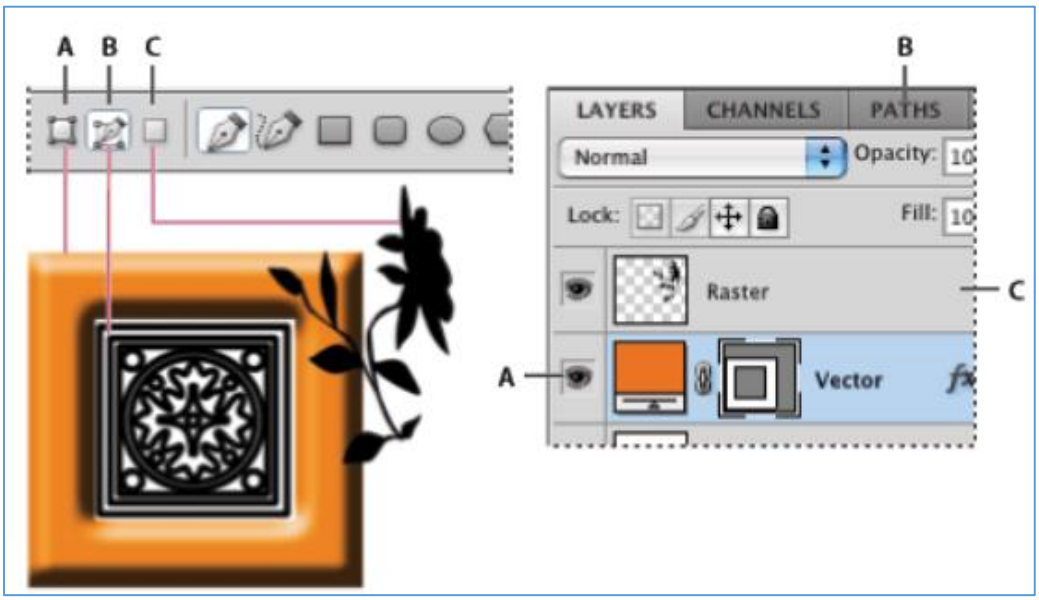


Figure 6.7: Drawing Options

A. Shape Layers **B.** Paths **C.** Fill Pixels

6.1.4. Draw and Edit Shapes

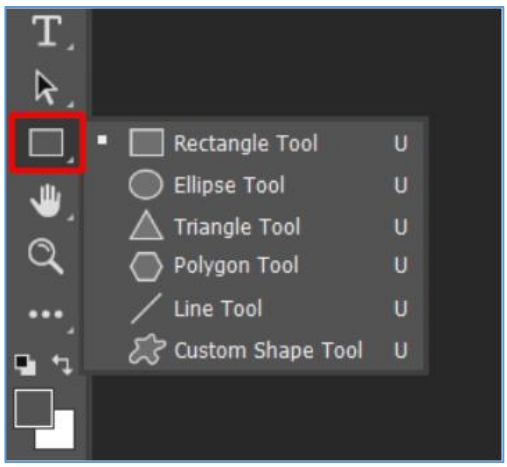
Photoshop comes with the ability to draw and edit vector shapes easily. You can also convert your vector shape to a raster or pixel-based shape.

Create Shapes

Follow these quick steps to create shapes in Photoshop:

1. Select a shape tool

   From the toolbar, click and hold the Shape tool ( ) group icon to bring up the various shape tool options — **Rectangle**, **Ellipse**, **Triangle**, **Polygon**, **Line**, and **Custom Shape**. Select a tool for the shape you want to draw.



2. Set shape tool options

   In the shape tool options bar, you can set the following:

   - **Mode:** Set a mode for your Shape tool — **Shape**, **Path**, and **Pixels**.
   - **Fill:** Choose a color to fill your shape.
   - **Stroke**: Choose the color, width, and type of your shape stroke.
   - **W&H:** Manually set the width and height of your shape.
   - **Path operations:** Use path operations to set the way your shapes interact with each other.
   - **Path alignment:** Use path alignment to align and distribute your shape components.
   - **Path arrangement:** Use path arrangement to set the stacking order of shapes you create.
   - **Additional shape and path options:** Click the gear ( ) icon to access additional shape and path options to set attributes such as width and color of the on-screen display of your path and constrain options while drawing shapes.

3. Draw a shape

Click and drag on the canvas with your selected shape tool to draw a shape. This automatically creates a new shape layer in the Layers panel.

- Hold the **Shift** key while drawing to make your shapes proportional.
- With your shape layer selected, use the **Move** tool to move your shape around and reposition it on the canvas.
- To easily scale, transform, or rotate your shape, choose **Edit ➔ Free Transform** or press **Control + T (Win) / Command + T (Mac).**

4. Edit shape properties

You can edit your shape properties directly using on-canvas controls or accessing Shape Properties under the Properties panel. On-canvas controls make your interaction with shapes more intuitive. You can use on-canvas transform and rounding controls to adjust the appearance of your shape. The keyboard modifiers will work the same way for on-canvas transform controls as they work in the Transform tool in Photoshop. You can modify the radius of all corners of your shape at once or hold Alt (Win) or Option (Mac) as you drag to change the radius of a single corner. All corners will be modified for triangles, even if you drag one of them. Easily rotate a shape using the on-canvas rotate handle that appears as you hover over your shape on the canvas.

Click the reset ( ) icon in the properties panel to reset all modifications at any time.

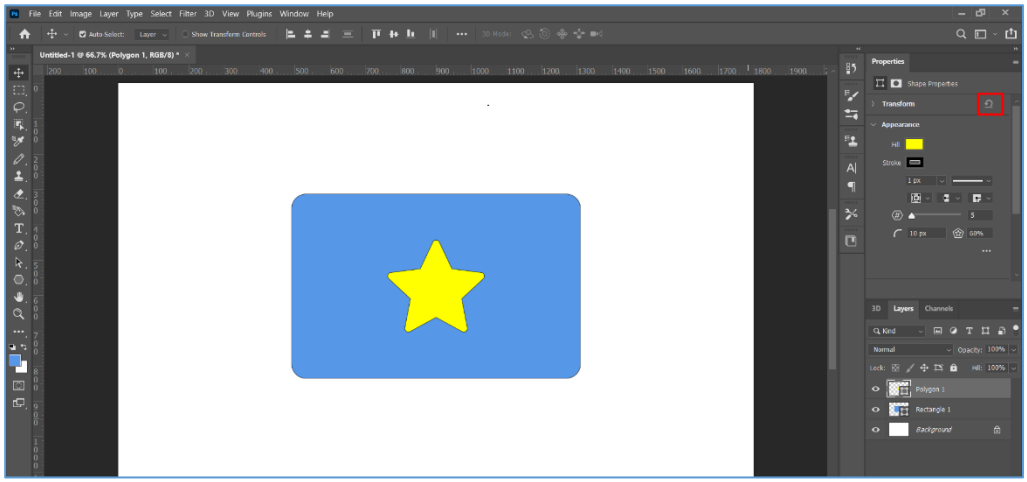


Figure 6.8: Live Shapes

Once you've drawn a shape, you can click anywhere on the canvas to bring up a Create Shape pop-up dialog and modify your shape parameters.

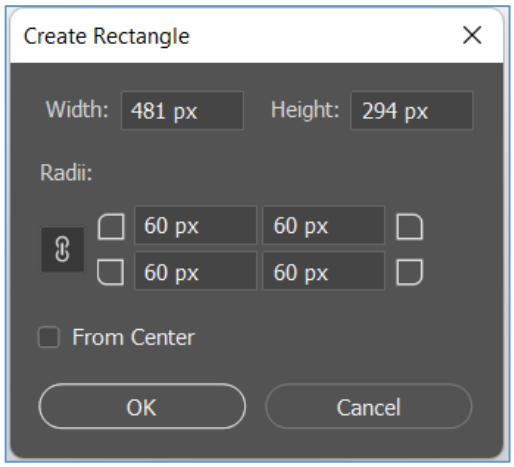


Figure 6.9: Create Rectangle Dialog

Fill and Stroke Shapes

Follow these quick steps to fill and stroke shapes:

1. In the **Layers** panel, select the shape layer you want to fill or stroke.
2. Do one of the following to set the shape fill or stroke type:
   - Select a shape tool (**press U**) from the toolbar. In the tool options bar, select **Fill** or **Stroke**.
   - In the **Properties** panel, click the fill or stroke type option.

3. In the pop-up menu, choose a fill or stroke option — **Solid Color, Gradient**, or **Pattern**.

   Solid Color: Fills or strokes the shape layer with the current foreground color. Use the Color Picker or color presets to select a different color.

   Gradient: Choose a gradient preset or click on the gradient to display the Gradient Editor dialog. Set additional gradient options:

   - Angle specifies the angle at which the gradient is applied.
   - Reverse flips the orientation of the gradient colors.
   - Style specifies the shape of the gradient.
   - Scale changes the size of the gradient.
   - Align with layer uses the bounding box of the layer to calculate the gradient fill. You can drag in the image window to move the center of the gradient.

   Pattern: Choose a pattern from the pop-up menu and set additional pattern options:

   - Angle specifies the angle at which the pattern is applied. Set the angle selector at a certain degree or manually type in an angle value to rotate your pattern at the desired angle.
   - Scale changes the size of the pattern. Enter a value or drag the slider.

Draw a Custom Shape

You can draw custom shapes by using shapes from the Custom Shape pop-up panel or save a shape or path to use as a custom shape.

1. Select the **Custom Shape** tool  from the shape tools in the toolbar.
2. To view all the custom shapes that come with Photoshop, click the gear icon on the right of the Custom Shape picker in the shape tool options bar. You will see the list of available shapes. Select any custom shape as desired.
3. If you don’t find the desired shape, click the gear icon in the Custom Shape picker panel and select the **Import Shapes** option to import the desired shape from your saved files.

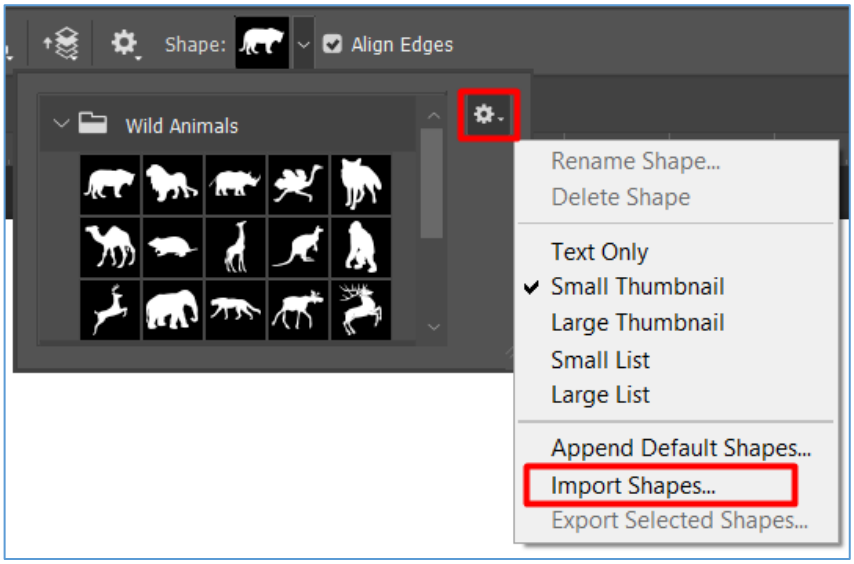


Figure 6.10: Custom Shape Picker

4. You can easily edit your Custom Shape Tool properties directly from **Shape Properties** under the **Properties** panel. You can also use on-canvas Transform controls to transform a custom shape while keeping intact its shape properties.
5. Click and drag anywhere on the canvas to draw your custom shape.

Figure 6.11: Enhanced Properties Panel for Custom Shape Tool

You also have the flexibility of setting the **Custom Shape Tool** preset directly from the **Shapes Windows** panel. When you select a custom shape from the **Windows ➔ Shape** panel, this preset will get updated in the **Custom Shape Tool ➔ Custom Shape** picker as well.

Note:

You can access the custom shape properties only for the shapes drawn using the Custom Shape Tool and not when a path has been converted to a shape.

Save a shape or path as a custom shape.

1. In the **Paths** panel, select a path—either a vector mask for a shape layer, a work path, or a saved path.
2. Choose **Edit ➔ Define Custom Shape**, and enter a name for the new custom shape in the **Shape** Name dialog box. The new shape appears in the **Shape** pop-up panel in the options bar.
3. To save the new custom shape as part of a new library, select **Save Shapes** from the pop-up panel menu.

Draw a star shape using the Polygon tool

One of the basic shapes that we learn to draw as kids is a five-pointed star shape.

Follow these three quick steps to draw a star shape with the Polygon shape tool:

1. From the toolbar, click and hold the shape tool group icon to bring up hidden shape tool options. Select the **Polygon tool**.
2. Drag on your canvas to draw a polygon.
3. Click anywhere on the canvas to bring up the **Create Polygon** dialog and set the following attributes:
    - **Width & Height:** Manually set the width and height of your polygon.
    - **Symmetric:** Select the checkbox to maintain symmetry in your polygon.
    - **Number of Sides:** Manually enter the number of sides you'd like the polygon to have. For example, set the number of sides to 5 if you want to draw a 5-cornered star shape.
    - **Corner Radius:** Manually set a radius to get rounded corners for your polygon.

- **Star Ratio:** Adjust the Star Ratio percentage to get the perfect star shape.
- **Smooth Star Indents:** Select the checkbox to round up the star indents.
- **From Center:** Select the checkbox to align the star shape from the centre.

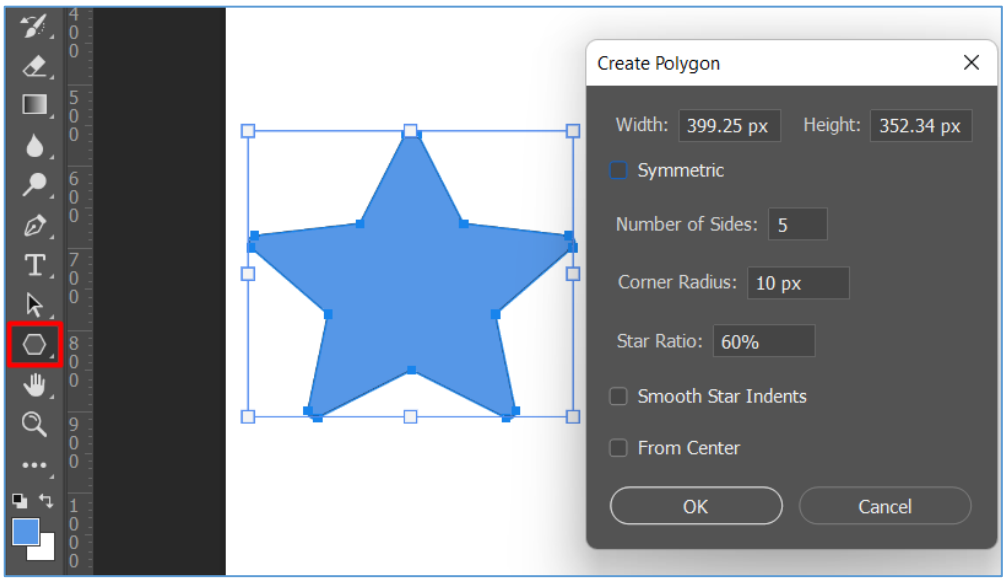


Figure 6.12: Create a Star Shape with the Polygon Tool

Accessing Legacy Custom Shapes

If you have used Legacy Custom Shapes from older versions of Photoshop and would like to add them to your current version, follow the steps below.

1. From the main window, select **Window ➔ Shapes**
2. In the top right corner of the Shapes panel, click on the menu icon ( ) and select **Legacy Shapes and More**

6.2. Text

Adding or Placing Text

1. Open a photo or Photoshop document (PSD).
2. From the toolbar, select the **Type** tool or simply press **'T'** to quickly select it. The **Horizontal Type Tool** with which you can add text horizontally is selected by default. If you want to add text vertically, click the **Type** tool again and select **Vertical Type Tool** from the context menu.

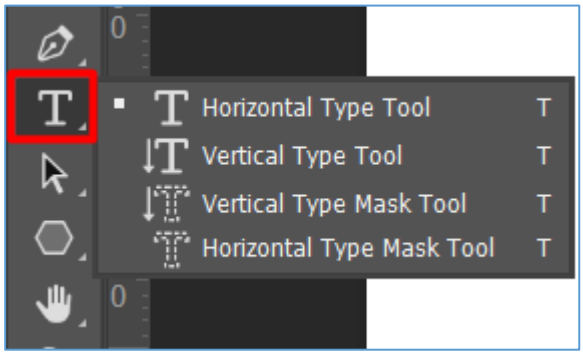


Figure 6.13: Text tool

3. Do you want to add a few words, like a heading or title? Click anywhere on the canvas to type it. In Photoshop, this is called point text. The other type of text in Photoshop is called paragraph text. As the name suggests, this is used when you want to type a paragraph. Click and drag the cursor on the canvas to create a bounding box where you can type your paragraph. This helps you efficiently edit and align the paragraph later.

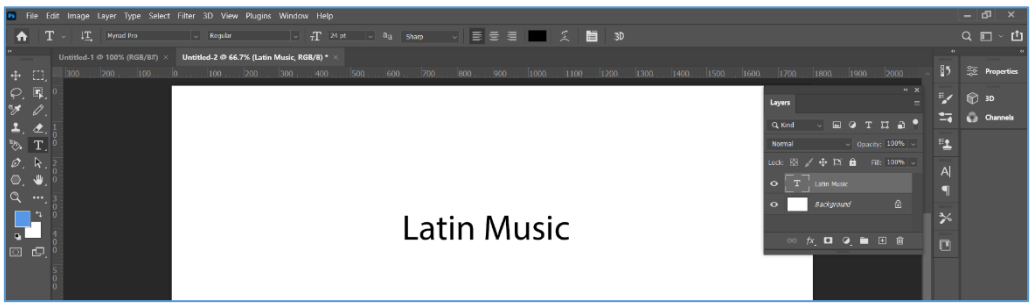


Figure 6.14: Add Titles or Headings with Point Text

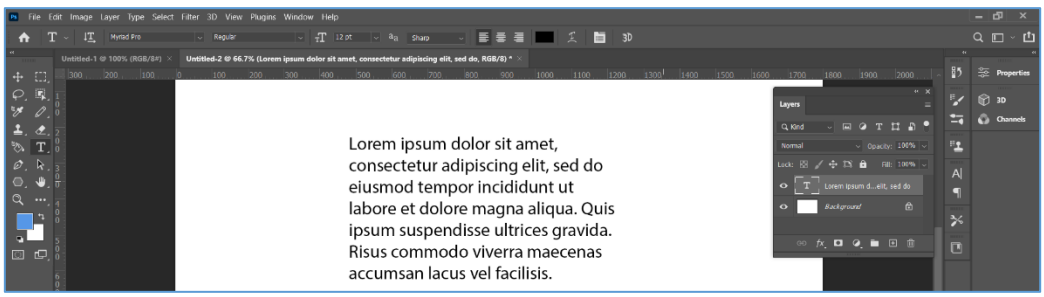


Figure 6.15: Add Paragraphs with Paragraph Text

Note:

A type layer gets automatically created when you create point or paragraph text and can be identified in the **Layers** panel with the **T** icon.

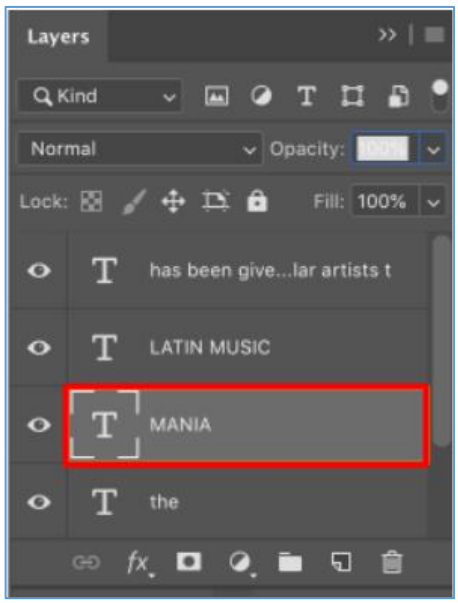


Figure 6.16: A Type Layer in the Layers Panel

4. Type your text. To save your changes, click ☑ in the options bar or press **Esc**, and you're good to go!

How to select text

1. Open the Photoshop document with the text you want to edit.

> **Note:**
> The text must be on a type layer. Don't see type layers in your document? See steps 2 and 3 in **how to add text**.

2. To select the entire text or paragraph on a type layer, select the Move tool in the toolbar and double-click the text you want to select.

> **Note:**
> If you are unable to do this step, you may not have the latest version of Photoshop. In this case, select the Type tool in the toolbar, click the text you want to select, and choose **Select ➔ All** in the menu bar.

3. To select one or more characters on a type layer, simply select the Type tool in the toolbar and then click and drag the cursor over the characters you want to select.

Once you have selected your text, you can edit your text, change the **color of the text**, **resize text**, **copy** and **paste text**, and **more**.

Editing Text

1. Open the Photoshop document with the text you want to edit.
2. Select the **Type** tool in the toolbar.
3. Select the text you want to edit.
4. The options bar in the top has options to edit your **font type**, **font size**, **font color**, **text alignment**, and **text style**.

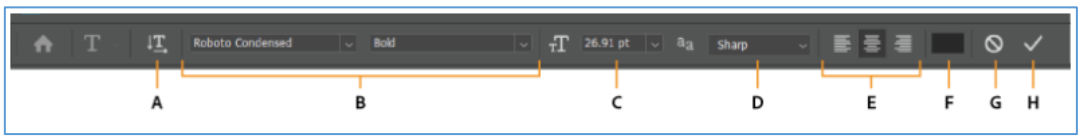


Figure 6.17: Options Bar in Photoshop on Windows

A. Change horizontal text to vertical text and vice-versa, **B.** Change font style **C.** Change font size, **D.** Change pixelation of text edge (anti-aliasing), **E.** Change text alignment, **F.** Change text color, **G.** Cancel changes, **H.** Save changes

5. Finally, click ☑ on the options bar to save your edits.

Copying and Pasting Text

You can copy and paste text in your Photoshop document (PSD) from other documents. For example, from a Word file, a PDF file, a web page, or another Photoshop file (PSD).

Copy and Paste Text from a Non-Photoshop File.

1. In your non-Photoshop files, such as a **Word file**, **PDF**, or **web page**, click and drag the cursor over the text to select it.
2. Press **Command + C** (**macOS**) or **Control + C** (**Windows**) to copy the selected text.
3. Open the Photoshop document (PSD) in which you want to paste the copied text, and then select the **Type** tool in the toolbar.

4. Select the type layer from the **Layers** panel where you want to paste the text. If you don't have type layers or want to add another type layer, see steps 2 and 3 on **how to add text**.
5. Choose **Edit ➔ Paste** or press **Command + V** (**macOS**) or **Control + V** (**Windows**) to paste your text. To undo, choose **Edit ➔ Undo Paste Text**.

Copy and Paste from Another Photoshop Document (PSD)

1. Open the PSD you want to copy the text from.
2. Select the text you want to copy and choose **Edit ➔ Copy** or simply press **Command + C** (**macOS**) or **Control + C** (**Windows**).
3. Open the PSD you want to paste the text in and select a type layer. If you don't have type layers or want to add another type layer, see steps 2 and 3 on **how to add text.**
4. Choose **Edit ➔ Paste** to paste your text in the center of your canvas. You can also choose **Edit ➔ Paste Special ➔ Paste** in Place to place the text as it was in the PSD from which you had copied.

Resizing Text

Struggling to change the size of your text? Here's how you can easily do it:

Resize the Entire Text on a Type Layer

1. Open the Photoshop document with the text you want to edit.
2. Select the **Move** tool  in the toolbar.
3. In the options bar, do this:
   (**macOS users**) Check that **Auto-select: Layer** and **Show Transform Controls** are selected.
   (**Windows users**) Check that **Layer** and  icon are selected.
4. Click to select the text you want to resize.
5. In the transform box that appears, drag one of the anchor points to resize your text proportionally. You can also do the following when you drag an anchor point:
   - Hold down the **Shift** key to resize your text non-proportionally.
   - Hold down the **Alt** key to keep the center of your text in the same place when you resize text.

- Hold down the **Command** (**macOS**) or **Control** (**Windows**) to explore skewed angles when you resize your text.

6. Finally, click in the options bar to save your edits

Resizing One or More Characters on a Type Layer

To change the size of specific letters, numbers, or words in your text, you can do this:

1. Open the Photoshop document with the text you want to edit.
2. Select the **Type** tool in the toolbar.
3. Select the text that you want to resize.
4. In the field of the options bar, select the text size option you want. You can see the changes in real-time.

Note:

If you have a paragraph text and are unable to view the entire paragraph after resizing it, drag the corners of the bounding box.

5. Click in the options bar, and you're done! To cancel your changes, click on the options bar.

Moving Text

To move your text around on the Photoshop canvas:

1. Open the Photoshop document with the text you want to edit.
2. Select the type layer that has the text you want to move.
3. Select the Move tool in the toolbar.
4. In the options bar, ensure that Auto Select **Layer** (**macOS**) or **Layer** (**Windows**) is selected, and then click the text you want to move. You can then view the transform box with the dark arrow.
5. Click and move the transform box and then release it to place the text where you want.

Changing the Color of the Text

Change the color of your entire text.

1. Open the Photoshop document with the text you want to edit.

2. Select the **Type** tool in the toolbar and click the text for which you want to change color. The entire text in the type layer is selected.
3. Click the **Color Picker** (**Text Color**) icon in the options bar.

Figure 6.18: Color Picker Icon in the Options Bar

5. Move the color slider as you want and pick your color. You can see your text color change in real-time as you pick different colors.
6. Once you're happy with your text color, click **OK**.

Aligning and Justifying Text

Need help aligning your text properly? Here's how you can justify and align your text:

1. Open the Photoshop document with the text you want to edit.
2. Select the type layer from the **Layers** panel with the paragraph you want to justify. If you want to justify a specific paragraph on a type layer, then select it.

Note:

If you have a word or a few words (that is point text), you need to convert it to paragraph text first to justify it. To change point text to paragraph text, select the type layer and choose **Type ➔ Convert to Paragraph Text** from the menu bar.

3. Choose **Window ➔ Paragraph** to view the **Paragraph** panel.
4. In the **Paragraph** panel, you can view the various **Justify** options. Select an option to view the changes in real time.

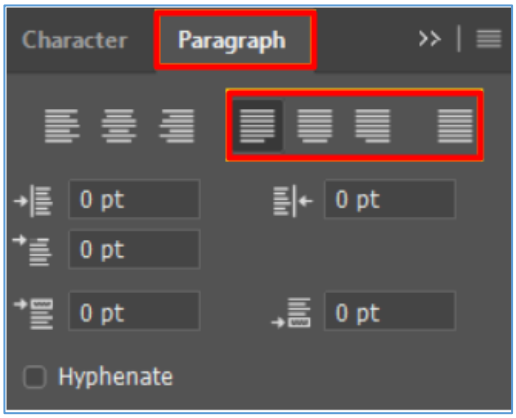


Figure 6.19: Align and Justify Text

5. After you've finalized your Justify option, click ✓ in the options bar, and you're set!

Rotating Text

Want to tilt or rotate your text to a certain angle? Here's how you can do it:

1. Open the Photoshop document with the text you want to edit.
2. Select the **Move** tool in the toolbar.
3. In the options bar, do this:

(**macOS users)** Check that **Auto-select**: **Layer** and **Show Transform Controls** are selected.

(**Windows users**) Check that **Layer** and icon are selected.

4. Click the text you want to rotate. You can then view the transform box around your text.
5. Hover near the corners of the transform box. The cursor changes to a two-sided arrow.
6. Click and drag the curved arrow to rotate the text the way you want. You can also specify values in the options bar to get a more precise rotation.
7. Click ✓ in the options bar and you're done!

Summary

In this chapter, you have learned:

Drawing in Adobe Photoshop involves creating vector shapes and paths. In Photoshop, you can draw with any shape tool, the Pen tool, or the Freeform Pen tool. Options for each tool are available in the options bar. Before drawing in Photoshop, choose a drawing mode from the options bar. The mode you choose to draw determines whether you create a vector shape on its layer, a work path on an existing layer, or a rasterized shape on an existing layer.

Adobe Photoshop provides several tools for painting and editing image color. The Brush and Pencil tools work like traditional drawing tools applying color with brush strokes. The Eraser, Blur, and Smudge tools modify the image's colors. In the options bar for each painting tool, you can set how color is applied to an image and choose from preset brush tips.

You can add text to your document by using the Type tool. Text can be used in various projects, such as combining it with photos to make a poster, student card, business card, or invitation. You will also be able to modify the text to meet your specific requirements.

Questions

1) List the tools used for drawing in Photoshop and explain them.
2) List the tools used for paining in Photoshop and explain them.
3) Explain what vector shapes and paths are.
4) What is the text tool in Photoshop used for?
5) Which tool helps insert text in Photoshop?

Exercises

1) **Exercises 1:** Create your own logo by using draw tools in Photoshop.
2) **Exercises 2:** Design your own slogan by using text tools in Photoshop.
3) **Exercises 3:** Painting exercise:
    1. Scan or take a photo of your face using a digital camera.
    2. Open the photo.
    3. Create a new layer.
    4. Paint over the photo using a variety of brushes and settings.

Additional Reading:

1) https://helpx.adobe.com/photoshop/user-guide.html
2) https://www.youtube.com/channel/UClH-KpveOLJszChWRfFmPfQ

Chapter 07

Using Adobe Photoshop 2021 (3)

Learning Objective:

The objective of this chapter is to introduce the basic usage of Adobe Photoshop 2021. It provides an understanding of color boxes and modes, image and color basics, and Image adjustment in Photoshop.

After completing this chapter, students should be able to:

- Implement color boxes and modes
- Demonstrate image and color basics
- Employ image adjustment

In this chapter, you will learn about:

7.1. Color Boxes and Modes

The foreground color appears in the upper selection box and represents an active color. The background color appears in the lower box and represents an inactive color.

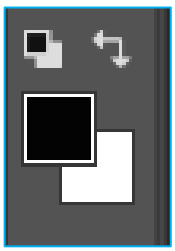


Figure 7.1: Color Boxes

1. To change the foreground color, click the upper color selection box in the **Toolbox**.
2. To change the background color, click the lower color selection box in the **Toolbox**.
3. To reverse the foreground and background colors, click the **Switch Colors** icon (the arrow) in the Toolbox.
4. To restore the default foreground and background colors, click the **Default Colors** icon (the little black and white boxes) in the Toolbox.

Note:

If you are using the **Gradient Tool**, the currently selected foreground and background colors will be the default colors of the gradient.

7.2. Image and Color Basics

7.2.1. Resizing Images

Image resizing is one of the most common image manipulation workflows that allows you to customize the size of your image based on your needs without losing its crispness.

Resize Images in Photoshop

Follow these steps to use **Image Size** in Photoshop and resize your image as desired:

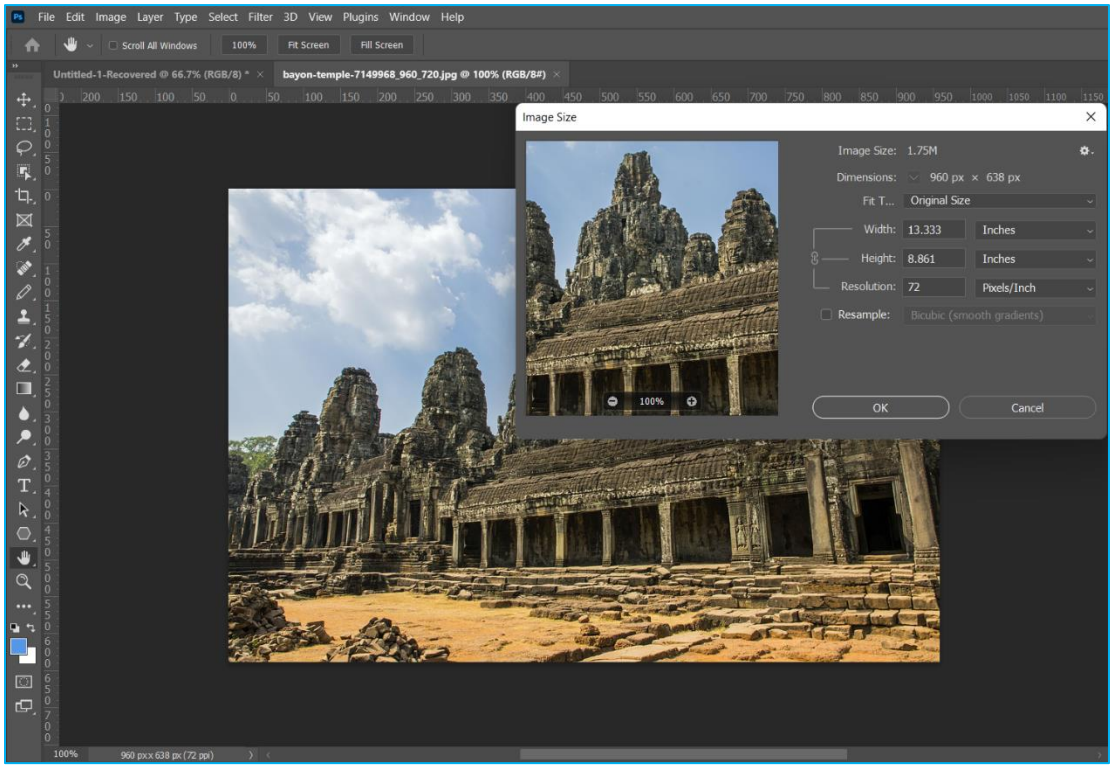


Figure 7.2: Resize an Image in Photoshop

1. Open an image in Photoshop and choose **Image ➔ Image Size**.
2. Modify image preview

   A window displays the preview image in the **Image Size** dialog. Do any of the following to modify the image preview:

   - To change the preview window size, drag a corner of the **Image Size** dialog box and resize it.
   - To view a different image area, drag the hand icon that appears within the preview.
   - To change the preview magnification, **Ctrl**-click (**Windows**) or **Command**-click (**macOS**) in the preview image to increase magnification. **Alt**-click (**Windows**) or **Option**-click (**macOS**) to reduce the magnification. After clicking, the magnification percentage briefly appears near the bottom of the preview image.
3. Modify image resizing parameters

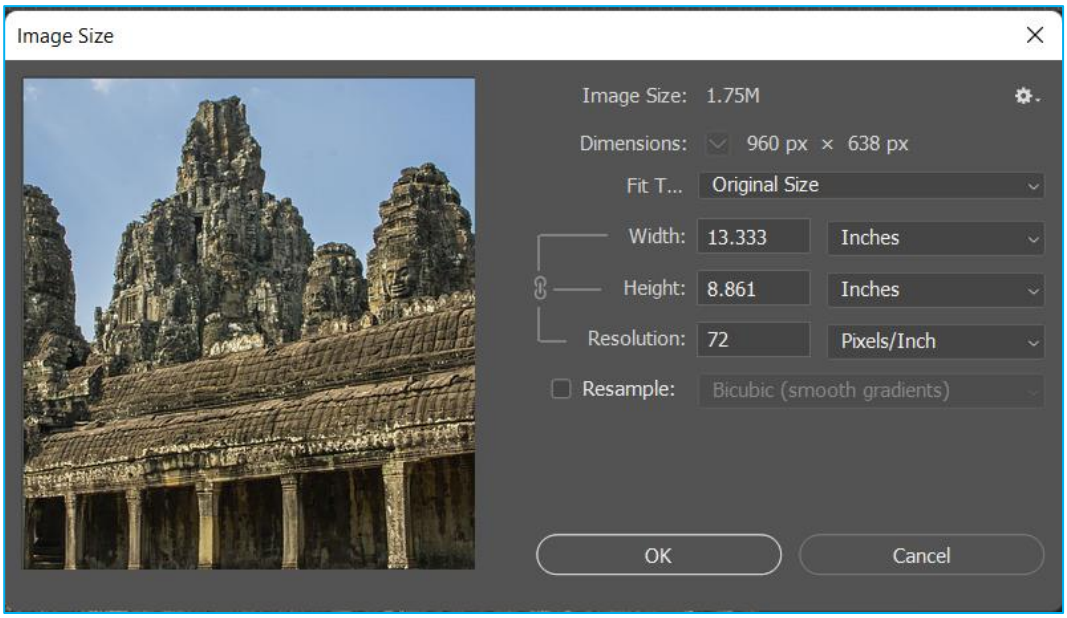


Figure 7.3: Modify Image Properties

- **Dimension:** To change the unit of measurement for the pixel dimension, click the triangle next to **Dimensions** and choose from the menu.
- **Fit To:** Using this option, you can:
  - Choose a preset to resize the image.
  - Choose Auto Resolution to resize the image for specific printing output. In the Auto Resolution dialog box, specify the Screen value and select **Quality**. You can change the unit of measurement by choosing from the menu to the right of the Screen text box.

- **Constrain:** To maintain the original width ratio to height measurement, ensure that the Constrain Proportions option is enabled. If you want to scale the width and height independently of each other, click the Constrain Proportions icon (link icon) to unlink them. You can change the unit of measurement for width and height by choosing from the menus to the right of the Width and Height text boxes.
- **Width/Height:** Enter values for Width and Height. To enter values in a different unit of measurement, choose from the menus next to the **Width** and **Height** text boxes. The new image file size appears at the top of the **Image Size** dialog box, with the old file size in parentheses.
- **Resolution:** To change the Resolution, enter a new value. (**Optional**) You can also choose a different unit of measurement.

- **Resample:** To change the image size or resolution and allow the total number of pixels to adjust proportionately, make sure that **Resample** is selected, and if necessary, choose an interpolation method from the **Resample** menu. To change the image size or resolution without changing the total number of pixels in the image, deselect **Resample**.

4. If your image has layers with styles applied, select **Scale Styles** from the gear icon to scale the effects in the resized image. This option is available only if you select the **Constrain Proportions** option.
5. When you finish setting options, click **OK**.

   To restore the initial values displayed in the **Image Size** dialog box, choose **Original Size** from the **Fit To** menu or hold down **Alt** (**Windows**) or **Option** (**macOS**), and click **Reset**.

7.2.2. Color Mode

Different color modes:

1. RGB mode (millions of colors)
2. CMYK mode (four-printed colors)
3. Index mode (256 colors)
4. Grayscale mode (256 grays)
5. Bitmap mode (2 colors)

The color mode or image mode determines how colors combine based on the number of channels in a color model. Different color modes result in different levels of color detail and file size. For instance, use **CMYK** color mode for images in a full-color print brochure, and use **RGB** color mode for images in web or email to reduce file size while maintaining color integrity.

RGB Color Mode

The color mode or image mode determines how colors combine based on the number of channels in a color model. Different color modes result in different levels of color detail and file size. For instance, use **CMYK** color mode for images in a full-color print brochure and **RGB** color mode for images on the web or email to reduce file size while maintaining color integrity.

RGB images use three colors, or channels, to reproduce colors on screen. In 8-bit-per-channel images, the three channels translate to 24 (8 bits x 3 channels) bits of color information per pixel. With 24-bit images, the three channels can reproduce up to 16.7 million colors per pixel. With 48-bit (16-bits-per-channel) and 96-bit (32-bits-per-channel) images, even more colors can be reproduced per pixel. In addition to being the default mode for new Photoshop images, the RGB model is used by computer monitors to display colors. This means that when working in color modes other than RGB, such as CMYK, Photoshop converts the CMYK image to RGB for display on the screen.

Although RGB is a standard color model, the exact range of colors represented can vary depending on the application or display device. The RGB color mode in Photoshop varies according to the working space setting specified in the Color Settings dialog box.

CMYK Color Mode

In the **CMYK** mode, each pixel is assigned a percentage value for each process ink. The lightest (highlight) colors are assigned small percentages of process ink colors; the darker (shadow) colors have higher percentages. For example, a bright red might contain 2% cyan, 93% magenta, 90% yellow, and 0% black. In CMYK images, pure white is generated when all four components have values of 0%.

Use the **CMYK** mode when preparing an image to be printed using process colors. Converting an RGB image into **CMYK** creates a color separation. If you start with an **RGB** image, it's best to edit first in **RGB** and then convert to **CMYK** at the end of your editing process. In **RGB** mode, you can use the Proof Setup commands to simulate the effects of a **CMYK** conversion without changing the actual image data. You can also use **CMYK** mode to work directly with **CMYK** images scanned or imported from high-end systems.

Although **CMYK** is a standard color model, the exact range of colors represented can vary depending on the press and printing conditions. The **CMYK** Color mode in Photoshop varies according to the working space setting specified in the Color Settings dialog box.

Lab Color Mode

The **CIE** L*a*b* color model (**Lab**) is based on the human perception of color. The numeric values in Lab describe all the colors a person with normal vision sees. Because Lab describes how a color looks rather than how much of a particular colorant is needed for a device (such as a monitor, desktop printer, or digital camera) to produce colors, **Lab** is considered a device-independent color model. Color management systems use **Lab** as a color reference to predictably transform a color from one color space to another color space.

The **Lab Color** mode has a lightness component (**L**) ranging from 0 to 100. In the Adobe Color Picker and Color panel, the component (green-red axis) and the b component (blue-yellow axis) can range from +127 to –128.

Lab images can be saved in Photoshop, Photoshop EPS, Large Document Format (PSB), Photoshop PDF, Photoshop Raw, TIFF, Photoshop DCS 1.0, or Photoshop DCS 2.0 formats. You can save 48-bit (16-bits-per-channel) Lab images in Photoshop, Large Document Format (PSB), Photoshop PDF, Photoshop Raw, or TIFF formats.

Grayscale Mode

Grayscale mode uses different shades of gray in an image. In 8-bit images, there can be up to 256 shades of gray. Every pixel of a grayscale image has a brightness value ranging from 0 (black) to 255 (white). In 16-and 32-bit images, the number of shades in an image is much greater than in 8-bit images.

Grayscale values can also be measured as percentages of black ink coverage (0% is equal to white, 100% to black).

Grayscale mode uses the range defined by the working space setting that you specify in the Color Settings dialog box.

Bitmap Mode

Bitmap mode uses one of two color values (black or white) to represent the pixels in an image. Images in Bitmap mode are called bitmapped 1-bit images because they have a bit depth of 1.

Duotone Mode

Duotone mode creates monotone, duotone (two-color), tritone (three-color), and quadtone (four-color) grayscale images using one to four custom inks.

Indexed Color Mode

Indexed Color mode produces 8-bit image files with up to 256 colors. Photoshop builds a color lookup table (CLUT) when converting to indexed color, storing and indexing the colors in the image. If a color in the original image does not appear in the table, the program chooses the closest one or uses dithering to simulate the color using available colors.

Although its palette of colors is limited, indexed color can reduce file size yet maintain the visual quality needed for multimedia presentations, web pages, and the like. Limited editing is available in this mode. For extensive editing, you should convert temporarily to RGB mode. Indexed color files can be saved in Photoshop, BMP, **DICOM** (Digital Imaging and Communications in Medicine), GIF, Photoshop EPS, Large Document Format (PSB), PCX, Photoshop PDF, Photoshop Raw, Photoshop 2.0, PICT, PNG, Targa®, or TIFF formats.

Multichannel Mode

Multichannel mode images contain 256 levels of gray in each channel and are useful for specialized printing. Multichannel mode images can be saved in Photoshop, Large Document Format (PSB), Photoshop 2.0, Photoshop Raw, or Photoshop DCS 2.0 formats.

These guidelines apply when converting images to Multichannel mode:

- Layers are unsupported and therefore flattened.
- Color channels in the original image become spot color channels in the converted image.
- Converting a CMYK image to Multichannel mode creates cyan, magenta, yellow, and black spot channels.
- Converting an RGB image to Multichannel mode creates cyan, magenta, and yellow spot channels.

- Deleting a channel from an RGB, CMYK, or Lab image automatically converts the image to Multichannel mode, flattening layers.
- To export a multichannel image, save it in Photoshop DCS 2.0 format.

7.2.3. About Color

In Adobe Photoshop, learn how colors are created and how they relate to each other, which helps you work more effectively.

Understanding Color

Knowing how colors are created and how they relate to each other lets you work more effectively in Photoshop. Instead of achieving an effect by accident, you will produce consistent results thanks to an understanding of basic color theory.

Primary Colors

Additive primaries are the three colors of light (red, green, and blue) that produce all the colors in the visible spectrum when added together in different combinations. Adding equal parts of red, blue, and green light produces white. The absence of red, blue, and green light results in black. Computer monitors are devices that use additive primaries to create color.

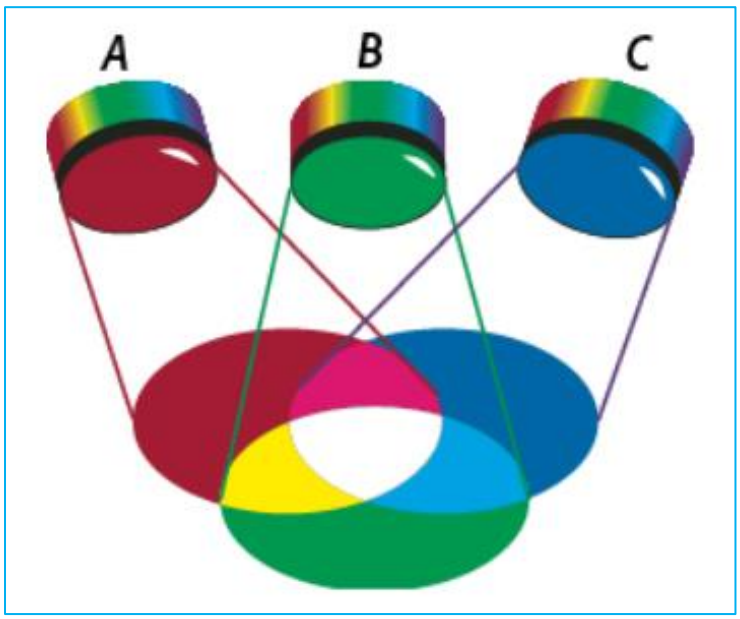


Figure 1.4: Additive Colors (RGB)

A. Red	B. Green	C. Blue

Subtractive primaries are pigments that create a spectrum of colors in different combinations. Unlike monitors, printers use subtractive primaries (cyan, magenta, yellow, and black pigments) to produce colors through subtractive mixing. The term "subtractive" is used because the primary colors are pure until you begin mixing them, resulting in colors that are less pure versions of the primaries. For example, orange is created through the subtractive mixing of magenta and yellow together.

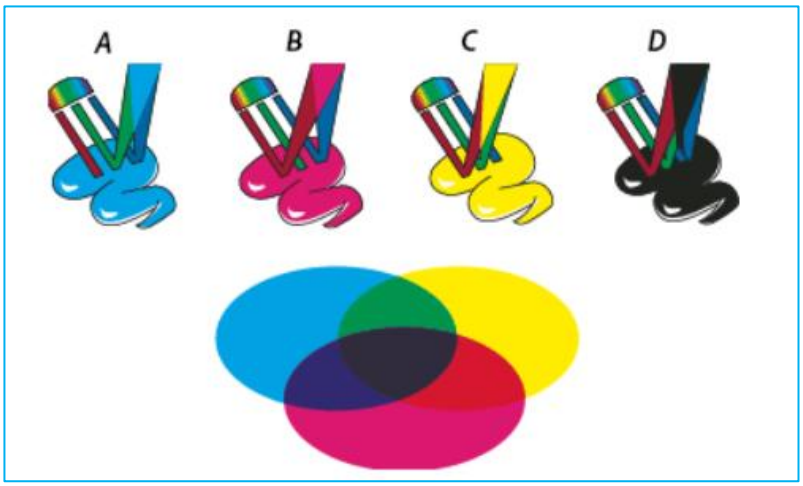


Figure 7.5: Subtractive Colors (CMYK)

A. Cyan	B. Magenta	C. Yellow	D. Black

The Color Wheel

If you are new to adjusting color components, it helps to keep a standard color wheel diagram on hand when you work on color balance. You can use the color wheel to predict how a change in one color component affects other colors and how changes translate between **RGB** and **CMYK** color models.

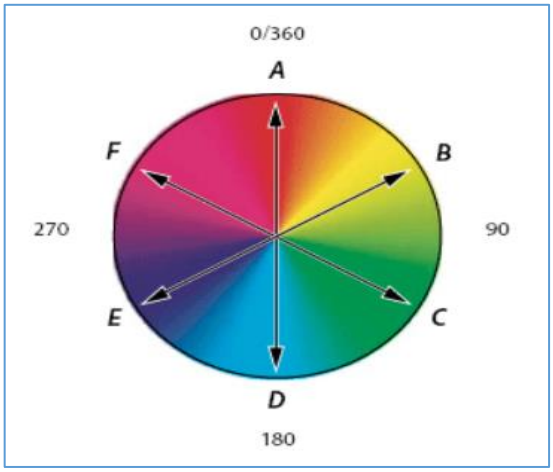


Figure 7.6: Color Wheel

A. Red B. Yellow C. Green D. Cyan E. Blue F. Magenta

Adjust Color Hue, Saturation and Brightness

Based on the human perception of color, the **HSB** model describes three fundamental characteristics of color:

- **Hue:** Color reflected from or transmitted through an object. It is measured as a location on the standard color wheel, expressed as a degree between 0° and 360°. In common use, hue is identified by the name of the color, such as red, orange, or green.
- **Saturation:** Strength or purity of the color (sometimes called **Chroma**). Saturation represents the amount of gray in proportion to the hue, measured as a percentage from 0% (gray) to 100% (fully saturated). On the standard color wheel, saturation increases from the center to the edge.
- **Brightness:** Relative lightness or darkness of the color, usually measured as a percentage from 0% (black) to 100% (white).

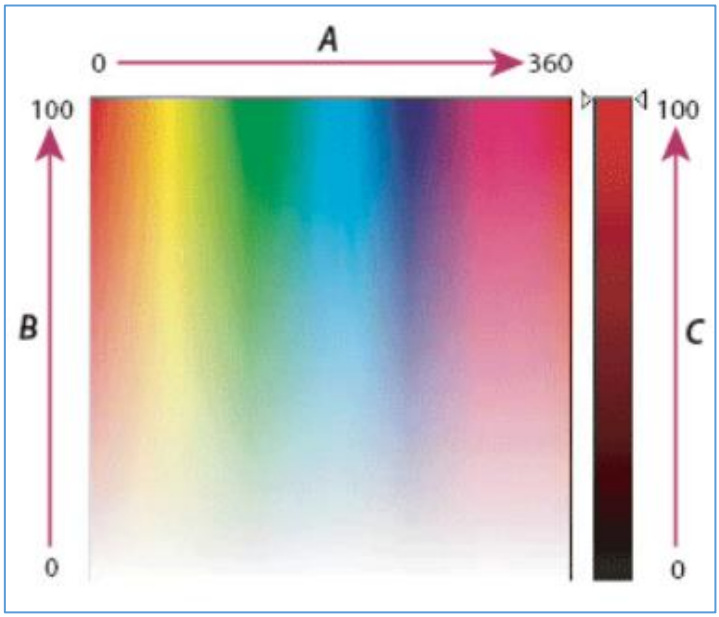


Figure 7.7: HSB Color Model

A. Hue B. Saturation C. Brightness

7.3. Image Adjustment

7.3.1. Levels Adjustment

You use the **Levels** adjustment to correct an image's tonal range and color balance by adjusting the intensity levels of image shadows, midtones, and highlights. The **Levels** histogram is a visual guide for adjusting the image key tones. You can save **Levels** settings as a preset, then apply them to other images.

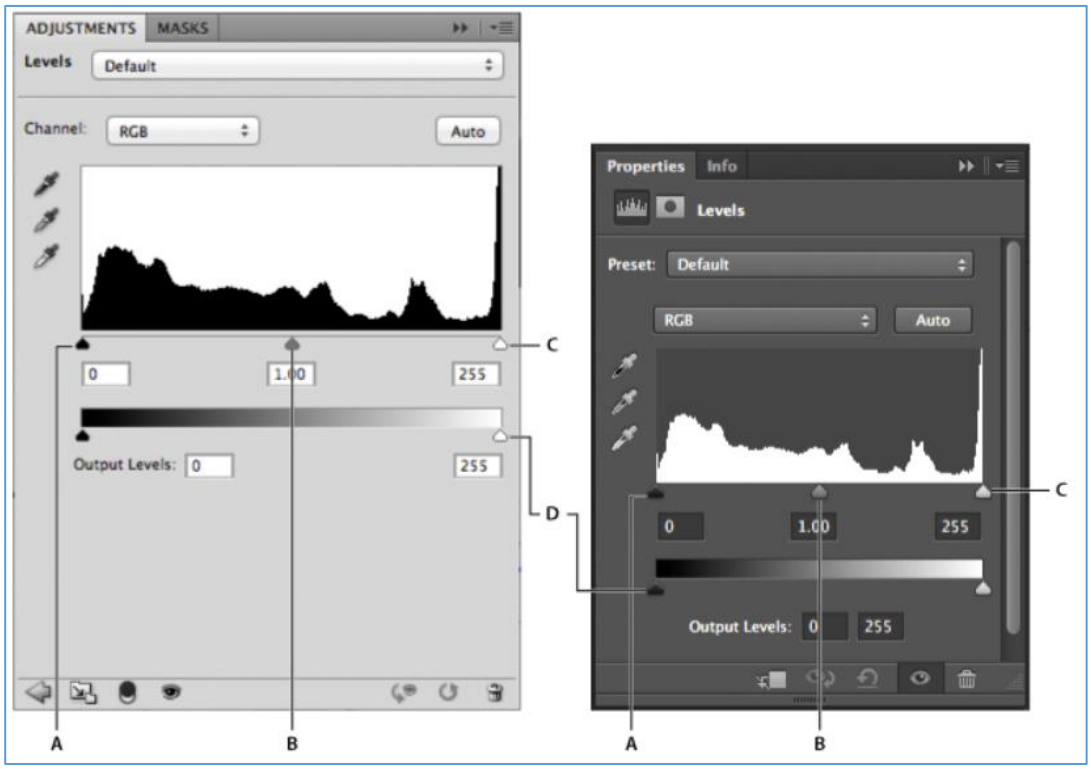


Figure 7.8: Adjusting Levels

A. Shadows B. Mudtones C. Highlight D. output Level Sliders

Adjust Tonal Range Using Levels

The outer two **Input Levels** sliders map the black point and white point to the settings of the **Output** sliders. By default, the **Output** sliders are at level 0, where the pixels are black, and level 255, where the pixels are white. With the **Output** sliders in the default positions, moving the black input slider maps the pixel value to level 0, and moving the white point slider maps the pixel value to level 255. The remaining levels are

redistributed between levels 0 and 255. This redistribution increases the image's tonal range, increasing the overall contrast of the image.

Note:

When shadows are clipped, the pixels are black, with no detail. When highlights are clipped, the pixels are white, with no detail.

The middle Input slider adjusts the gamma in the image. It moves the midtone (level 128) and changes the intensity values of the middle range of gray tones without dramatically altering the highlights and shadows.

1. Do one of the following:
   - Click the **Levels** icon  in the **Adjustments** panel, or choose **Levels** from the panel menu.
   - Choose **Layer ➔ New Adjustment Layer ➔ Levels**. Click **OK** in the **New Layer** dialog box.

Note:

Choosing **Image ➔ Adjustments ➔ Levels** makes direct adjustments to the image layer and discards image information.

2. (**Optional**) To adjust tones for a specific color channel, choose an option from the **Channel** menu.
3. (**Optional**) To edit a combination of color channels at the same time, **Shift**-select the channels in the **Channels** panel before choosing the **Image ➔ Adjustments ➔ Levels** command. (This method does not work in a **Levels** adjustment layer.) The **Channel** menu then displays the abbreviations for the target channels—for example, **CM** for cyan and magenta. The menu also contains the individual channels for the selected combination. **Edit** spot channels and alpha channels individually.
4. To adjust the shadows and highlights manually, drag the black and white **Input Levels** sliders to the edge of the first group of pixels at either end of the histogram. For example, if you move the black point slider to the right at level 5, Photoshop maps all the pixels at level 5 and lower to level 0. Similarly, if you

move the white point slider to the left at level 243, Photoshop maps all pixels at level 243 and higher to level 255. The mapping affects the darkest and lightest pixels in each channel. The corresponding pixels in the other channels are adjusted proportionately to avoid altering the color balance.

Note:

You can also enter values directly into the first and third **Input Levels** text boxes.

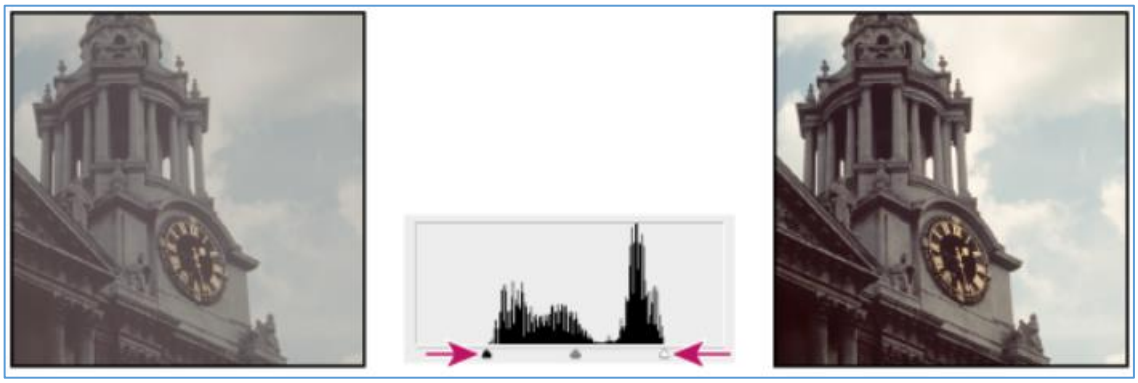


Figure 7.9: Adjusting Black and White Points with Levels Input Sliders

5. (**Optional**) To identify areas in the image that are being clipped (completely black or completely white), do one of the following:
   - Hold down **Alt** (**Windows**) or **Option** (**macOS**) as you drag the black and white point sliders.
   - Choose **Show Clipping for Black/White Points** from the panel menu.
6. To adjust midtones, use the middle Input slider to make a gamma adjustment. Moving the middle Input slider to the left makes the overall image lighter. This slider adjustment maps a lower (darker) level to the midpoint between the Output sliders. If the Output sliders are in their default position (0 and 255), the midpoint is level 128. In this example, the shadows expand to fill the tonal range from 0 to 128, and the highlights are compressed. Moving the middle Input slider to the right has the opposite effect, making the image darker.

Note:

You can also enter a gamma adjustment value directly in the middle Input Levels box.

Adjust Color Using Levels

If the image needs overall contrast because it doesn't use the full tonal range, click the **Levels** icon in the Adjustments panel. Then drag the Shadow and Highlight input sliders inward until they touch the ends of the histogram.

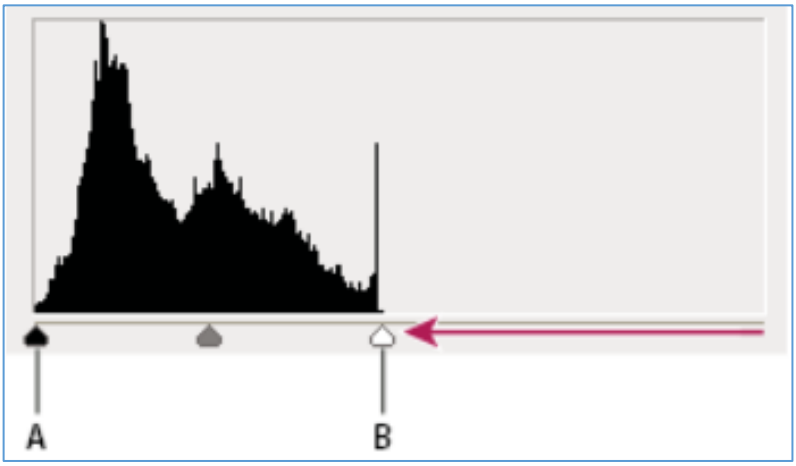


Figure 7.10: Contrast Levels

A. Shadow Input slider	B. Highlight Input slider

7.3.2. Adjust Shadow and Highlight Detail

The **Shadow/Highlight** command is one method for correcting photos with silhouetted images due to strong backlighting or correcting subjects that have been slightly washed out because they were too close to the camera flash. The adjustment can also be used for brightening areas of shadow in an otherwise well-lit image.

The **Shadow/Highlight** command does not simply lighten or darken an image; it lightens or darkens based on the surrounding pixels (local neighborhood) in the shadows or highlights. For this reason, there are separate controls for the shadows and the highlights. The defaults are set to fix images with backlighting problems.

The **Shadow/Highlight** command also has a **Midtone Contrast** slider, a **Black Clip** option, and White Clip option for adjusting the overall contrast of the image, and a Color Correction slider for adjusting saturation.

Adjust Image Shadow and Highlights

1. Choose **Image ➔ Adjustments ➔ Shadow/Highlight.**
   Make sure that the **Preview** option is selected in the dialog box if you want the image updated as you make adjustments.
2. Adjust the amount of lighting correction by moving the Amount slider or entering a value in the **Shadows** or **Highlights** percentage box. Larger values provide either greater lightening of shadows or greater darkening of highlights. You can adjust both **Shadows** and **Highlights** in an image.
3. For finer control, select Show More Options to make the additional adjustments.

Note:
To increase shadow detail in an otherwise well-exposed image, try values in the 0-25% range for Shadows Amount and Shadows Tonal Width.

4. (**Optional**) Click the **Save As Defaults** button to save your current settings and make them the default settings for the **Shadow/Highlights** command. Hold the Shift key while clicking the **Save As Defaults** button to restore the original default settings.
5. Click **OK**.

7.3.3. Adjust Color and Tone with Levels and Curves Eyedroppers

Set Black and White Points Using the Eyedropper Tools

Remember that using the eyedroppers undoes any previous adjustment you made in **Levels** or **Curves**. If you plan to use the eyedroppers, it is best to use them first and then fine-tune your adjustments with the Levels sliders or Curves points.

1. Apply a **Curves** or **Levels** adjustment.
2. In the **Properties** panel, do any of the following:
   - Double-click the Set Black Point eyedropper tool to set the black point.
   - Double-click the Set White Point eyedropper tool to set the white point.
3. In the **Adobe Color Picker**, determine the values you want for the darkest and lightest tones in the image:
   - To set the black point value to pure black, type 0 for R, G, and B.

- To set the white point value to pure white, type 255 for R, G, and B.
- To specify a shade of gray for either the black or white point, type identical values (between 0 and 255) for R, G, and B. The lower the values, the darker the gray. The higher the values, the lighter the gray.

4. Do one of the following to adjust the tonal areas to the black or white points you specified in Step 2:
   - With the **Set Black Point** eyedropper, click an image area that represents the black point (area with the lowest tonal values).
   - With the **Set White Point** eyedropper, click an image area that represents the white point (area with the lightest tonal values).

Color Correct Using Eyedroppers

You can use the eyedroppers in the **Levels** or **Curves** adjustment to correct a color cast, such as an unwanted tint from an excess color (red, green, blue, cyan, magenta, yellow). It's easier to color-balance an image by first identifying an area that you want to be neutral and then removing the color cast from that area. Depending on the image, you can use one or all three of the eyedroppers. The Set Gray Point eyedropper works best on images that don't require significant adjustments and have easily identified neutrals.

Keep in mind that using the eyedroppers undoes any previous adjustment you made in Levels or Curves. If you plan to use the eyedroppers, it's best to use them first and then fine-tune your adjustments with the Levels sliders or Curves points.

Note:

The eyedropper tool that sets the gray point  is used primarily for color correction and is unavailable when you work with grayscale images.

1. Before applying an adjustment, identify an area in the image that you want to be neutral gray. For example, a paved road.

Note:

Use a color sampler to mark a neutral area so that you can click it with an eyedropper later.

2. Click the **Levels** or **Curves** icon in the **Adjustments** panel.

3. In the **Properties** panel, double-click the **Set Gray Point** tool .
4. In the **Adobe Color Picker**, verify that the currently selected color has identical R, G, and B values for a neutral gray (for example, 128,128,128). If necessary, type the identical values for R, G, and B. Photoshop asks whether you want to save the new target color as a default.
5. With the **Set Gray Point** eyedropper tool, click the neutral area that you identified in Step 1. This should reset midtones and remove the color cast from the image.
6. (**Optional**) Make final **Levels** or **Curves** adjustments in the **Properties** panel.

7.3.4. Adjusting Hue and Saturation

Hue/Saturation lets you adjust the hue, saturation, and lightness of a specific range of colors in an image or simultaneously adjust all the colors in an image. This adjustment is especially good for fine-tuning colors in a **CMYK** image so that they are in the gamut of an output device.

Apply a Hue/Saturation Adjustment

1. Add an adjustment layer. Do one of the following:

   - Choose **Layer** è **New Adjustment Layer** è **Hue/Saturation in the menu bar.** Click **OK** in the **New Layer** dialog box.
   - In the **Adjustments** panel, click the **Hue/Saturation** icon.

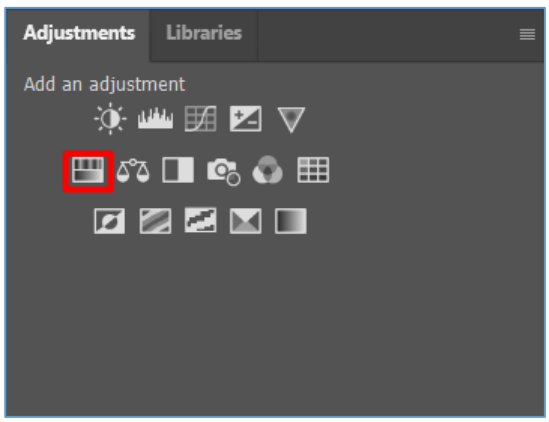


Figure 7.11: Adjustment Panel

You can also choose **Image ➔ Adjustments ➔ Hue/Saturation**. But keep in mind that this method makes direct adjustments to the image layer and discards image information.

2. In the **Properties** panel, choose the following options:
    - From the **Preset** menu, choose a **Hue/Saturation** preset.
    - From the menu to the right of the On-image adjustment tool
        - Choose Master to adjust all colors at once.
        - Choose one of the other preset color ranges listed for the color you want to adjust.

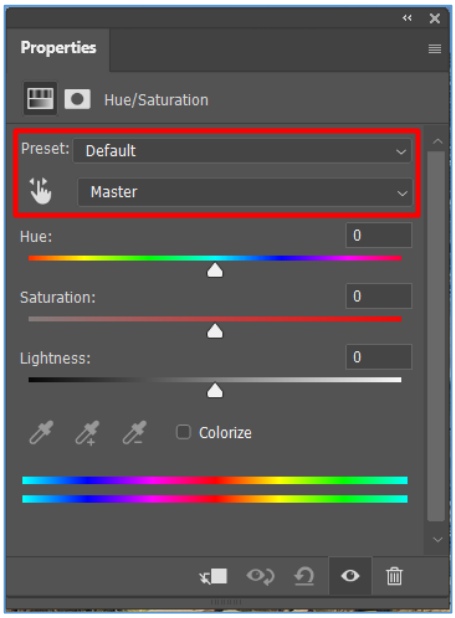


Figure 2.12: Hue/Saturation Adjustment Preset

3. To adjust the hue, do any of the following:
    - Drag the **Hue** slider or enter a value until you are satisfied with the colors. The values displayed in the box reflect the number of degrees of rotation around a color wheel from the original color of the pixel. A positive value indicates clockwise rotation; a negative value indicates counterclockwise rotation. Values can range from -180 to +180.
    - Select the On-image adjustment tool Then **Ctrl**-click (**Windows**) or **Command**-click (**macOS**) a color in the image and drag left or right in the image to modify the **Hue** value.
4. To adjust the saturation, do any of the following:

- Enter a value or drag the Saturation slider to the right to increase the saturation or to the left to decrease it.

  Values can range from -100 (percentage of desaturation, duller colors) to +100 (percentage of saturation increase).
- For Lightness, enter a value or drag the slider to the right to increase the lightness (add white to a color) or to the left to decrease it (add black to a color). Values can range from -100 (percentage of black) to +100 (percentage of white).

To undo a **Hue/Saturation** setting, click the reset button  at the bottom in the **Properties** panel.

Specify the Range of Colors Adjusted Using Hue/Saturation

1. Apply a **Hue/Saturation** adjustment.
2. In the **Properties** panel, choose a color from the menu to the right of the On-image adjustment button  .

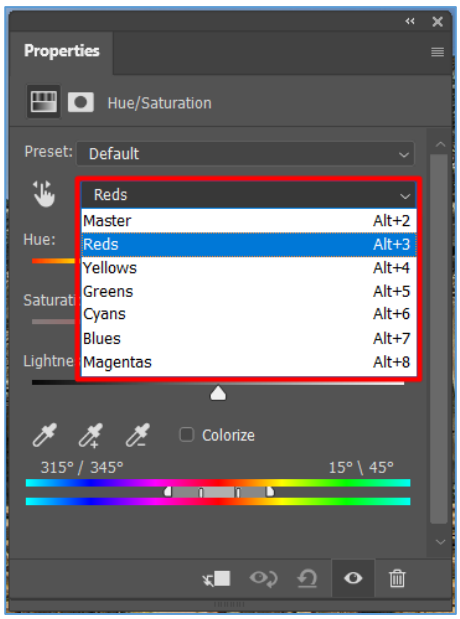


Figure 7.13: Specify Color Range

The adjustment sliders and their corresponding color wheel values (in degrees) appear between the two color bars.

- The two inner vertical sliders define the color range.

- The two outer triangle sliders show where the adjustments on a color range 'fall off' (fall-off is a feathering or tapering of the adjustments instead of a sharply defined on/off application of the adjustments).

3. Use either the eyedropper tools or the adjustment sliders to modify the range of colors.

7.3.5. Convert a Color Image to Black and White

Color photography is indispensable when colors and shades, or hues, in your image are distinctive and vivid, allowing you to see even the most intricate details. Black and white photography is the better option when you want to focus on the subject and the textures in an image without being distracted by colors. Black and white effects can help bring out the drama in your images.

Figure 7.14: Color Image Convert to Black and White

To easily convert a color image to black and white with the **Black & White** adjustment layer in Photoshop, follow the quick steps below:

1. Convert your image to black and white with the **Black & White** adjustment layer

   To access the **Black & White** adjustment layer, do one of the following:

   - Select **Window ➔ Adjustments**. Click the **Black & White** icon ( ) in the **Adjustments** panel that opens.
   - Choose **Layer ➔ New Adjustment Layer ➔ Black & White**. In the **New Layer** dialog box, type a name for the adjustment layer and click **OK**.

2. (**Optional**) Fine-tune your results in the **Properties** panel

Preset: Select a predefined grayscale mix or a previously saved Custom mix. To save your custom mix, click the properties menu ( ) icon and select **Save Black & White Preset.**

Auto: Sets a grayscale mix based on the color values of your image. The Auto mix often produces excellent results or can be used as the starting point for tweaking gray values using the color sliders.

Tint: To apply a color tone, enable **Tint**. Click the color swatch to open the Color Picker and select the tint color.

Color sliders: Adjust the gray tones of a specific color in your image. Drag a slider left to darken or right to lighten the gray tones corresponding to the original color of the image.

- To adjust colors directly on the canvas, use the On-image adjustment tool ( ). Click on the image and drag left (darken) or right (lighten) to modify the color slider for the corresponding color(s) at that location.
- Click the Reset ( ) icon to reset the adjustment defaults.

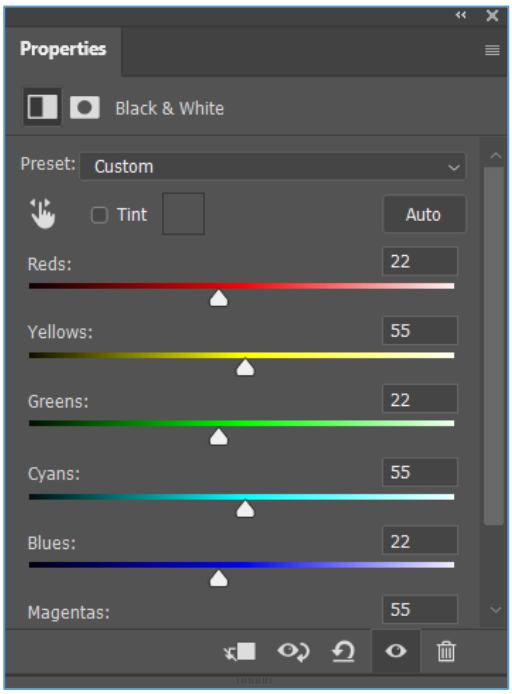


Figure 7.15: Black & White Adjustment Layer Properties

3. Save and share your results

Summary

In this chapter, you have learned:

The Color box in the Tools panel displays the current foreground/background colors and is called the Color Picker. To adjust the foreground color, click the Foreground square and tune the color in the Color Picker. To adjust the background color, click on the Background square and use the Color Picker.

The color mode, or image mode, determines how the components of a color are combined based on the number of color channels in the color model. Color modes include grayscale, RGB, and CMYK, among others. Photoshop Elements supports bitmap, grayscale, indexed, and RGB color modes.

Image adjustment generally includes level, contrast, gamma, hue, saturation, and brightness modification. These tools can be used to fix an overexposure image, correct the color, and improve the brightness. Proper adjustment can also facilitate other image processing.

Questions

1) What are Color boxes in Photoshop?
2) What are foreground and background? How are they different?
3) What is a Color mode?
4) What is the importance of Color mode?
5) What is the image adjustment?

Exercises

1) **Exercises 1:** Colouring exercise:
    1. Scan in a black-and-white line art comic strip or cartoon.
    2. Convert the file to RGB color.
    3. Create a new layer and use *Multiply* for the blending mode.
    4. Use the selection, painting, and fill tools to color the comic.
2) **Exercises 2:** Open your photo in Photoshop and change the color of your clothing.
3) **Exercises 3:** Open an image from your computer and convert it into black and white.

Additional Reading:

1) https://helpx.adobe.com/photoshop/user-guide.html
2) https://www.youtube.com/channel/UClH-KpveOLJszChWRfFmPfQ

Chapter 08

Using Adobe Photoshop 2021 (4)

Learning Objective:

This chapter aims to introduce the fundamental usage of Adobe Photoshop 2021. It provides an understanding of filters and effects, basic image editing, correcting an image, and saving, exporting, and printing documents from Photoshop.

After completing this chapter, students should be able to:

- Employ filters and effects
- Discover image editing
- Practice the correct image
- Use a valuable feature for saving and exporting documents
- Illustrate how you can print documents from Photoshop

In this chapter, you will learn about:

8.1. Filter and Effects

You can use filters to clean up or retouch your photos, apply special art effects that give your image the appearance of a sketch or impressionistic painting, or create unique transformations using distortions and lighting effects. The filters provided by Adobe appear in the Filter menu. Some filters provided by third-party developers are available as plug-ins. Once installed, these plug-in filters appear at the bottom of the **Filter** menu.

Smart Filters, applied to **Smart Objects**, let you use filters non-destructively. **Smart Filters** are stored as layer effects in the **Layers** panel and can be readjusted anytime, working from the original image data in the **Smart Object**.

Choose the appropriate submenu command from the **Filter** menu to use a filter. These guidelines can help you in choosing filters:

- Filters are applied to the active, visible layer or a selection.
- For 8 bits per-channel images, most filters can be applied cumulatively through the Filter Gallery. All filters can be applied individually.
- Filters cannot be applied to Bitmap-mode or indexed-color images.
- Some filters work only on RGB images.
- All filters can be applied to 8-bit images.
- The following filters can be applied to 16-bit images: Liquify, Vanishing Point, Average Blur, Blur, Blur More, Box Blur, Gaussian Blur, Lens Blur, Motion Blur, Radial Blur, Surface Blur, Shape Blur, Lens Correction, Add Noise, Despeckle, Dust & Scratches, Median, Reduce Noise, Fibers, Clouds, Difference Clouds, Lens Flare, Sharpen, Sharpen Edges, Sharpen More, Smart Sharpen, Unsharp Mask, Emboss, Find Edges, Solarize, De-Interlace, NTSC Colors, Custom, High Pass, Maximum, Minimum, and Offset.
- The following filters can be applied to 32-bit images: Average Blur, Box Blur, Gaussian Blur, Motion Blur, Radial Blur, Shape Blur, Surface Blur, Add Noise, Clouds, Lens Flare, Smart Sharpen, Unsharp Mask, De-Interlace, NTSC Colors, Emboss, High Pass, Maximum, Minimum, and Offset.
- Some filters are processed entirely in RAM. You may get an error message if you do not have enough RAM to process a filter effect.

Apply a Filter from the Filter Menu

You can apply a filter to the active layer or a Smart Object. Filters applied to a Smart Object are non-destructive and can be readjusted at any time.

1. Do one of the following:
   - To apply a filter to an entire layer, ensure the layer is active or selected.
   - To apply a filter to an area of a layer, select that area.
   - To apply a filter non-destructively so you can change your filter settings later, select the Smart Object that contains the image content you want to filter.
2. Choose a filter from the submenus in the **Filter** menu. If no dialog box appears, the filter effect is applied.
3. If a dialog box or the **Filter Gallery** appears, enter values or select options, and then click **OK**.

Note:

Applying filters to large images can be time-consuming, but you can preview the effect in the filter dialog box. Drag in the preview window to center a specific area of the image. In some filters, you can click on the image to center it where you click. Click the + or – buttons under the preview window to zoom in or out.

Filter Gallery Overview

The **Filter Gallery** provides a preview of many of the special effects filters. You can apply multiple filters, turn on or off the effect of a filter, reset options for a filter, and change the order in which filters are applied. When you are satisfied with the preview, you can apply it to your image. Not all filters in the **Filter** menu are available in the **Filter Gallery**.

Display the Filter Gallery: Choose **Filter** ➔ **Filter Gallery**. Clicking a filter category name displays thumbnails of available filter effects.

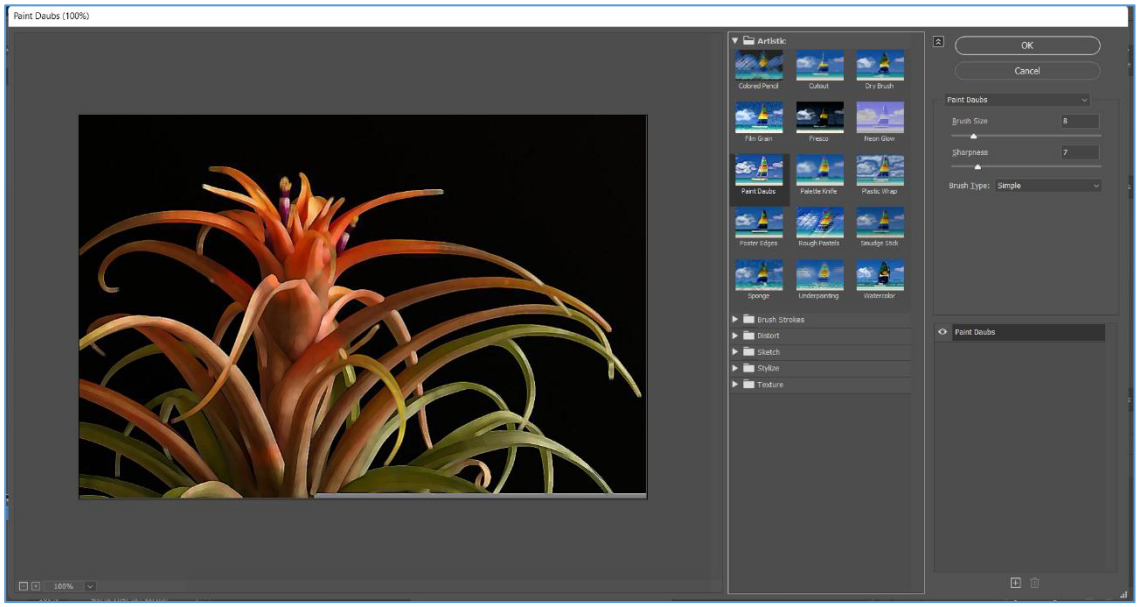


Figure 8.1: Filter Gallery Dialog Box

8.2. Basic Image Editing

Now that you know how to find your way around the Adobe Photoshop 2021 interface and are familiar with the most common commands, palettes, and tools, you can start doing some basic image editing. In the following few chapters of this tutorial, you will learn how to crop, resize, correct, and sharpen/blur your image.

8.2.1. Cropping

Cropping is one of the most basic editing techniques to improve your image. Cropping helps to highlight the most important features in your image and focus the viewer's attention on these features. Cropping also allows you to make your image a standard photo size.

There are several ways to crop images in Adobe Photoshop:

1. Cropping with the **Crop Tool**
2. Cropping to a specific size
3. Cropping with the **Marquee Tool**

Cropping with the Crop Tool

The Crop Tool allows you to make a precise selection of an image you wish to edit. To crop with the Crop Tool, follow these steps:

1. Open the image you wish to crop.
2. Select the **Crop Tool** from the Toolbox.
3. It will automatically select your entire image. Drag the edges to fit the dimensions you desire. (*See Figure 8.2*).

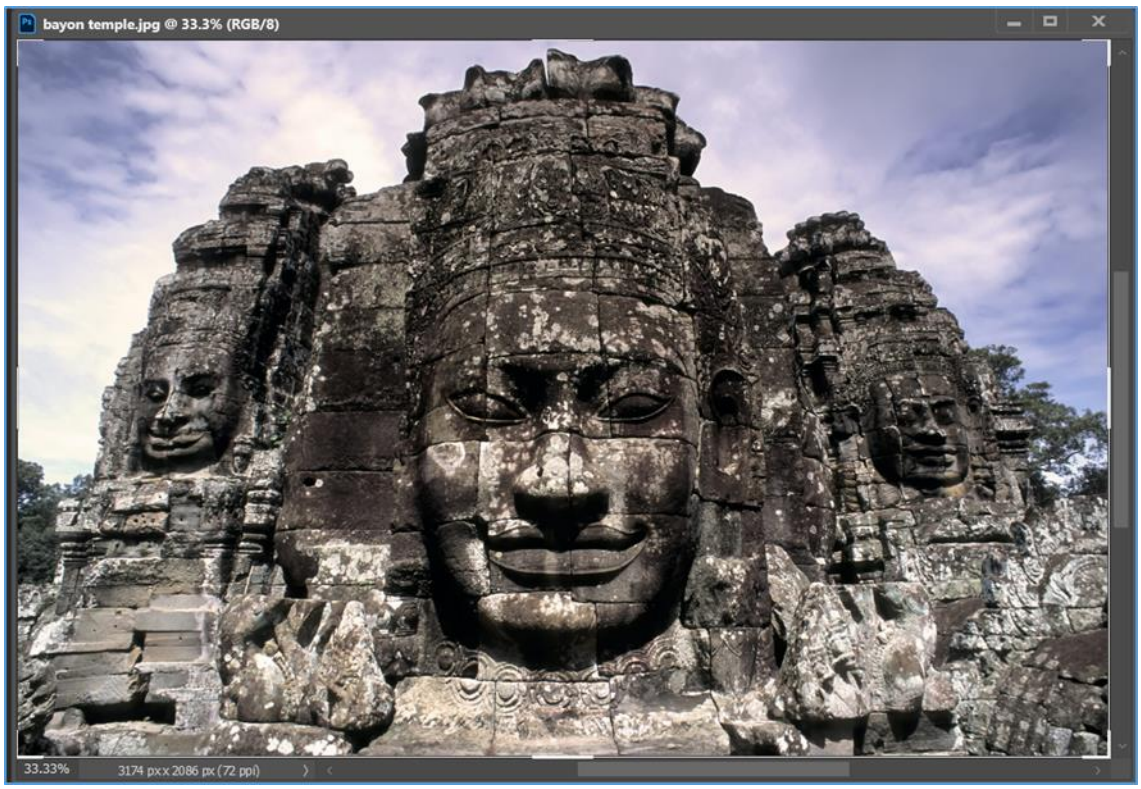


Figure 8.2: Cropping Border

4. Resize the border by dragging the squares at slides and corners until you are satisfied with the way your image looks.
5. Once you are completely satisfied with your cropped image, press **Enter**.

Note:

You can also rotate your cropping border. Move the cursor outside the border. You will see how it turns into a double-headed arrow (*See Figure 8.3*). Drag the arrows in the directions you wish to rotate your selection.

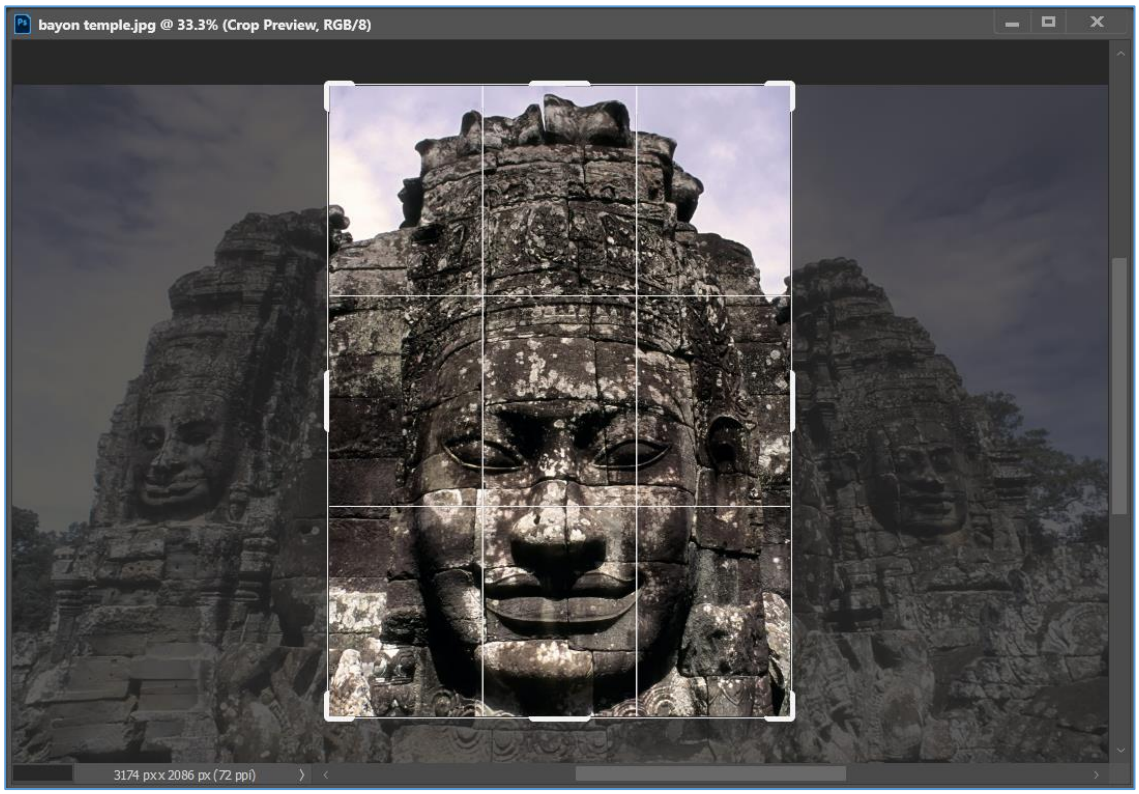


Figure 8.3: Rotating the Cropped Border

Cropping to a Specific Size

If you wish to print your digital photos or other images on standard-size photo paper, you must crop your images to a specific size, such as 8×10. To crop an image to a specific size, do the following:

1. Open the image you wish to crop.
2. Select the **Crop Tool** from the **Toolbox**.
3. In the **Options** bar, specify the value for **Width** and **Height** (*See Figure 8.4*).

Figure 8.4: Crop Tool Option Bar

4. Click on your image and drag the cropping border. Notice that the border is constrained. You cannot make it wider or longer than the specified values (*See Figure 8.5*). For example, if you entered 8 for **Width** and 10 for **Height**, whatever size you make the border, the area within it will fit on an 8×10 photo.

Figure 8.5: Cropping to a Specific Size

5. Once you are completely satisfied with your cropped image, press **Enter**.

Cropping with the Marquee Tool

If you are in a hurry and need a simple crop, you can use the **Marquee Tool** and a menu command. To crop with the **Marquee Tool**, follow the steps below:

1. Open the image you wish to crop.
2. Select the **Rectangular Marquee Tool** from the Toolbox.
3. Click and drag the mouse to draw a marquee around the area you wish to crop (*See Figure 8.6*).

Figure 8.6: Drawing a Marquee

4. In the main menu, go to **Image ➔ Crop** (*See Figure 8.7*). The image will be immediately cropped.

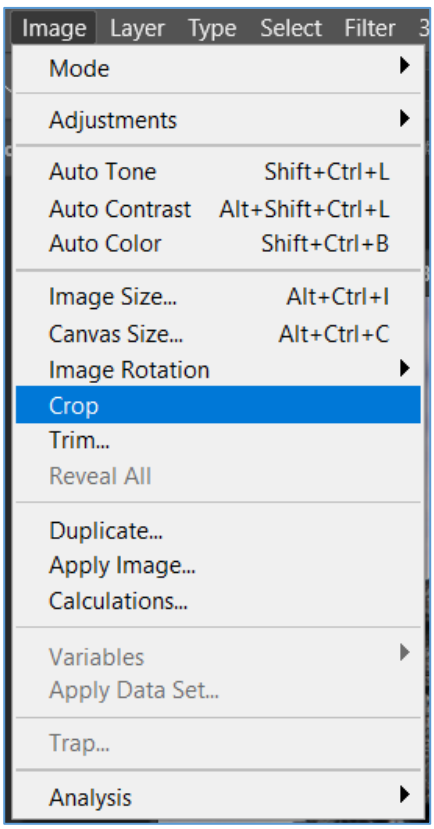


Figure 8.7: Image > Crop

8.2.2. Resizing

Resizing in Photoshop can help you print your images in standard photo sizes, resize and preserve the high quality of digital photos, and enlarge small images to poster size.

Resizing to a Specific Size

To resize your image to a preset size, follow the steps below:

1. In the main menu, go to **File ➔ New**.
2. In the **New** dialog box, click on the **Preset** dropdown menu. You will see several preset sizes, such as 2×3, 4×6, and 5×7. Remember that 72 ppi is fine for online images, but a ppi of 150-300 is better for printed images. (*See Figure 8.8*).

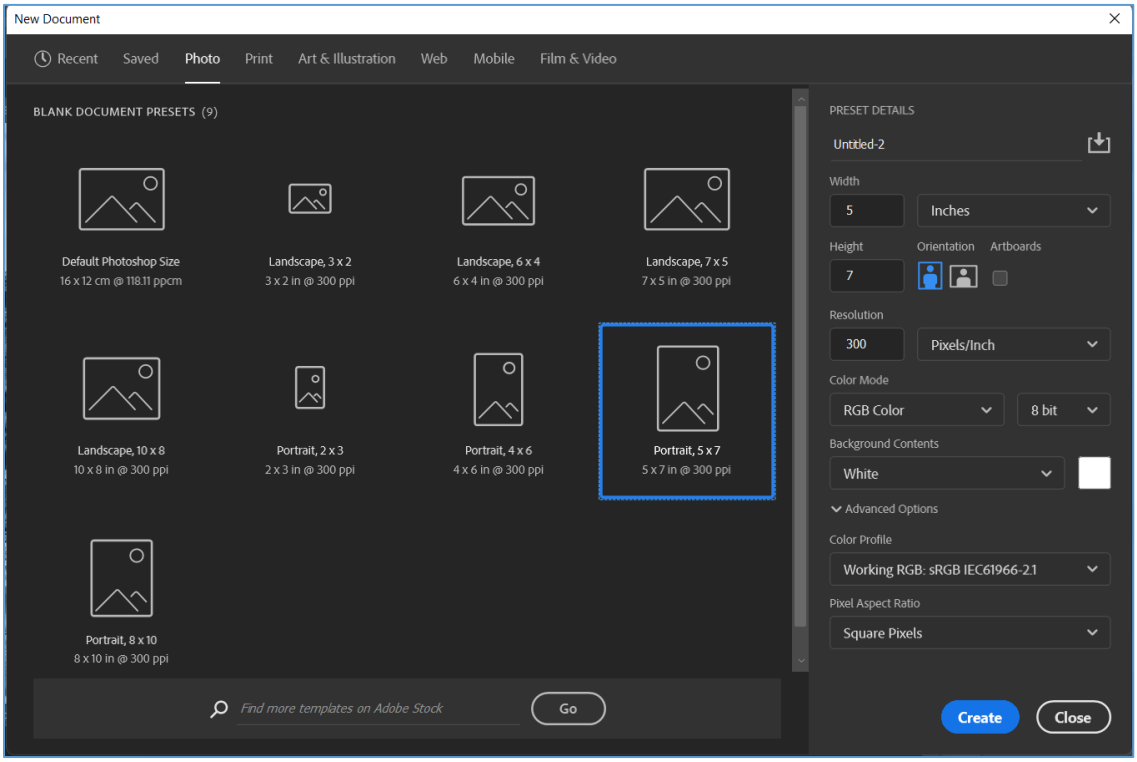


Figure 8.8: Preset Size in the New Dialog Box

3. Choose the size that you wish and click **Create**.

Note:

All the preset sizes are in portrait orientation. If you wish to resize an image with the landscape orientation, you need to create your own preset. To create your own size, do the following:

1. Type in the values for **Width** and **Height**, for example, 7×5
2. Type in your desired resolution (150 ppi for high-quality prints, and 72 ppi is suitable for web images.)
3. Click the **Save Preset** button (*See Figure 8.9*).

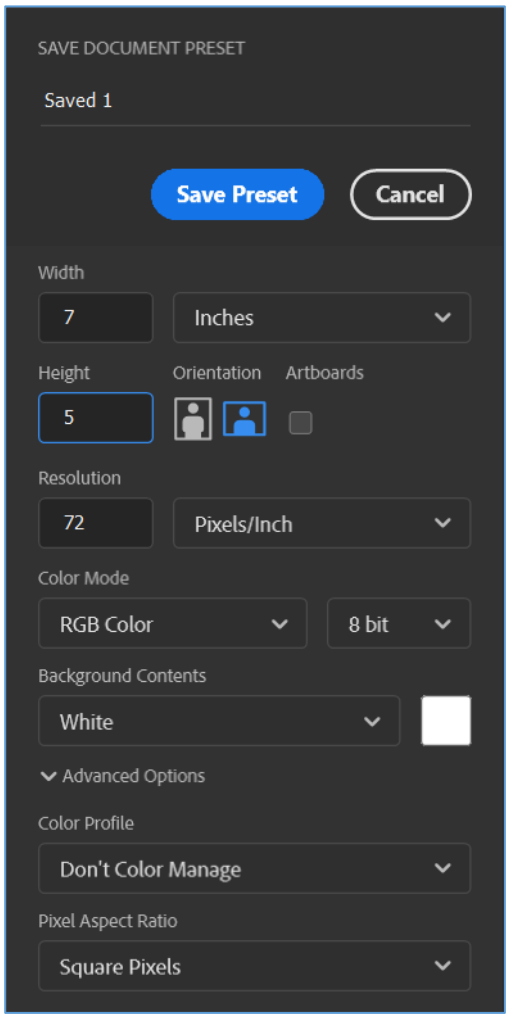


Figure 8.9: Save Preset

Resizing Digital Photos

Digital photos usually have large dimensions but low resolution, 72 ppi, which affects their quality when their size is decreased or increased. When printed, the photos with the changed size will look pixelated. To resize the digital photos without losing the quality, follow these steps:

1. Open the digital photo you wish to resize.
2. In the main menu, go to **View ➔Rulers**. You will see the dimension of your photo (*See Figure 8.10*).

Figure 8.10: Dimensions of a Digital Photo

3. In the main menu, go to **Image ➔ Image Size**.
4. In the **Image Size** dialog box, check the **Resample Image** box off (*See Figure 8.11*). Type in your desired resolution (anything between 150 and 300 ppi). The photo is now 21.18 × 13.907 inches.

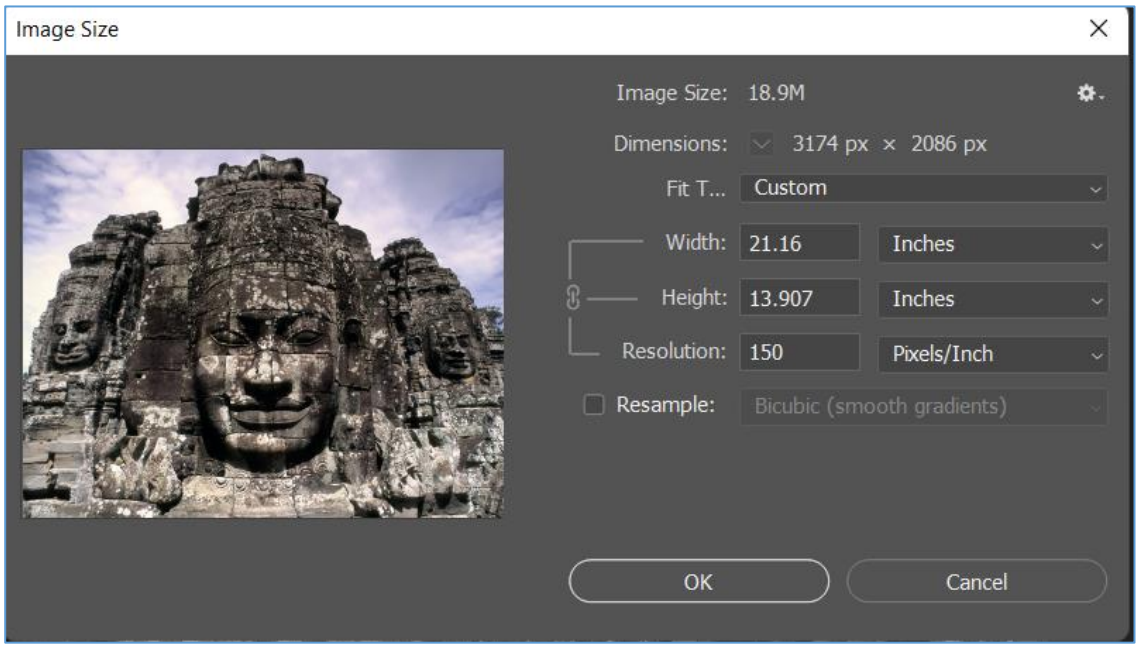


Figure 8.11: Changing Resolution

8.3. Correcting

Digital cameras tend to cause various problems, such as “red-eye” or “hot spots” if you use flash or underexposure if you do not. In Photoshop, you can correct these problems and adjust the overall color of your digital photo.

Red Eye Removal

The digital camera flash is located right above the lens, which causes the “red eye”. However, you can fix your photos easily in Photoshop. To remove the “red eye,” follow the steps below:

1. Open a photo you wish to correct.
2. Select the **Zoom Tool** from the **Toolbox**. Click and drag a rectangle around the eye (*See Figure 8.12*).

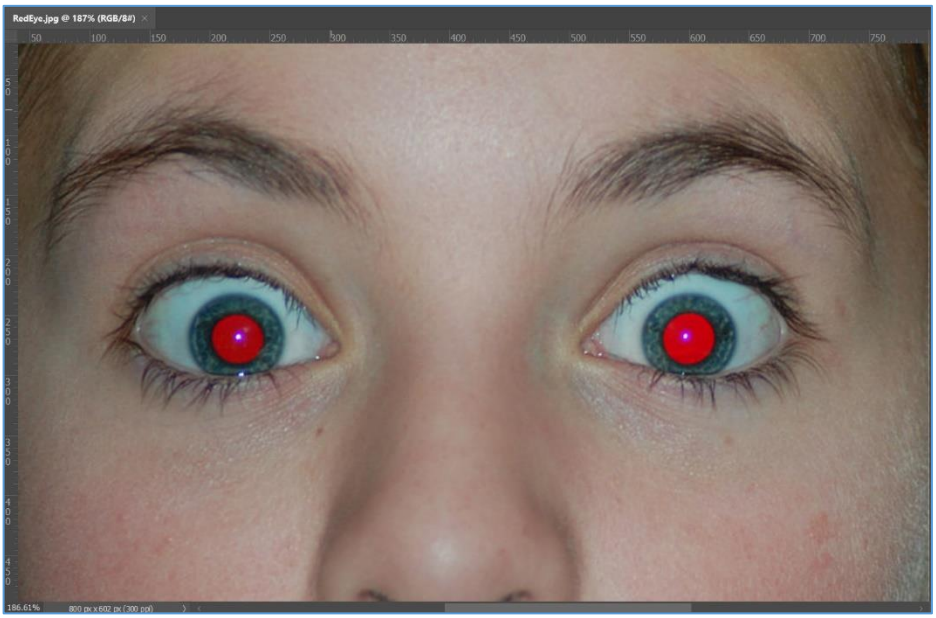
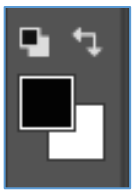


Figure 8.12: Rey Eye Photo

3. Make sure your default **Foreground** and **Background** colors are black and white.



4. Click and hold on to the little black triangle of the **Spot Healing Brush Tool** button and select the **Red Eye Tool** (*See Figure 8.13*).

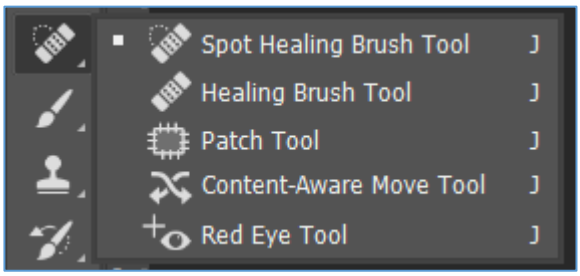


Figure 8.13: Red Eye Tool

5. Click on the red part of the eye and paint, holding down the mouse button. You will see how the red will disappear (*See Figure 8.14*).

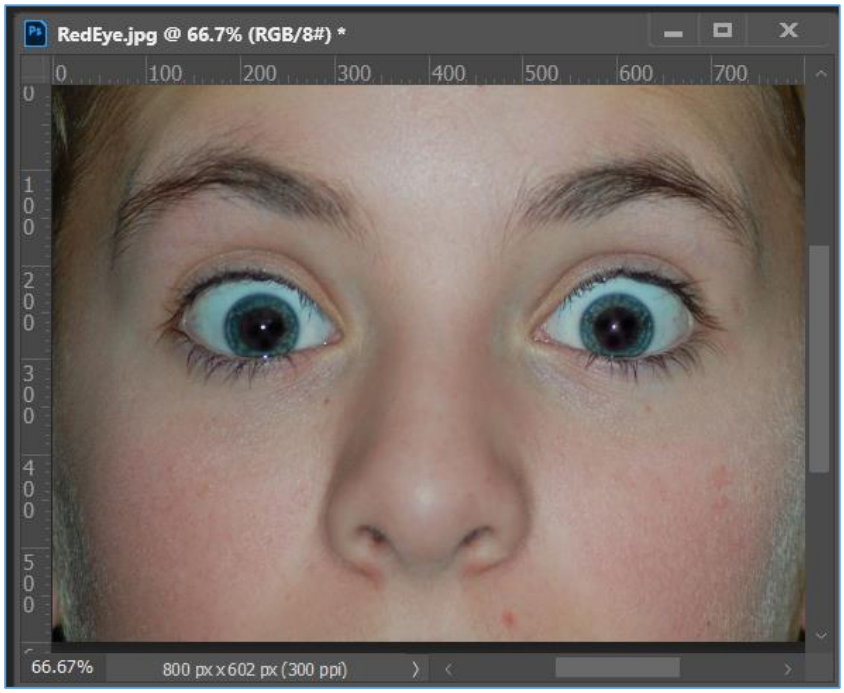


Figure 8.14: Red Eye Corrected

Hot Spot Removal

Using a flash can also cause shiny areas on people's faces or the flash to reflect on shiny surfaces. To correct this problem, follow the steps below:

1. Open the photo you wish to correct.
2. Select the **Clone Stamp Tool** from the **Toolbox**.
3. In the Options bar, change the **Blend Mode** from **Normal** to **Darken** (*See Figure 8.15*).

Figure 8.15: Setting Options for Clone Stamp Tool

4. Set the **Opacity** to 50 percent.
5. Choose a soft-edged brush, and set the diameter to 40 or 50.
6. Hold down the **Shift** key and click in the clean area (without "hot spots") to get a sample of color (*See Figure 8.16*).

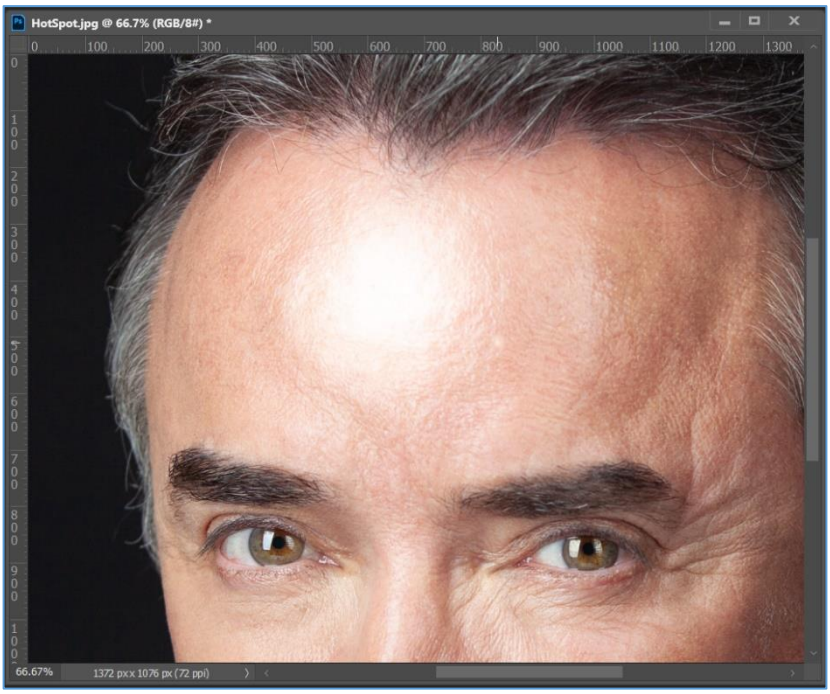


Figure 8.16: Clone Stamp Selection

7. Paint over the "hot spot." The light area will gradually darken (*See Figure 8.17*).

Figure 8.17: Corrected Image

Adding Flash

If you take pictures indoors without a flash, they will turn out underexposed and dark. To fix underexposed photos, follow these steps:

1. Open a digital photo you wish to correct (*See Figure 8.18*).

Figure 8.18: Underexposed Photo

2. In the main menu, go to **Layers ➔ Duplicate Layer**. In the next window, name the layer **Layer 1**.
3. Make sure **Layer 1** is selected in the Layers palette. Select **Image** from the menu, select **Adjustments,** and **Exposure** (*See Figure 8.19*). Select the amount of exposure. The whole image will lighten.

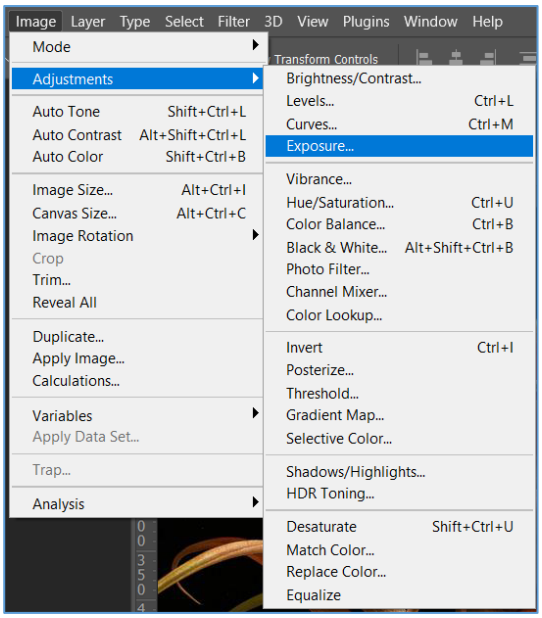


Figure 8.19: Changing the Blending Mode

4. Keep duplicating **Layer 1** until you are satisfied with your image (*See Figure 8.20*).

Figure 8.20: Corrected Photo

Color Adjustment

Color adjustment options in Photoshop 2021 can help you to make your digital photos look more natural. To color-correct your images, follow these steps:

1. Open the image you wish to correct.
2. In the main menu, go to **Image** ➔ **Adjustments** ➔ **Levels**. You will see a dialog box displaying a diagram of the colors in your image (*See Figure 8.21*). The black triangle is for shadows, the gray is for midtones, and the white is for highlights. In the **Channels** dropdown menu, you can choose between RGB. These indicate whether your changes affect all the colors or just one (red, green, or blue).

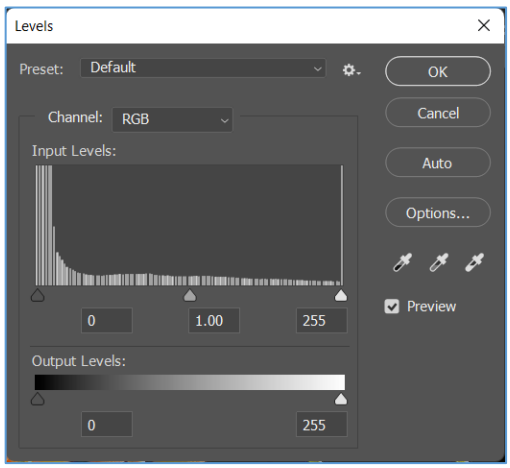


Figure 8.21: Levels Dialog Box

3. Make sure the **Preview** box is checked off. Choose the channel you wish to change and drag the triangles. Dragging the black triangle to the right will make the shadows in your photo darker. Dragging the white triangle to the left will make the highlights in your photo lighter, and dragging it to the right will make the midtones darker. You will be able to see the changes in your image. *Figure 8.22* shows an underexposed photo. By correcting the highlights and making the image lighter, we are able to make the photo appear much brighter (*See Figure 8.23*).

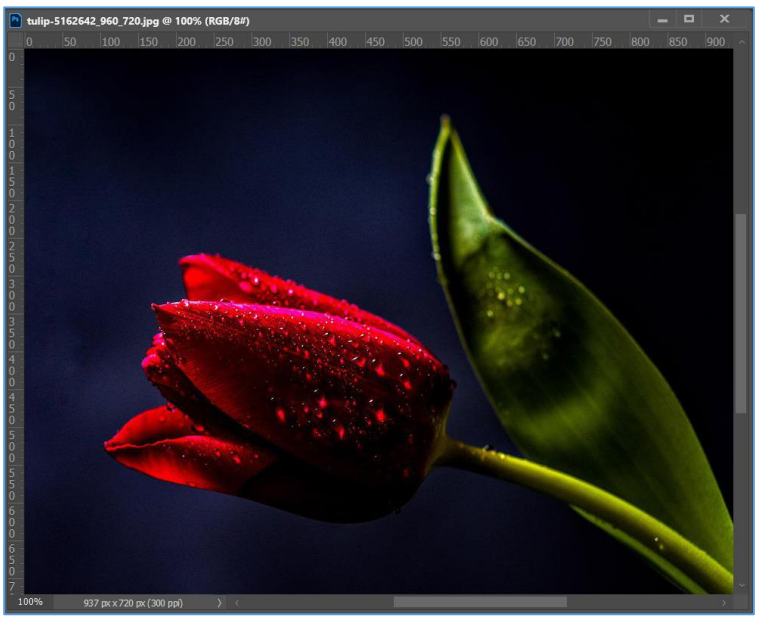


Figure 8.22: Underexposed Photo

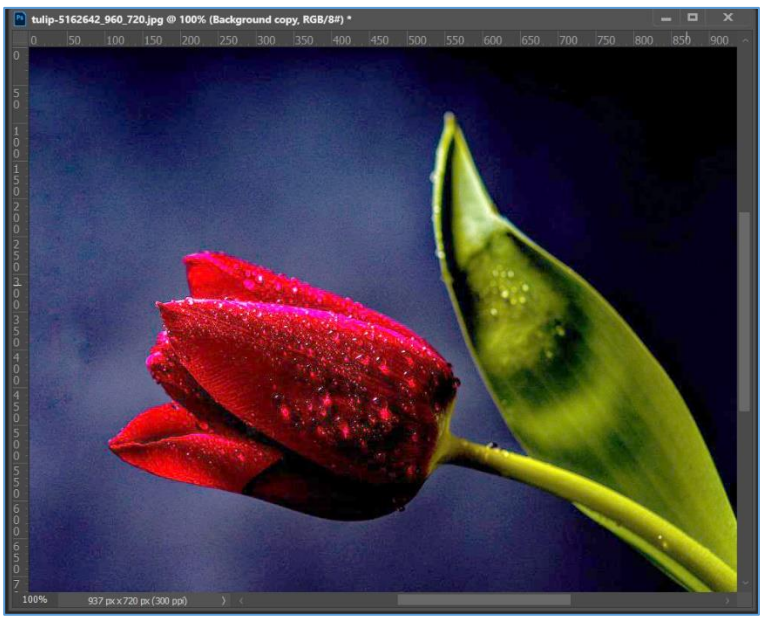


Figure 8.23: Corrected Photo

8.4. Saving and Exporting

Remember to save your work often. Saving frequently lessens the risk of losing the work you have been doing. To save your Photoshop document, do the following:

1. Click **File ➔ Save As**.
2. Navigate to the place you would like your document to be saved by using the drop-down menu and the navigation window.
3. Enter the name of your document in the **Save As** text field.
4. Choose a format to save your project in from the **Format** drop-down menu (*See Figure 8.24*).

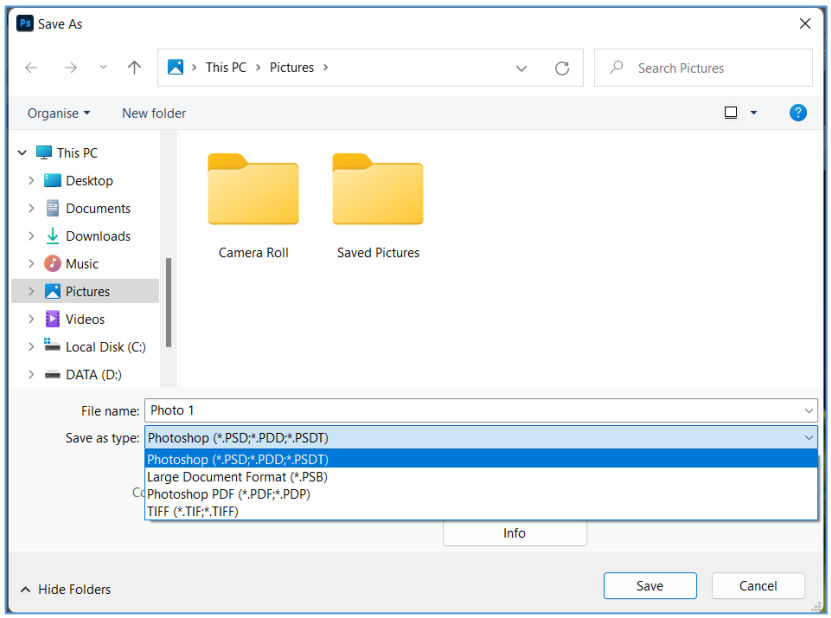


Figure 8.24: Saving a Document

5. Click the Save button in the button right corner of the dialogue box.
6. Check to ensure that your document is saved where you intended.

Note:

If you save your file as PSD (default Photoshop saving format), your layers will be preserved, but the file size will be large. If you save your file as JPEG (a common image format), your layers will be flattened and become one layer, and the file size will be significantly smaller.

Export Files in Different Sizes

You can export the selected layers, artboards, or documents as assets in multiple sizes using the **Export As** dialog.

To do so, follow these steps:

1. Click **File ➔ Export ➔ Export As**
2. In the left pane of the **Export As** dialog, select a relative asset size—for example, 1.25x.
3. Choose a suffix for the asset exported at the relative asset size. For example, @1,25x. Suffixes help you easily manage the exported assets.
4. Click the '+' icon to add more sizes and suffix for the exported assets.
5. For **File settings**, choose the file format, image size, and Canvas size.
6. Click the **Export** button.

The scaling options you choose are applied to all of your selected layers or artboards.

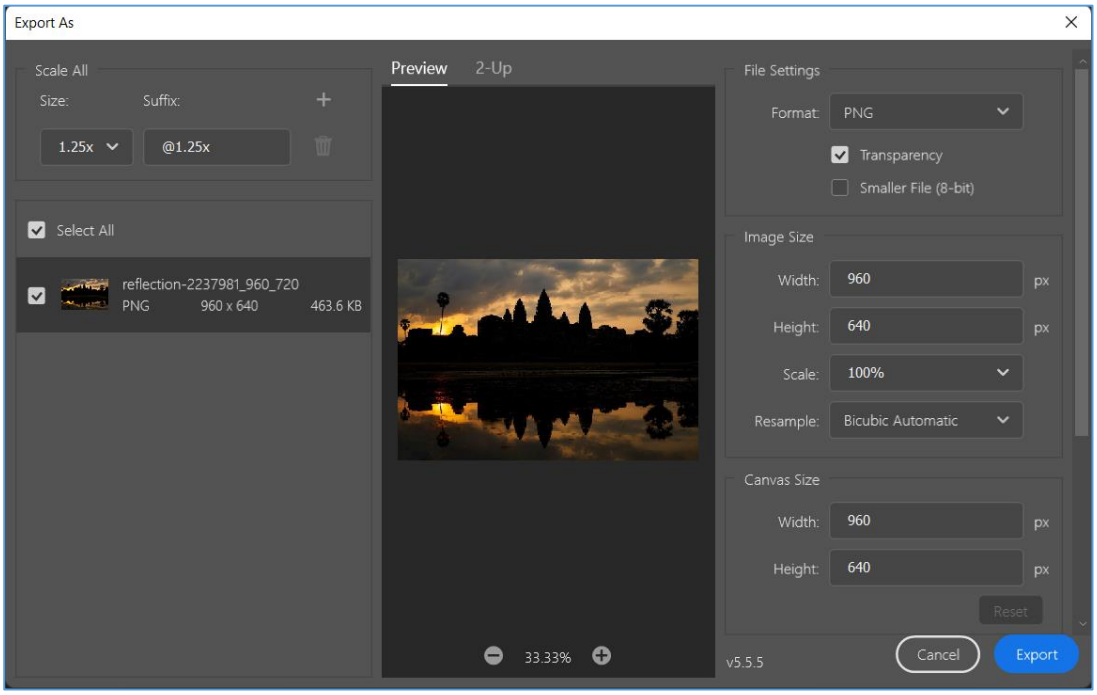


Figure 8.25: Export Different Sized Files Using the Export as Dialog

8.5. Printing

Photoshop provides the following printing commands in the **File menu**:

Print –Displays the Print dialog box, where you can preview the print and set options. (Customized settings are saved as new defaults when you click **Done** or **Print**.)

Print One Copy –Prints one copy of a file without displaying a dialog box.

Set Photoshop Print Options and Print

1. Click **File ➔ Print**
2. Select the printer, number of copies, and layout orientation.
3. In the preview area at left, visually adjust the position and scale of the image relative to the selected paper size and orientation. Alternatively, to the right, set detailed options for Position and Size, Color Management, Printing Marks, and so on.
4. Do one of the following:
    - To print the image, click **Print**.
    - To close the dialog box without saving the options, click **Cancel**.
    - To preserve the options and close the dialog box, click **Done**.

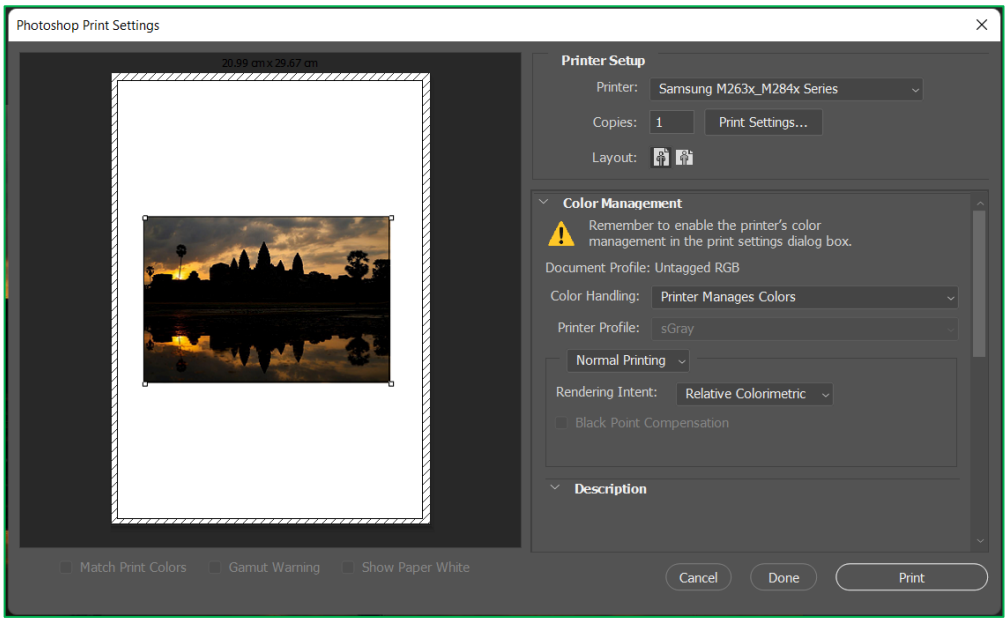


Figure 8.26: Photoshop Print Setting

Summary

In this chapter, you have learned:

You can use filters to clean up or retouch your photos, apply special art effects that give your image the appearance of a sketch or impressionistic painting, or create unique transformations using distortions and lighting effects. The filters provided by Adobe appear in the Filter menu. Some filters provided by third-party developers are available as plug-ins. Once installed, these plug-in filters appear at the bottom of the Filter menu.

Cropping is one of the most basic editing techniques to improve your image. Cropping helps to highlight the most significant features in your image and focus the viewer's attention on these features. Cropping also allows you to make your image a standard photo size.

Resizing in Photoshop can help you print your images in standard photo sizes, resize and preserve the high quality of digital photos, and enlarge small images to poster size.

Questions

1) What is the function of filter effects in Photoshop?
2) What is the purpose of the filter's effect on an image?
3) What are the two ways of applying filters in Photoshop?
4) What are three examples of filters in Photoshop?
5) What is image correction in Photoshop?
6) What are the correction tools in Photoshop?
7) How many types of images are supported by Photoshop?
8) Which Photoshop format is best for printing?

Exercises

1) **Exercises 1:** Open your photo in Photoshop and choose one of the filters in the gallery to apply to your photo.
2) **Exercises 2:** Change the image size. Open your image in Photoshop and do as following:
    1. Resize an image
    2. Set the resolution
    3. Crop and straighten an image
    4. Expand the canvas
3) **Exercises 3:** Adjust the image quality. Open your image in Photoshop and do as following:
    1. Adjust brightness and contrast
    2. Adjust color vibrance
    3. Adjust hue and saturation

Additional Reading:

1) https://helpx.adobe.com/photoshop/user-guide.html
2) https://www.youtube.com/channel/UClH-KpveOLJszChWRfFmPfQ

Chapter 09

HTML 5.0 and Installing and Setting up a Website in IIS on Windows 11

Learning Objective:

The objectives of this chapter are to introduce the concepts of HTML 5.0, installation and setup of a website in IIS on Windows 11. Likewise, this chapter will explain some languages used in website and what Internet Information Services (IIS) is.

After completing this chapter, students should be able to:

- Describe what HTML is
- Explain some languages used on a website
- Implement the installation and setup of a website in IIS on Windows 11

In this chapter, you will learn about:

9.1. Website

The Internet is accessible in almost every part of the world. In the last two decades, the Internet and the web have grown rapidly, and so have websites. If you go two decades back, the websites were very different. They were not at all attractive, of course, and most importantly, they were static. By static we mean that everything on a web page was fixed. However, nowadays websites are dynamic and generated by web applications.

9.1.1. Static and Dynamic Websites

On a static website, everything is fixed until someone changes it manually. Such websites are created using HTML and are the most straightforward part of website development. All the users visiting a static website have the same view. However, the content on a dynamic website can be different for every user. For example, amazon's homepage is a bit different for a signed-in user and a non-signed-in user. You can only see your account information, order history, and other info if you are signed in. It appears when you sign in with your credentials.

A dynamic website is linked with at least one database where all the dynamic information is stored. There is no such database in the case of static websites. User interaction is another essential part of a dynamic website.

HTML is used to create a static website. HTML is one of the core technologies of the World Wide Web (WWW). The other two technologies are CSS and JavaScript. You can also use CSS and JavaScript on a static website to make it more attractive and intractable. However, the central concept, i.e., data, is fixed and does not change. Nevertheless, using these three technologies more effectively, primarily JavaScript, can create beautiful, high-performing, dynamic websites.

We will discuss all these three technologies in depth after this chapter. However, before moving further, let us briefly discuss HTML, CSS, and JavaScript so you can have a better idea of what you will learn.

1) HTML

HTML stands for Hypertext Markup Language. It does not matter how big or complicated your website will be; you will always start with HTML. It is the standard language used to create structures for the web. While CSS and JavaScript have changed a lot over the years, the HTML of the 1990s and that of 2022s is not much different.

While Tim Berners-Lee wrote the first version of HTML v 1.0 in 1993, it has been revamped many times to provide more features and uses. HTML5 is the current version of HTML. We will learn more about HTML5 and its previous version, HTML4, in the following sections.

The basic structure of a web page is created using HTML. There are several HTML elements, and they are the building block of these pages. HTML elements are used in the form of tags. The tags are angular brackets with HTML names written inside them. For example, the HTML tag for the image is <img/>. Most of these tags have a closing tag like and . However, some tags, such as <img/>, do not require a closing tag. CSS and JavaScript are further applied to HTML to change its appearance and make it dynamic.

2) CSS

Cascading Style Sheets, commonly known as CSS, is a web page's presentation part. HTML creates a structure, and CSS converts it into an attractive, more readable version. No website is complete without CSS today. Users expect a website to be appealing, engaging, and above all, properly readable.

With CSS, you can change a page's font, color, size, positions, layout, and many more. There are multiple ways of using CSS in an HTML file, each having its own advantage.

3) JavaScript

JavaScript is considered the most crucial part of a website. It was the most popular language of the year 2019, according to StackOverflow insights. Most of the websites you visit are created using JavaScript. It is a scripting language that is used on the client-side as well as the server-side. Earlier, JavaScript could only run in a browser, but with the introduction of node.js, it can run outside too. Web frameworks and libraries such as

Angular, React, and Vue are built using JavaScript. As node.js, it is also used to create backend services.

9.1.2. The Differences between HTML 4.0 and HTML 5.0

1) What is HTML4?

HTML 4.0 is an iteration of the HTML 3.2 version. It offers many new features over its predecessors, such as style sheets, embedding objects, richer tables, object support, and more. Additionally, it is compatible with many web browsers. HTML 4 was one of the significant updates published as a W3C Recommendation in 1997.

An HTML 4 document starts with a DOCTYPE declaration and contains a HEAD and a BODY. Its elements have three parts: a start tag, content, and an end tag.

Table 9.1: Structure of HTML4 Document

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN"
      "http://www.w3.org/TR/html4/strict.dtd">
<html>
   <head>
         <title>Document title goes here</title>
    </head>
   <body>
         <h1>Main heading goes here</h1>
         <p>Paragraph content goes here</p>
    </body>
</html>
```

2) What is HTML5?

HTML5 is the fifth version of HTML. This version was released in 2014. With HTML5, there are new and advanced features. It allows developers to build animations and simple to complex applications that run on the browser.

HTML5 can help developers build web apps for Entertainment, Online streaming, Video players, Audio players, etc.

In the previous versions, for video playback and drag-and-drop features, users had to depend on third-party browser plug-ins like Adobe Flash. However, HTML5 offers all these features to the users along with many other new features and HTML attributes for building attractive websites. Almost all web browsers, including Google Chrome, Safari, Mozilla Firefox, Microsoft Edge, and mobile browsers, such as Android and iOS, support most of the HTML5 features.

Table 9.2: Structure of HTML5 Document

```
<!DOCTYPE HTML>
<html>
   <head>
      <meta charset="utf-8">
      <title>Document title goes here</title>
   </head>
   <body>
      <h1>Main heading goes here</h1>
      <p>Paragraph content goes here</p>
   </body>
</html>
```

3) HTML 4 vs HTML 5: Difference between HTML 4 and HTML 5

The following table depicts the main differences between HTML4 and HTML5.

Table 9.3: HTML 4 vs HTML 5

HTML4	HTML5
It is the fourth iteration of HTML.	It is the fifth iteration of HTML – an update over HTML4.
Lengthy Doctype declaration: <!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN" "http://www.w3.org/TR/html4/strict.dtd">	Simple Doctype declaration: <!DOCTYPE html>
These tags are not available in HTML4.	Comes with new HTML tags, including <audio>, <video>, <header>, <footer>, <canvas>, <article>, and more.
Multimedia supporting tags are not available.	Multimedia supporting tags are available.
Challenging for developers to handle inaccurate syntax errors.	It can handle inaccurate syntax errors.
The browser's cache is used to store essential data on the client-side.	HTML5 uses the web SQL database, web storage, and application cache to store offline data that can be accessed through HTML5's JavaScript interface.

9.2. Microsoft IIS (Internet Information Service)

A web server can deliver information to users in several forms, such as static webpages coded in HTML; through file exchanges as downloads and uploads; text documents, image files, and more.

Internet Information Services (**IIS**) is a flexible, general-purpose web server from Microsoft that runs on Windows systems to serve requested HTML pages or files.

An IIS web server accepts requests from remote client computers and returns the appropriate response. This basic functionality allows web servers to share and deliver information across local area networks (LAN), such as corporate intranets, and wide area networks (WAN), such as the Internet.

9.2.1. How IIS Works

IIS works through a variety of standard languages and protocols. HTML is used to create elements such as text, buttons, image placements, direct interactions/behaviors, and hyperlinks. The Hypertext Transfer Protocol (HTTP) is the basic communication protocol used to exchange information between web servers and users. HTTPS - HTTP over Secure Sockets Layer (SSL) - uses Transport Layer Security or SSL to encrypt communication for added data security. The File Transfer Protocol (FTP), or its secure variant, FTPS, can transfer files. Additional supported protocols include the Simple Mail Transfer Protocol (SMTP) to send and receive an email, and the Network News Transfer Protocol, to deliver articles on USENET.

9.2.2. History of IIS Version

Table 9.4: History of IIS Version

Version	Start Date	End Date
IIS 10 on Windows 11		
IIS 10 on Windows Server 2019	Nov 13, 2018	Jan 9, 2029
IIS 10 on Windows Server (Semi-Annual Channel)	Oct 17, 2017	

IIS 10 on Windows Server 2016	Oct 15, 2016	Jan 12, 2027
IIS 10 on Windows 10, Enterprise and Education	Jul 29, 2015	
IIS 10 on Windows 10 Pro	Jul 29, 2015	
IIS 8.5 on Windows Server 2012 R2	Nov 25, 2013	Oct 10, 2023
IIS 8.5 on Windows 8.1	Nov 13, 2013	Jan 10, 2023
IIS 8 on Windows Server 2012	Oct 30, 2012	Oct 10, 2023
IIS 7.5 on Windows 7*	Oct 22, 2009	Jan 14, 2020
IIS 7.5 on Windows Server 2008 R2*	Oct 22, 2009	Jan 14, 2020
IIS 7.0 on Windows Server 2008*	May 6, 2008	Jan 14, 2020
IIS 6.0 on Windows Server 2003	May 28, 2003	Jul 14, 2015

9.2.3. Features (IIS 10)

IIS 10 also adds several new features and functionality. IIS 10 adds support for the HTTP/2 protocol to offer more efficient resource use and lower latency compared to HTTP 1.1. IIS 10 works on the minimal server deployment model Nano Server under Windows Server 2016 and can run ASP.NET Core, Apache Tomcat, and PHP workloads on IIS on the Nano Server.

IIS 10 works in a container and virtual machine, so developers and administrators have more flexibility in deployment choices and the density to accommodate a broad range of web applications.

9.2.4. Installing IIS on Windows 11

There are several ways to install IIS on Windows 11. A method of installing IIS using a control panel will be described among them.

1. To start, click the Windows 11 search icon beside the Windows key in the Taskbar.
2. Type the word control panel in the Windows 11 search box.
3. From the result of your search, double-click on the Control Panel.

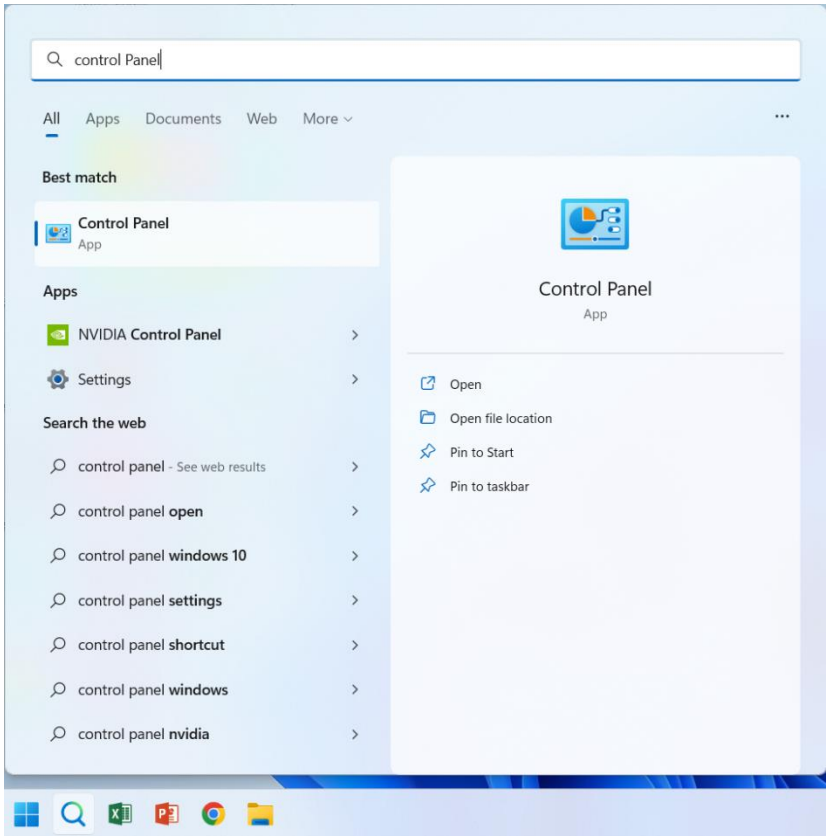


Figure 9.1: IIS Installation 1

4. In Control Panel, confirm that View is set in the Category option. If it is not on this option, click the drop-down and select Category.

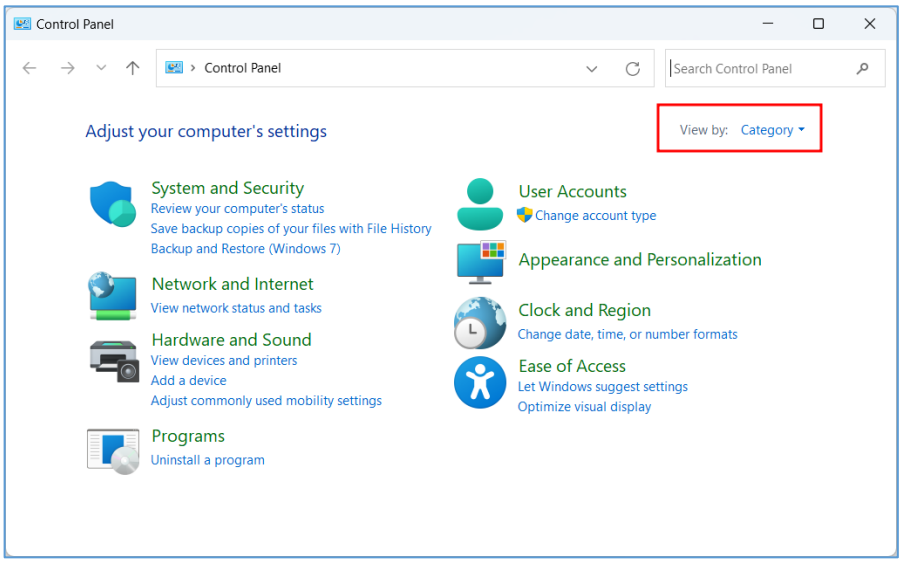


Figure 9.2: IIS Installation 2

5. Once that is done, click on Programs.

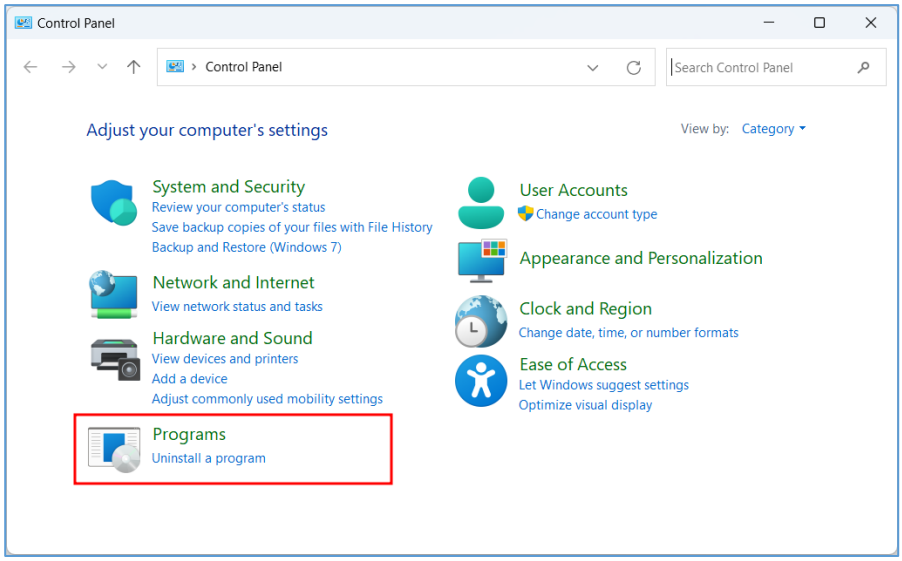


Figure 9.3: ISS Installation 3

6. When Programs opens, click on Turn Windows features on or off under the Programs and Features option. Clicking this will open a Windows Features pop-up menu.

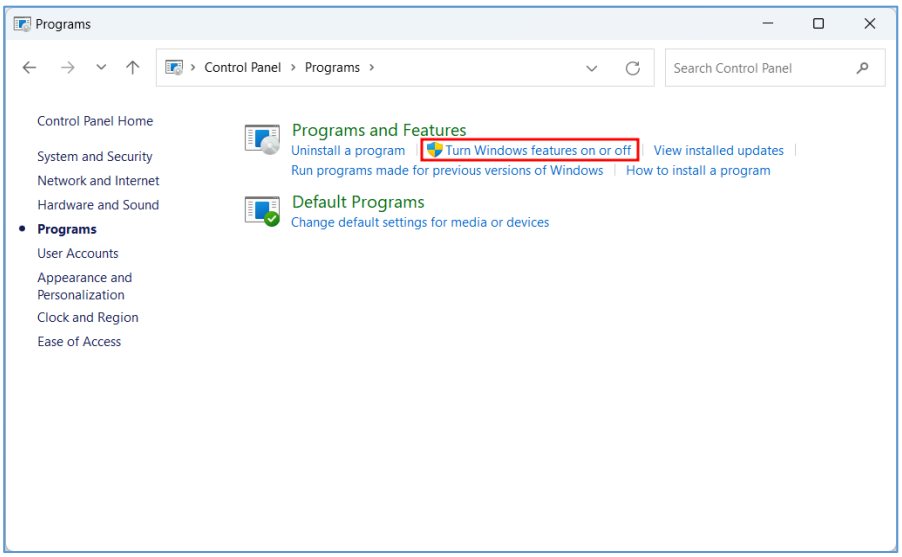


Figure 9.4: IIS Installation 4

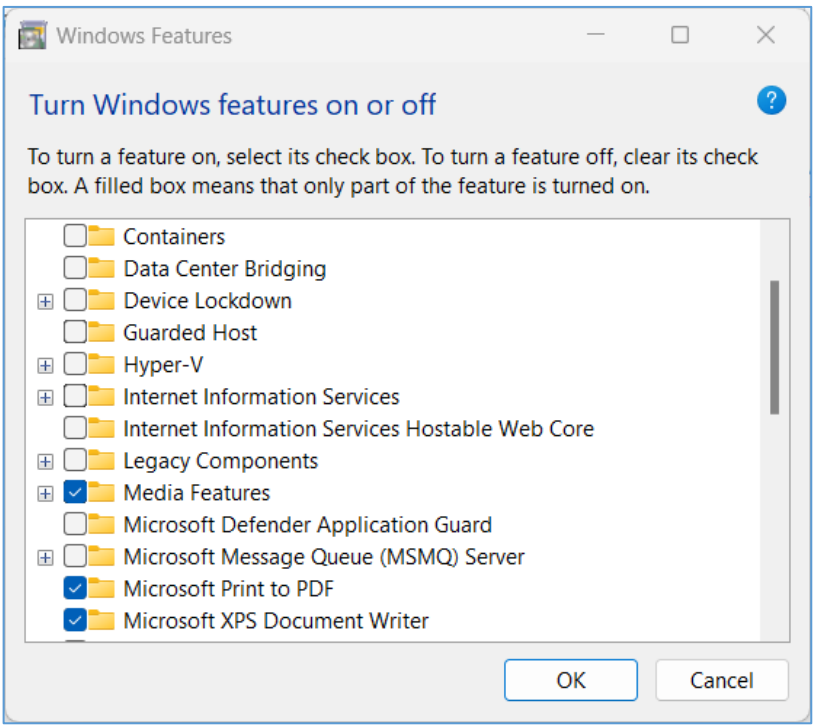


Figure 9.5: IIS Installation 5

7. On the Windows Features pop-up menu, locate the Internet Information Services option and click on the check box beside it. By clicking on the check box, you have checked the default sub-features in this option.

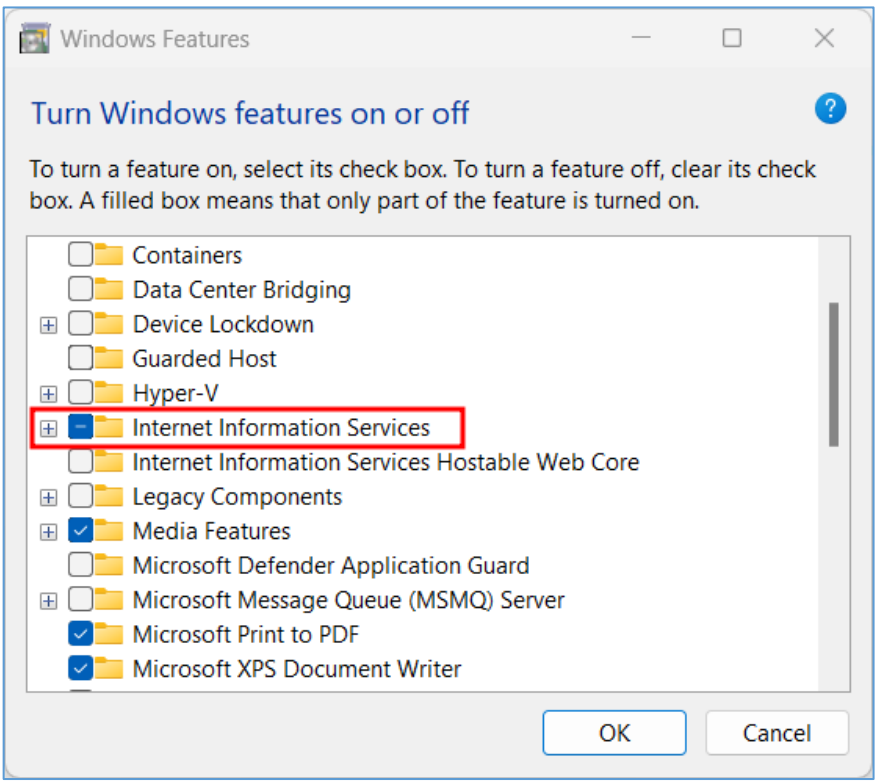


Figure 9.6: IIS Installation 6

8. While still on the Windows Features pop-menu, if you wish to customize the features in the Internet Information Services option, click on the + sign beside the check box. Furthermore, you can expand the 3-sub-features folders and check additional feature(s) you wish to add to the installation.
9. When you are done with your selection, click on the **OK** button to start the installation.

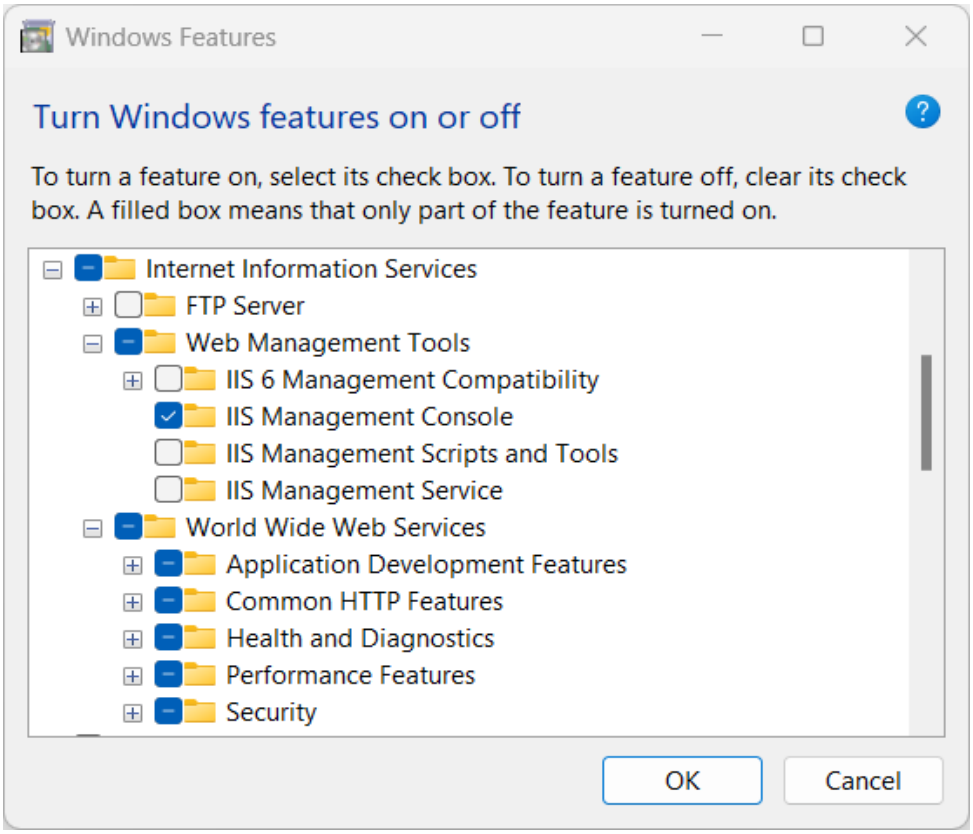


Figure 9.7: IIS Installation 7

10. The installation process will commence by searching for the required files.

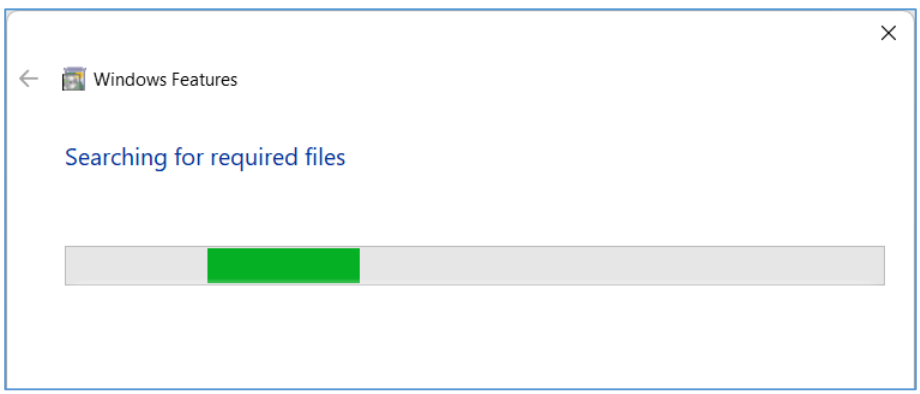


Figure 9.8: IIS Installation 8

11. Once the search is complete, the features will start applying. Here's what it looks like.

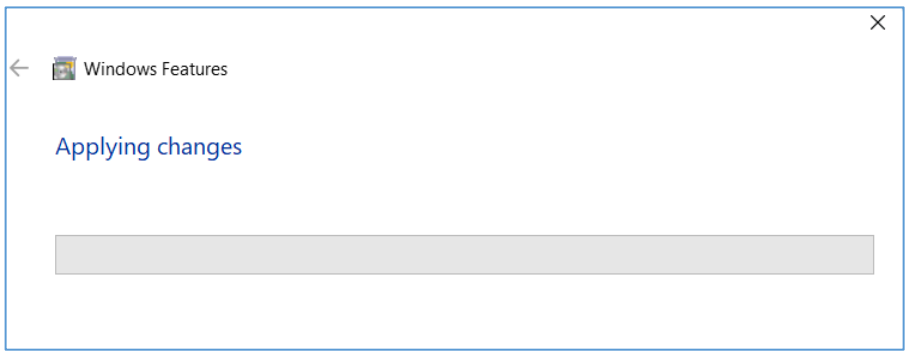


Figure 9.9: IIS Installation 9

12. When the installation is completed, click the Close button at the bottom right corner of the pop-up screen.

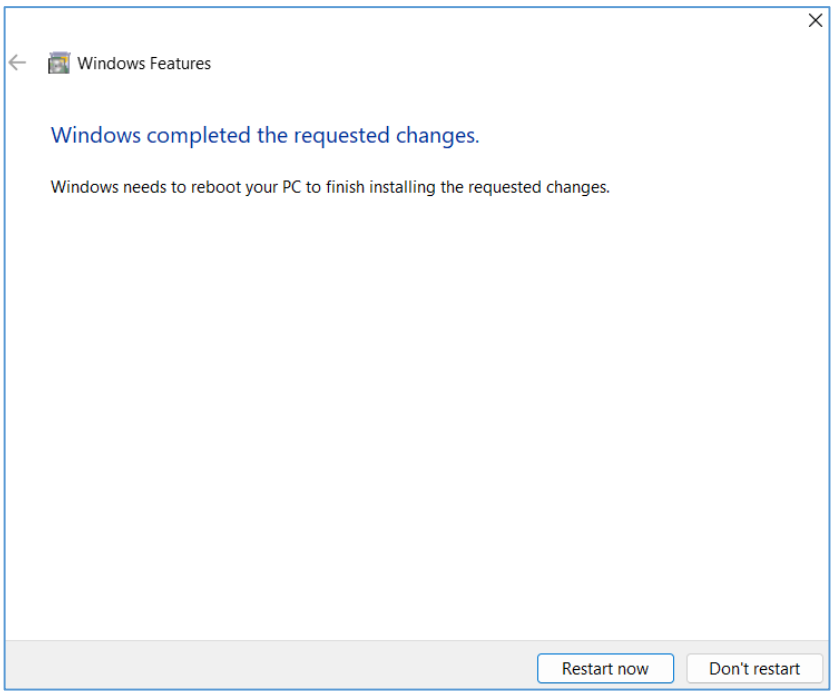


Figure 9.10: IIS Installation 10

13. To confirm that your installation was successful, click on the search icon beside the Windows start and type IIS in the search field.

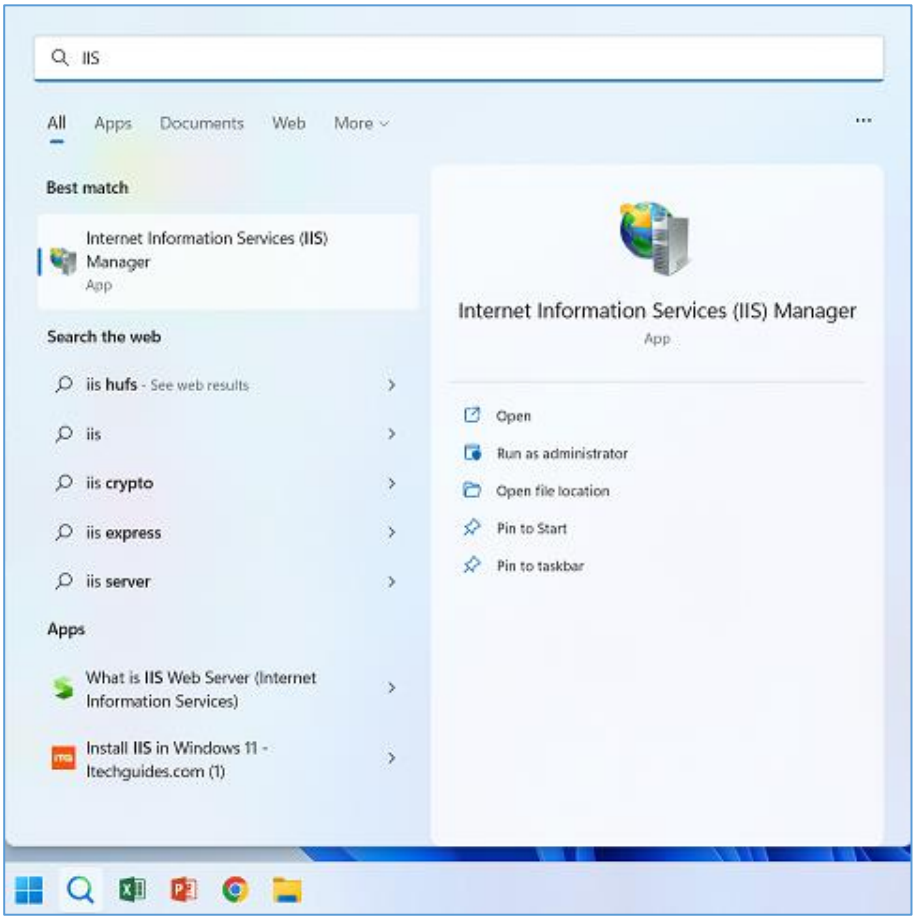


Figure 9.11: IIS Installation 11

14. To know which version of the Microsoft web server you are using, on the IIS Manager, click on the Help option in the menu and select "About Internet Information Service."

Figure 9.12: IIS Installation 12

15. After the installation of IIS, Windows will automatically start the webserver services on default port number 80. Thus, to check whether it is functioning properly, open your system browser and type “http://localhost” to see.

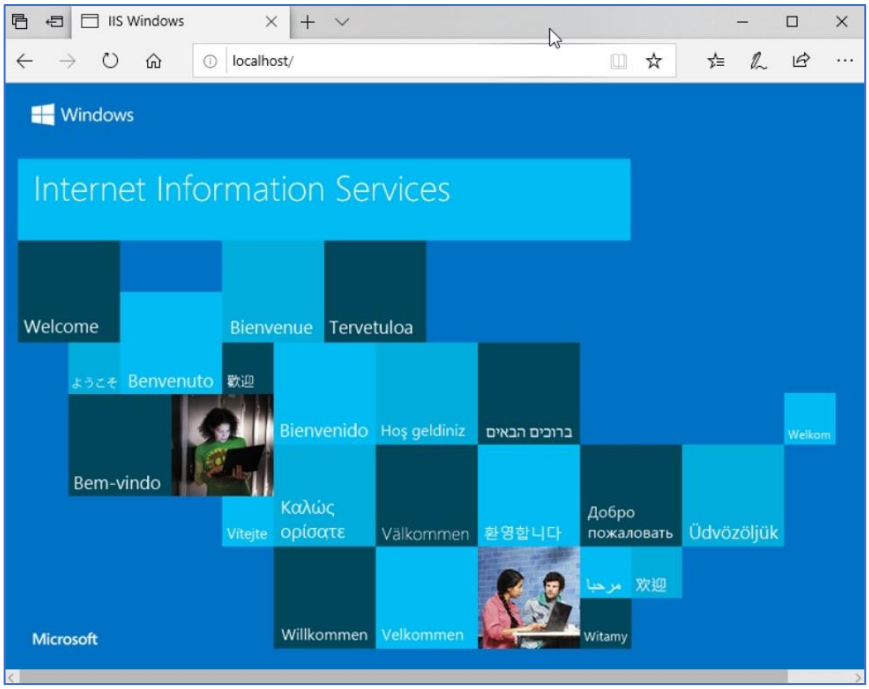


Figure 9.13: IIS Installation 13

By default, the IIS shows the local HTML page that everything is working fine. In the case that things aren’t working fine, check whether the HTTP server (localhost) is listening on port 80. Run the following command in the command prompt:

9.2.5. Creating a Simple Test Website

1. Create a new file called test.html. Add the following content to the file:

Table 9.5: 1. Create a new file called test.html.

```
<!DOCTYPE html>
<html lang="en-us">
<head>
<title> Simple Test Website </title>
<meta content="text/html; charset=utf-8" />
<link rel="stylesheet" href="styles.css">
```

```
<link rel="stylesheet"
   href="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/css/bootstrap.min.css">
</head>
<body>
<div class="nav">
<nav class="navbar navbar-inverse nav">
<div class="navbar-header">
<a class="navbar-brand" href="#"> Website </a>
</div>
<ul class="nav navbar-nav">
<li class="active"> <a href="#"> Home </a> </li>
<li> <a href="#"> About </a> </li>
<li> <a href="#"> Contact </a> </li>
</ul>
</nav>
</div>
<div class="container">
<h1> This is a test website </h1>
</div>
</body>
</html>
```

2. Create a new CSS file called styles.css. Add the following styling to the file.

Table 9.6: 2. Create a new CSS file called styles.css.

```
* {
font-family: sans-serif;
}
.nav {
border-radius: 0px !important;
color: white;
}
```

```
.link {
margin-right: 10px;
font-size: 12pt;
}
.brand {
margin-left: 20px;
margin-right: 40px;
font-size: 18pt;
}
.container {
text-align: center;
padding: 40px 20px;
}
```

3. Copy or move the test.html and styles.css files into the “C:\inetpub\wwwroot” folder.

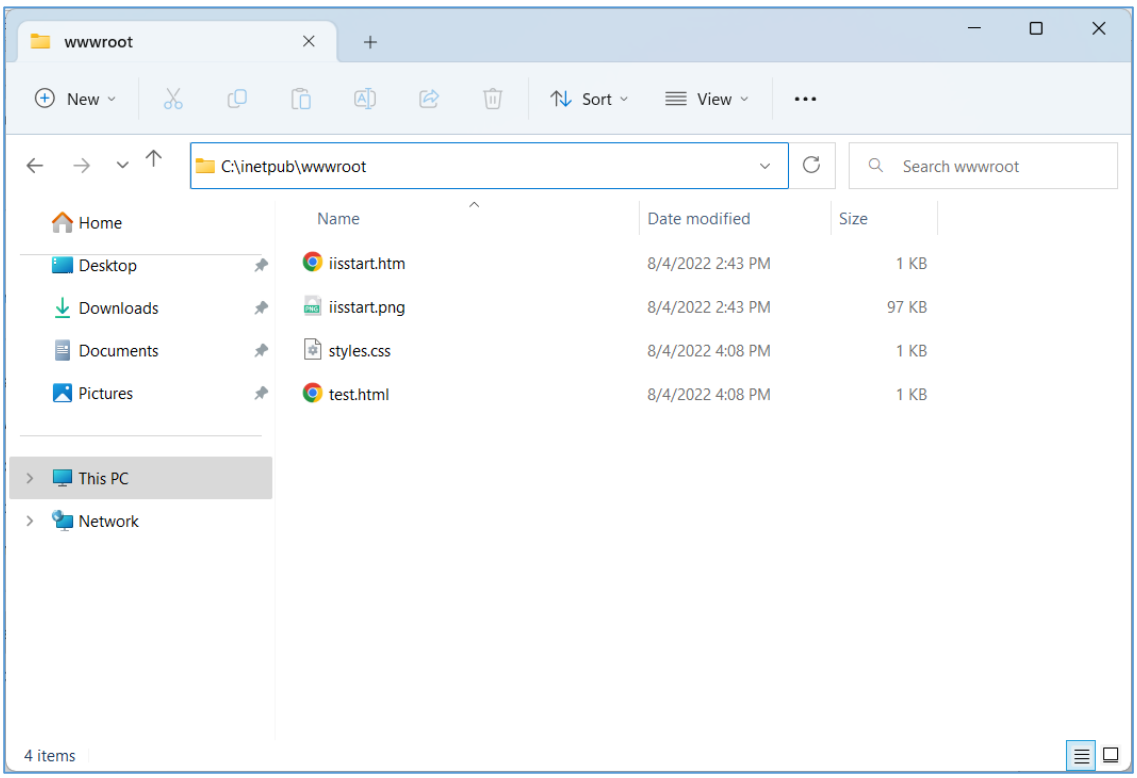


Figure 9.14: Simple Files

4. You can access it via the URL “https://localhost/test.html.”

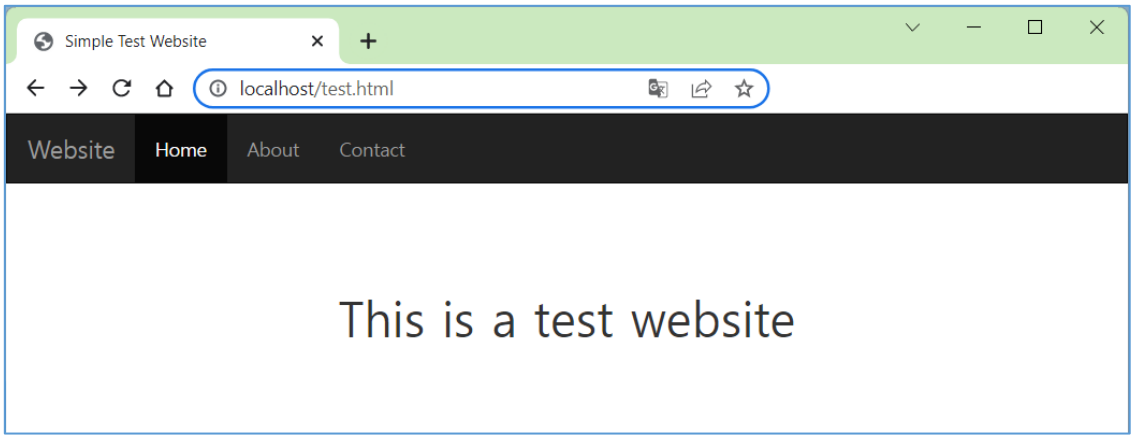


Figure 9.15: Simple Website

Summary

In this chapter, you have learned:

The **HyperText Markup Language** or **HTML** is the standard mark-up language for documents designed to be displayed in a web browser. HTML is the universal mark-up language for the Web. HTML lets you format text, add graphics, create links, input forms, frames, tables, etc., and save it all in a text file that any browser can read and display.

Hyper Text: HyperText simply means "Text within Text." A text that has a link within it is a hypertext. You have clicked on a hypertext whenever you click on a link that brings you to a new webpage. HyperText is a way to link two or more web pages (HTML documents) with each other.

Markup language: A mark-up language is a computer language that applies layout and formatting conventions to a text document. Mark-up language makes the text more interactive and dynamic. It can turn text into images, tables, links, etc.

HTML 4.0 is an iteration of the HTML 3.2 version. It offers many new features over its predecessors, such as style sheets, embedding objects, richer tables, object support, and more. Additionally, it is compatible with many web browsers. HTML 4 was one of the significant updates published as a W3C Recommendation in 1997.

HTML5 is the fifth version of HTML. This version was released in 2014. Also, HTML5 comes with new and advanced features. It allows developers to build animations and simple to complex applications that run on the browser. HTML5 can help developers build web apps developed for Entertainment, Online streaming, Video players, Audio players, etc.

Internet Information Services (IIS) is a flexible, general-purpose web server from Microsoft that runs on Windows systems to serve requested HTML pages or files. An IIS web server accepts requests from remote client computers and returns the appropriate response. This basic functionality allows web servers to share and deliver information across local area networks (LAN), such as corporate intranets, and wide area networks (WAN), such as the Internet.

Questions

1) What is HTML?
2) What are the features of HTML?
3) What are the differences between HTML 4.0 and HTML 5.0?
4) Name some new features not present in HTML but added to HTML 5.
5) Explain the structure of the HTML webpage.
6) What is the Internet Information Service (IIS)?
7) How does the Internet Information Service (IIS) work?
8) What are the most significant features of Internet Information Services (IIS)?
9) Why do we need to install IIS?

Exercises

1) **Exercise 1:** Write the basic structure of the HTML template.
2) **Exercise 2:** Install IIS on your computer.

Additional Reading:

1) https://www.w3schools.com/html/default.asp
2) https://learn.microsoft.com/en-us/iis/get-started/introduction-to-iis/iis-web-server-overview

Chapter 10

HTML Elements, Tags and Attributes I

Learning Objective:

The objectives of this chapter are to introduce HTML Elements, tags, and attributes. You will get a basic understanding of some elements, tags, and attributes used in HTML. Additionally, this chapter illustrates the HTML5 footer, header, nav, article, section, and aside elements.

After completing this chapter, students should be able to:

- Implement HTML5 footer, header, nav, article, section, and aside elements
- Examine HTML elements, tags, and attributes I

In this chapter, you will learn about:

10.1. HTML5 Footer, Header, Nav, Article, Section and Aside Elements

We will use some semantic tags to introduce explicitly in HTML5 as described below. To start things as simply as possible and avoid concepts of overcrowding, we have deliberately omitted the discussion about these elements in the HTML mark-up. Although we will not use all these elements during this course, you should still be familiar with them as you might want to use them for your projects and/or might encounter them in somebody else's code that you plan to use.

The names of the footer, header, nav, article, section, and aside elements are suggestive of their role/meaning, which is, however, a bit subtler, flexible and articulated than might be expected.

Figure 10.1 illustrates the "simple" or "expected" more immediate meaning of these tag elements. As in HTML5, these tags do not indicate an element's physical position on the page but rather the nature/meaning of the element's contents. Therefore, the position of the elements, as shown in the figure, is just a graphical possibility that fits well with the semantics of the elements, which could very well be respected and represented by an entirely different graphical arrangement.

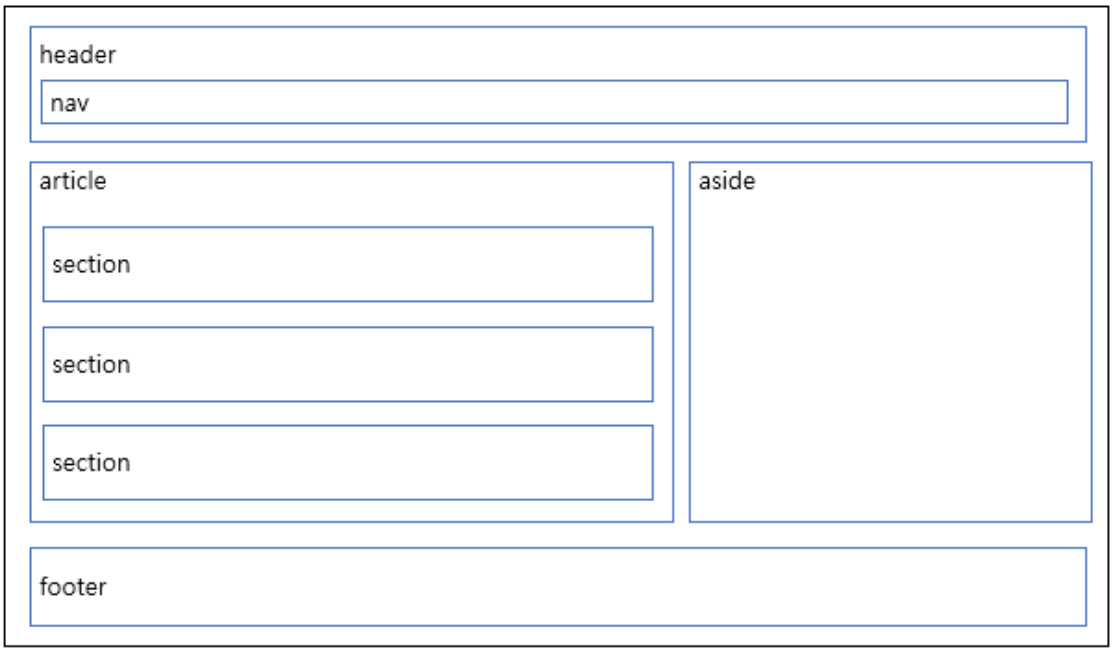


Figure 10.1: HTML5 Tags

So, to define the meaning and structure of 1 - 6 parts, determine how to mark them up in HTML as clearly as possible.

HTML 5 is used:

<header> to define 1 as a header that appears at the top of the page.
<footer> to define 6 as a footer appearing at the page's bottom.
<section> to define 2 - 5 as a section that consists of main contents.

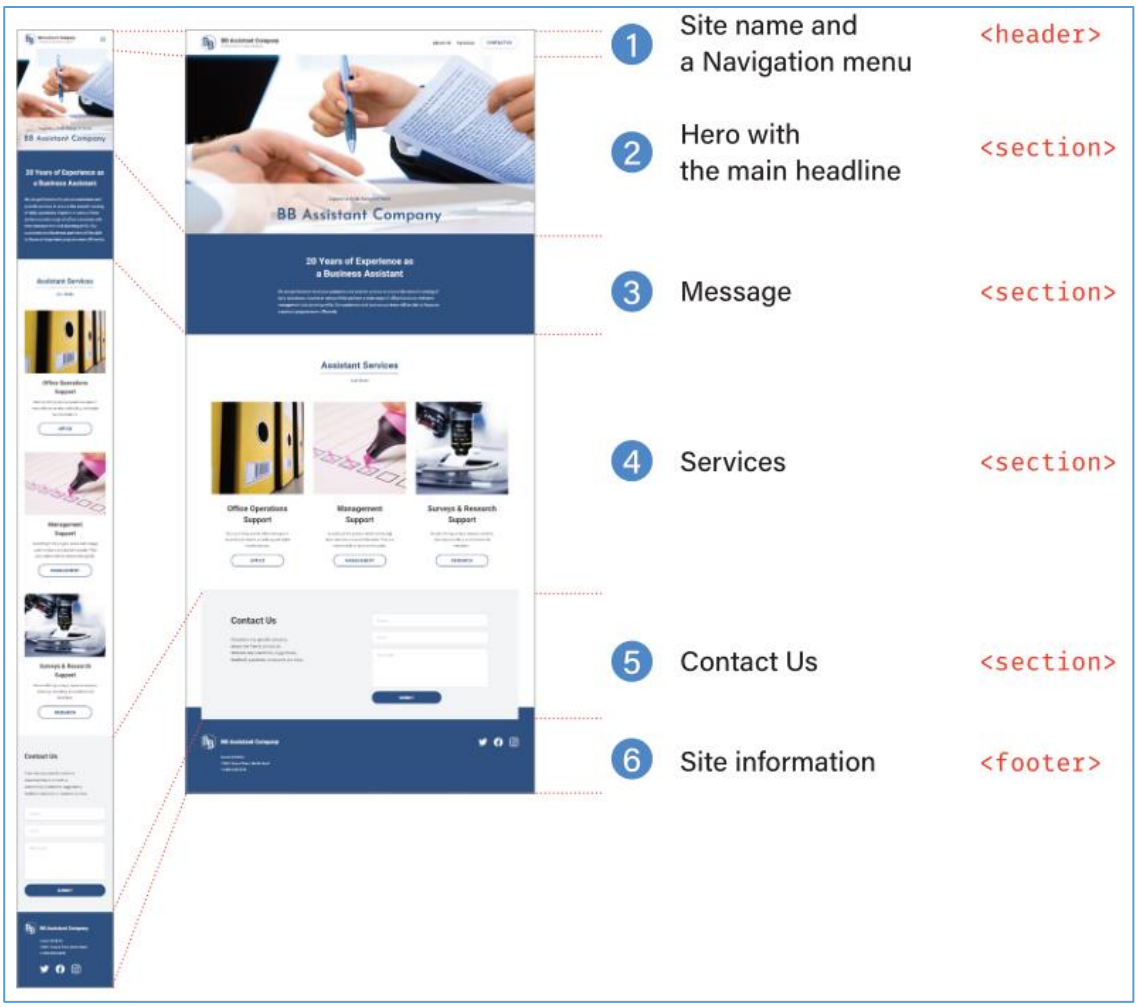


Figure 10.2: Difference Between Mobile (left) and Desktop (right)

10.1.1. Header and Footer Elements

The **header** and **footer** belong/refer to the element they are contained into, their parent. As used in the figure, the header is the header of the whole page, and so is the footer, which is absolutely fine and correct. The header can typically embrace a nav element with the website navigation menu in this setup. It is the kind of arrangement we will adopt for our pages during this course.
Let us consider a page with several articles inside (just one is shown in the figure), for example, a posts page in a Blog. Each article could have its own header and footer. The header could contain the title and author of the article, and the footer could contain links related to the article, contact info for the author, or something else. In this case, the header would be the header of the parent article element rather than the header of the whole page.

Therefore, several header and footer elements can co-exist on a page, each related to its parent element. As for all elements, you should use multiple headers and footers only if they are really relevant to your page. Less is better and simple is better. Every code you write may need maintenance or editing in the future; the simpler it is, the easier the maintenance.

10.1.2. Article

The semantics of the article element is related to the fact that articles are intended as self-contained, reusable elements. For the purpose of this course, we do not really need this element.

10.1.3. Section

The section element is not a generic container element. When an element is needed only for styling purposes or as a convenience for scripting, authors are encouraged to use the “div” element instead. A general rule is that the section element is appropriate only if the element’s contents are listed explicitly in the document’s outline.

Examples of sections would be chapters, the various tabbed pages in a tabbed dialog box, or the numbered sections of a thesis. A Web site’s home page could be split into sections for an introduction, news items, and contact information.

10.1.4. Aside

The aside element represents a section of a page that consists of content that is tangentially related to the content around the aside element and which could be considered separate from that content. Such sections are often represented as sidebars in printed typography. The element can be used for typographical effects like pull quotes or sidebars, for advertising, for groups of nav elements, and for other content that is considered separate from the page's main content. It is generally appropriate that lateral columns or boxes in a web page or website are marked up as asides. A typical aside could be the navigation sidebar to the left of these very pages.

10.1.5. Nav

Nav elements generally contain website navigation links. These links are typically structured in the form of an unordered list (ul).

In HTML5, article, section, aside, and nav are known as sectioning elements. Note that the header and footer do not belong to this category.

The main characteristic of these sectioning elements is that each can have its own hierarchy of h1-h6 tags. This is a significant change with respect to HTML4.01, where the h tags themselves were the only means to shape the document outline, and you expected a single h1 tag on a page. These new sectioning elements can heavily influence the document outline, making it more articulated and potentially more accessible and understandable under a semantic profile, independently from the kind of device it is accessed from. Remember that HTML5 is very much about accessibility over a wide range of devices, including mobiles, tablets, and others, where a correct rendering could rely more on the semantics mark-up of your content than on your own graphical specifications.

10.1.6. HTML 5 Example

Let us see the complete example to understand HTML5 Template Design better. Check out the HTML5 template source code. It is just a sample, so you do not have to understand it perfectly.

Table 10.1: HTML5 sample.html

```
<!DOCTYPE html>
<html>
<head>
   <meta charset="utf-8">
   <title>HTML5 Sample</title>
   <meta content='width=device-width, initial-scale=1' name='viewport' />
   <link rel="stylesheet" href="sample.css" />
</head>

<body>
    <div id="main-container">
      <header id="header">
         <section> HTML5 Sample </section>
          <nav>
            <ul>
               <li><a href="">A Menu</a>
               </li>
               <li><a href="">B Menu</a>
               </li>
               <li><a href="">C Menu</a>
               </li>
               <li><a href="">D Menu</a>
               </li>
               <li><a href="">E Menu</a>
               </li>
            </ul>
         </nav>
      </header>
      <section id="title-ads">
         <h1><center> Title </center> </h1>
      </section>
      <section id="main-body-container">
```

```
        <article id="main-article">
            <h1> Article Box </h1>
            <section> You can write or mention your article description here
</section>
        </article>
        <aside id='sidebar'>
            <h1> Slider Box </h1>
            <section> You can write or mention your Slider description here
</section>
        </aside>
      </section>
      <footer id="footer">Copyright here </a>
      </footer>
   </div>
</body>
</html>
```

Table 10.2: sample.css

```
* {
    margin: 0px;
    padding: 0px
}
 #main-container {
    width: 100%;
    margin: 0px auto;
}
 #header {
    width: 100%;
    background-color: black;
    padding: 10px;
    color: white;
}
```

```
#header:after {
    content: ".";
    display: block;
    height: 0;
    clear: both;
    visibility: hidden;
}
#header section {
    float: left;
    width: 20%;
    font-size: 18px;
    font-weight: bold;
}
#header nav {
    width: 50%;
    float: left;
}
#header nav ul {
    list-style: none;
}
#header nav ul li {
    float: left;
    min-width: 10%;
    padding: 4px;
    margin-left: 10px;
    background-color: #fdf1e5;
    text-align: center;
    color: black;
}
#header nav ul li a, a {
    text-decoration: none;
}
#main-body-container {
```

```
    padding: 10px;
    margin: 10px;
  }
 #main-body-container:after {
    content: ".";
    display: block;
    height: 0;
    clear: both;
    visibility: hidden;
}
 #title-ads{
    padding: 20px;
    margin: 20px;
    background: #e5e5e5;
}
 #main-article {
    float: left;
    width: 60%;
    min-height: 450px;
    background: #e5e5e5;
}
 #sidebar {
    float: right;
    width: 38%;
    min-height: 450px;
    background: #e5e5e5;
}
 #footer {
    width: 100%;
    background-color: black;
    padding: 10px;
    color: white;
}
```

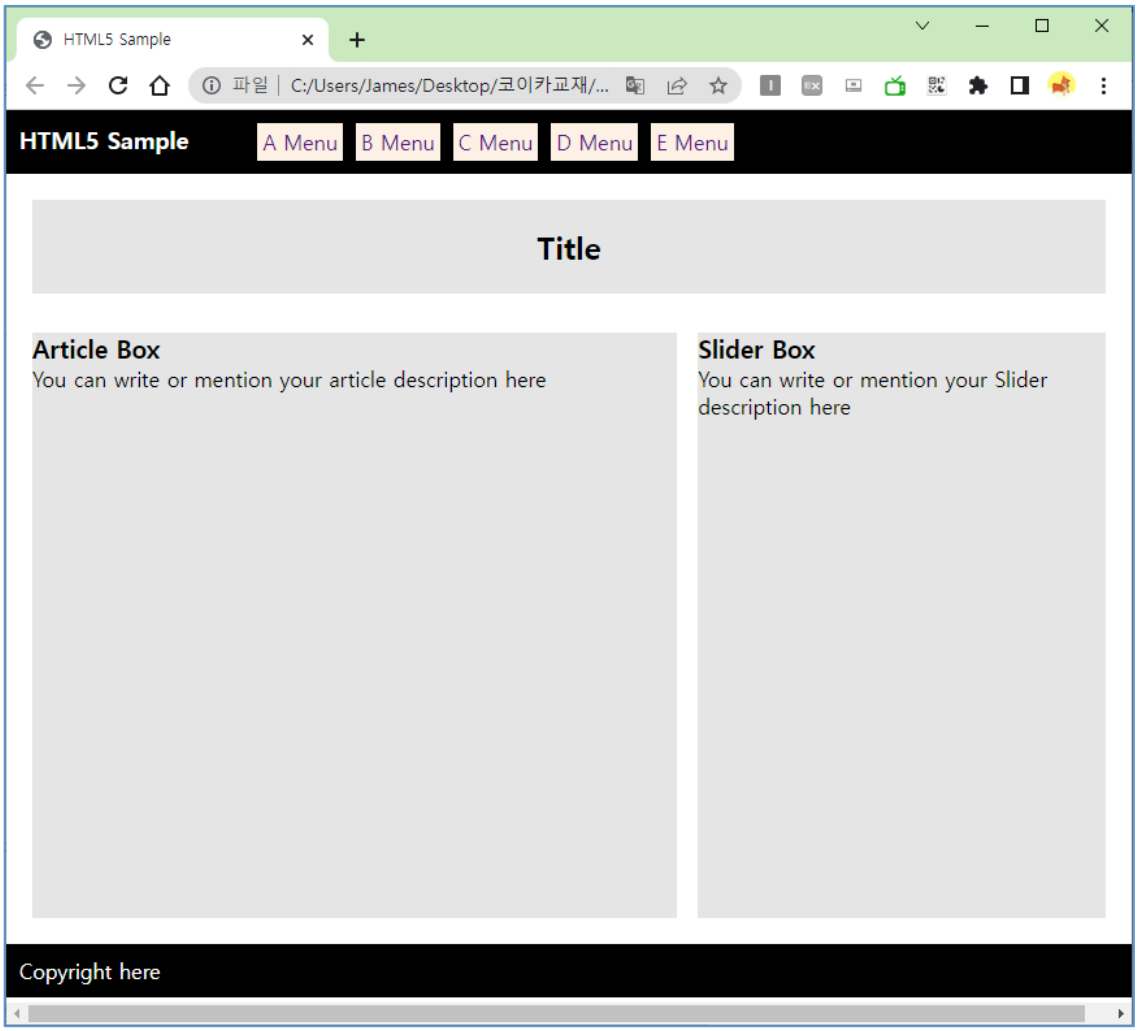


Figure 10.3: HTML 5 Sample on Web Browser

10.2. HTML Elements, Tags, and Attributes I

HTML elements are the building blocks of a web page. These elements are enclosed in angular brackets. Further, many HTML tags have corresponding closing tags. There are also a few tags that do not require such closing tags. We will discuss all these tags in the upcoming chapter, but first, you need to understand how HTML tags work. Look at the *Figure 10.4.*

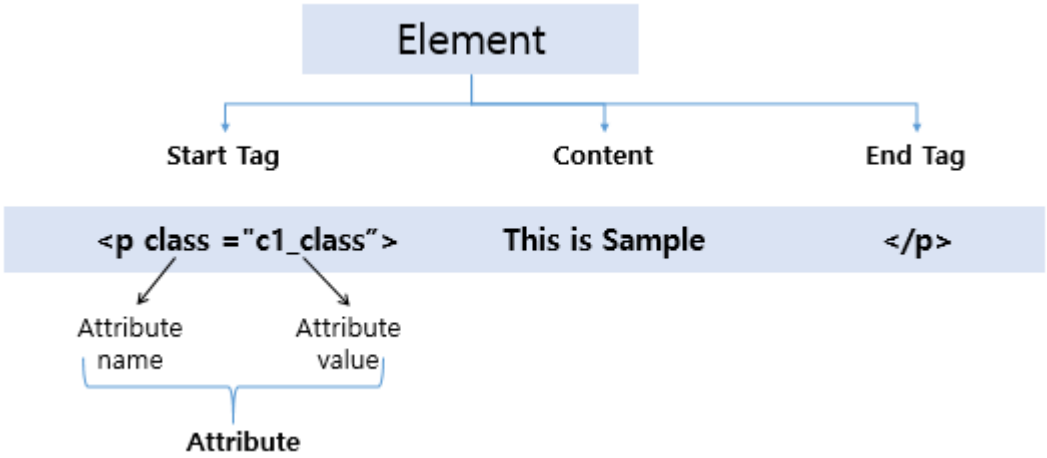


Figure 10.4: Element, Tags and Attribute

10.2.1. Basic HTML Tags

Every HTML document starts with <html> tag and ends with its corresponding closing tag, </html> tag. Other HTML tags are nested inside this tag only. Likewise, the other two basic HTML tags are <head> and <body> tags. HTML files can render in a browser. The visible part in the browser window is written inside the <body> tag. It can contain several elements, such as paragraphs, headings, images, videos, sections, divisions, etc.

Another basic tag is the <head> tag. All the information regarding the document is listed in the <head> tag. It includes HTML tags such as <link>, <title>, <meta>, <style>, etc. In the early versions, the <head> tag was mandatory, but in HTML 5, it can be omitted.

```
1  <!DOCTYPE html>
2  <html>
3     <head>
4     </head>
5     <body>
6
7     </body>
8   </html>
```

This is how an HTML document is usually structured, the <head> tag first, followed by the <body> tag.

10.2.2. HTML Attributes

All the HTML tags are built for a specific purpose. For example, the <p> is used for paragraphs, and <img/> is used for images. Most HTML tags have additional properties or characteristics that are defined by attributes. A tag may or may not have mandatory attributes. For example, the <img/> tag must contain src and alt attributes. Further, you can place height and width attributes, but they are not mandatory. Have a look at the below HTML code.

```
1  <!DOCTYPE html>
2  <html>
3     <body>
4          <img src="" alt="">
5          </p>
6     </body>
7  </html>
```

A <img> tag is defined with two attributes - src and alt. Value for an attribute is written inside the double quotes. As of now, these two attributes do not have any values.

10.2.3. Closing and Opening Tags

As I have mentioned above, many tags have corresponding closing tags. The difference between the opening and closing tags is that the closing tag has a forward slash. Some tags, such as <img/>, only have a forward slash within themselves.

10.2.4. <!DOCTYPE html>

You can run HTML documents in a browser. The <HTML> tag defines that it is an HTML document. However, the browser needs to interpret the type of file. The <!DOCTYPE html> is the declaration that informs the browser that it is an HTML document. <!DOCTYPE html> is not an HTML tag. You must declare it at the top of every HTML document. Also, to create an HTML file, you should save the file with the .html extension.

10.2.5. Paragraphs and Headings

We can add a variety of content in an HTML document. Simple text is the most common content on any web page. Besides this, the text can be in any form or style. We can create paragraphs of any length and headings of any size, and you can change color, font size, font style, and background color.

A paragraph in HTML is added using the <p> tag. For headings, we have multiple tags. These include <h1>, <h2>, <h3>, <h4>, <h5>, and <h6>, each of them having a different size.

1) <p> tag

A paragraph is a block of the text created using the <p> tag.

```
1  <!DOCTYPE html>
2  <html>
3     <body>
4        <p>
5           Hello World!
6        </p>
7     </body>
8  </html>
```

It has the corresponding closing tag on line 6 while the content is written between the tags.

**2)
 tag**

So, each paragraph starts from a new line. Nevertheless, what if you want to add a new line inside a particular paragraph? Suppose we have the following text:

Nice to meet you!

My name is Kompheak.

I am 26 years old.

```
1  <!DOCTYPE html>
2  <html>
3     <body>
4        <p>
5           Nice meet you!
6           My name is Kompheak.
7           I am 26 years old.
8        </p>
9     </body>
10 </html>
```

Lines 5, 6, and 7 have new lines. Do you think it will display correctly in the browser?

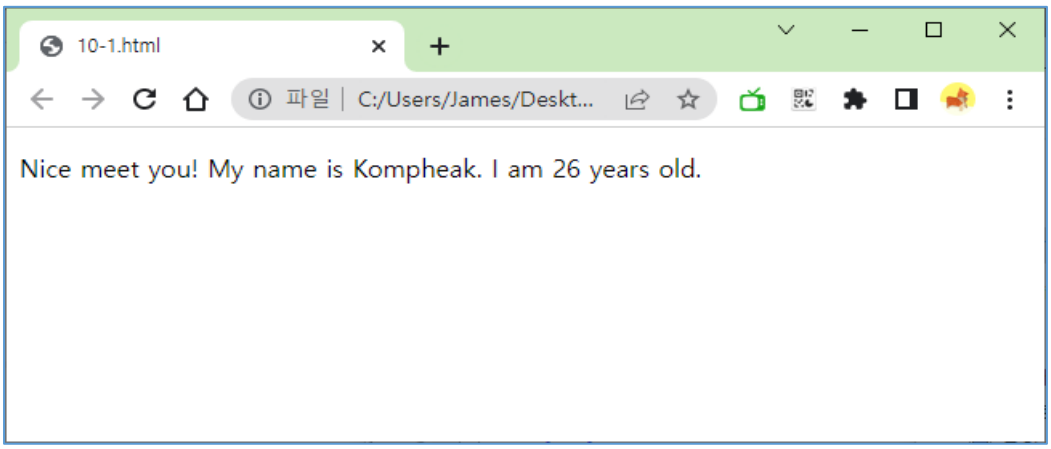


Figure 10.5: Sample Display on Browser

It does not display the text in the same format as written in the <p> tag. Why? The reason is simple. It does not matter how we format the text in the <p> tag. It will always consider the whole content of a <p> tag as a single paragraph. To add a new line, HTML provides the <br> tag. Just place the tag at the end of the line where you want a new line to start.

```
1  <!DOCTYPE html>
2  <html>
3     <body>
4        <p>
5           Nice meet you!<br>
6           My name is Kompheak.<br>
7           I am 26 years old.<br>
8        </p>
9     </body>
10 </html>
```

As you can see, the <br> tag does not have a closing tag. It is an empty tag. It does not require a closing tag. Let's see what it displays in the browser.

*Figure 10.6:
 Tag Sample*

3) <h1> and Other Heading Tags

To give headings and subheadings, HTML provides the heading tags. They include <h1>, <h2>, <h3>, <h4>, <h5>, and <h6>. The size is the only difference between each of these tags.

```
1  <!DOCTYPE html>
2  <html>
3     <body>
4          <h1>First Heading</h1>
5          <h2>Second Heading</h2>
6          <h3>Third Heading</h3>
7          <h4>Fourth Heading</h4>
8          <h5>Fifth Heading</h5>
9          <h6>Sixth Heading</h6>
10    </body>
11  </html>
```

Lines 4 to 9 contain different types of headings.

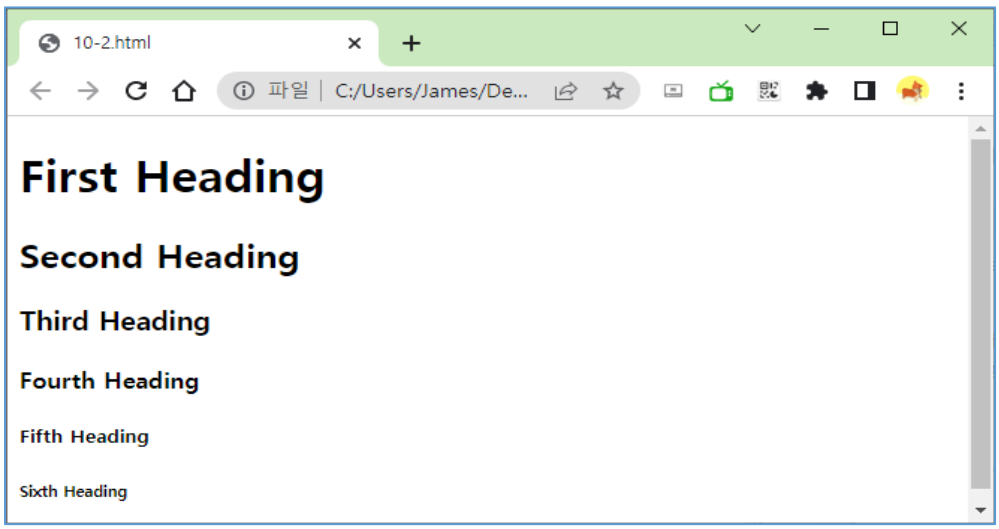


Figure 10.7: Heading Tags

The <h1> has the largest size, while the <h6> has the smallest. These tags are meant to provide headings and subheadings on a webpage. Headings are different from paragraphs. They are bold and big. However, it does not mean we should use them between paragraphs to make the text bold or big. Use these tags efficiently.

10.2.6. Text Formatting

While adding text in an HTML document, you may need to define special meaning for some parts. By special meaning, I mean pointing out a part of the text that appears different.

HTML provides several tags for formatting the text.

1) <b> and tags

The <b> tag defines bold text.

```
<!DOCTYPE html>
<html>
   <body>
        <p>My name is <b> Kompheak </b> </p>
   </body>
</html>
```

In the paragraph, one word, i.e., 'Kompheak,' is enclosed within the <b> tag.

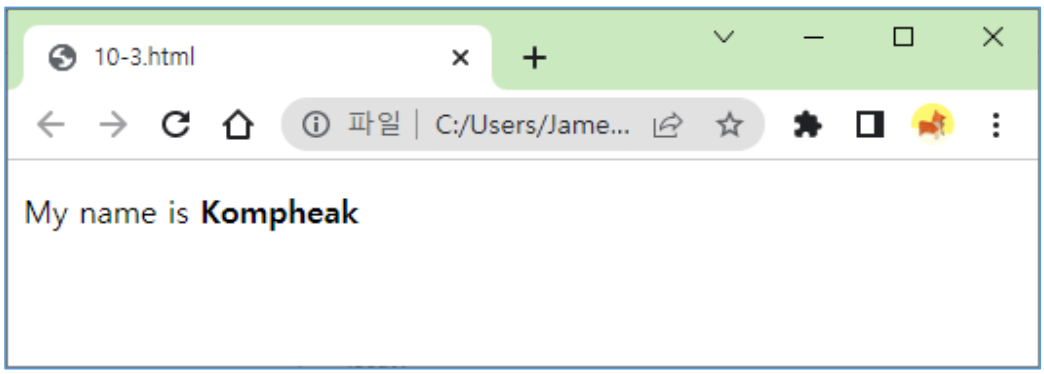


Figure 10.8: <b> Tag

The text enclosed within the <b> tag is bold now. Similarly, there is another tag that behaves in the same. It is called the tag. However, the also defines the text as important. You may not find any difference between <b> and , but the strong text has an extra meaning while the bold does not.

2) <i> and tags

The <i> tag defines italic text.

```
<!DOCTYPE html>
<html>
   <body>
        <p>My name is <i> Kompheak </i> </p>
   </body>
 </html>
```

In the paragraph, one word, i.e., 'Kompheak,' is enclosed within the <i> tag.

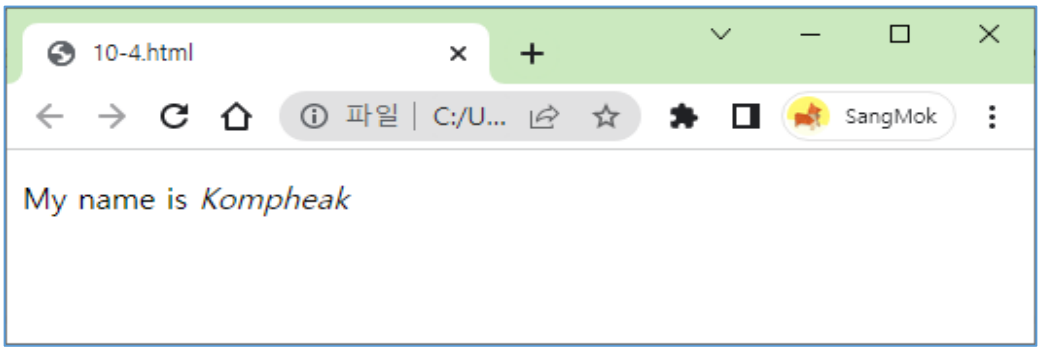


Figure 10.9: <i> Tag

Similarly, another tag, , also defines the italic text, but with extra importance. Let us see what happens when the text is enclosed within the tag. There does not appear to be any difference, but the text within the tag has extra importance, similar to the tag.

3) <sub> and <sup> tags

The <sub> tag defines the subscripted text, while the <sup> tag defines superscripted text.

```
<!DOCTYPE html>
<html>
   <body>
        <p> H <sub> 2 </sub> O </p>
        <p> 100 <sup> 10 </sup> </p>
   </body>
 </html>
```

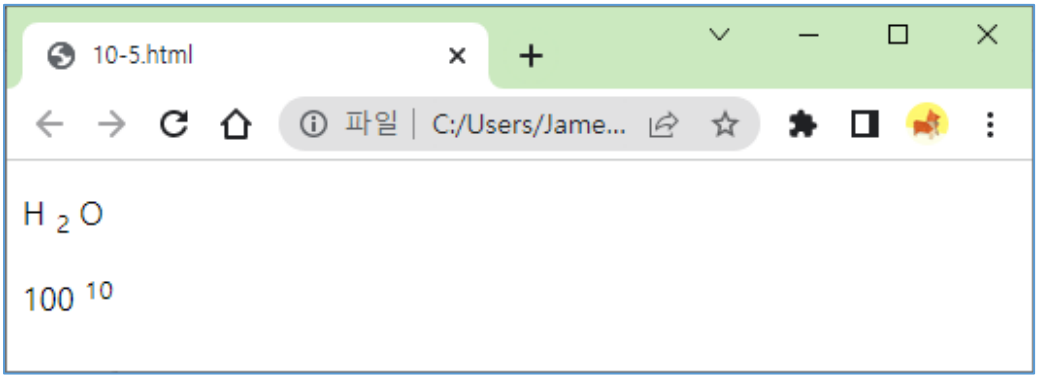


Figure 10.10: <sup> and <sup> Tag

4) <small> tag

Sometimes, you may need to define a text in a small size compared to others. The <small> tag in HTML defines small text.

```
<!DOCTYPE html>
<html>
   <body>
       <p> My name is <small> Kompheak </small> </p>
   </body>
 </html>
```

Figure 10.11: <small> Tag

5) <mark> tag

Highlighting is one of the most common ways of pointing out a subtext from a text. In HTML, highlighting or marking text can be achieved using the <mark> tag.

```
<!DOCTYPE html>
<html>
   <body>
       <p> My name is <mark> Kompheak </mark> </p>
   </body>
 </html>
```

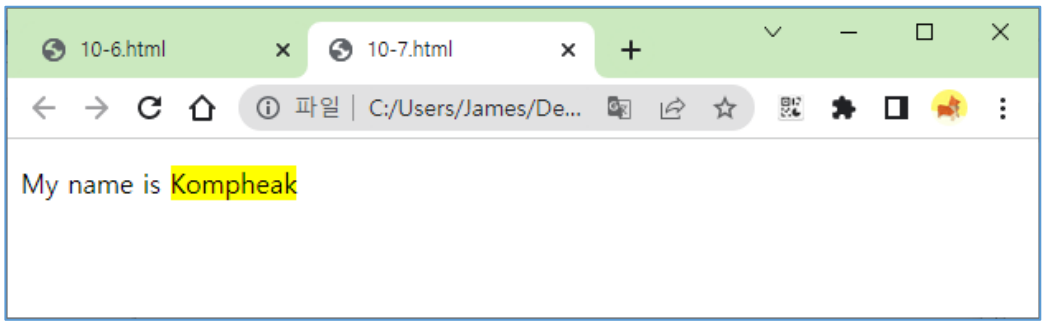


Figure 10.12: <mark> Tag

10.2.7. Hyperlinks

There are multiple web pages on a website. We can navigate from one page to another. The links in HTML allow a user to navigate from one web page to another. Such links in HTML are called hyperlinks. The <a> is used to create hyperlinks in HTML. In this chapter, we will discuss how to use the <a> tag to move from one HTML document or web page to another.

1) <a> Tag

The <a> tag has few attributes. One of these attributes - href, is a mandatory attribute that holds the link to the document or web page that will open when clicked. Observe the syntax of the <a> tag.

The URL should be written within the quotes. The text will appear on the screen, and when we click on it, the URL specified for the href attribute will open. Observe the following HTML code.

```
<!DOCTYPE html>
<html>
   <body>

       <h2> Click <a href="https://google.com"> here </a> to open Google <h2>

   </body>
 </html>
```

In the paragraph, the word – 'here' is a hyperlink. The href is ' https://google.com .' This means the homepage of Google will open when clicked on the hyperlink.

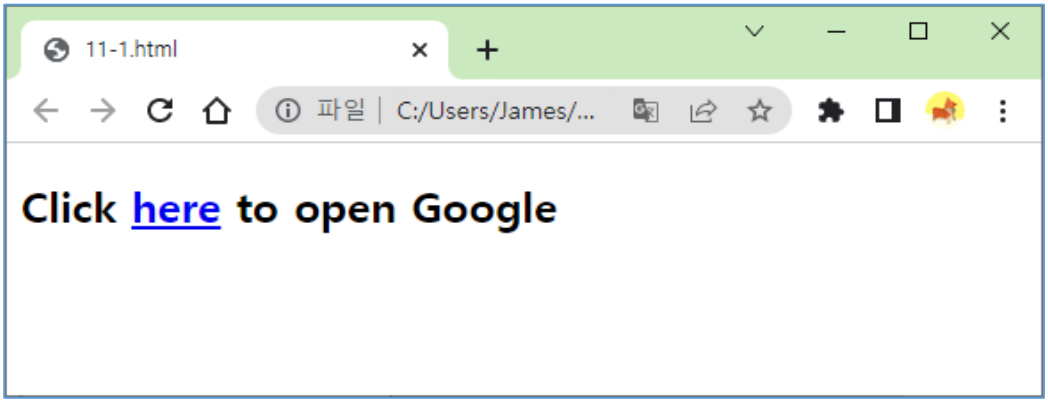


Figure 10.13: <a> Tag

Did you notice something different with the appearance of the hyperlink? It is underlined and blue. There is a way to remove this styling by using CSS.

You can also move locally from one HTML document to another. In the href attribute, you have to provide the proper path for the document you want to navigate.

```
<!DOCTYPE html>
<html>
   <body>

      <h2> Click <a href="sample.html"> here</a> to open another document <h2>

   </body>
</html>
```

In the above <a> tag, the name of a document is specified that happens to be in the same folder. Clicking on the hyperlink will open the sample.html document.

Target Attribute

The target attribute is an optional attribute of the <a> tag. It specifies where to open the document or web page. It can have the following four values:

- **_self:** Open the document or web page in the same tab/window. The target is set to _self by default.
- **_blank:** Open the document or web page in a new tab/window.
- **_top:** To open the document or web page in the full body of the window.

- **_parent:** Open the document or web page in the parent frame. You can also provide a frame name as the value of the target attribute to open the document in a particular frame.

```
<!DOCTYPE html>
<html>
   <body>

      <h2> Click <a href="https://google.com" target="_blank"> here</a> to open Google <h2>

   </body>
</html>
```

The hyperlink in the above paragraph will open in a new tab/window.

Title Attribute

The title attribute provides a title for a hyperlink. Whenever the mouse hovers over the hyperlink, it will display a text which is called the title. By default, it does not show anything.

The title is usually extra information about the hyperlink in a very short form.

```
<!DOCTYPE html>
<html>
   <body>

      <h2> Click <a href="https://google.com" title="Go to Google"> here</a> to open Google <h2>

   </body>
</html>
```

2) More with <a> Tag

The <a> tag is not limited to text. You can also use images and buttons as hyperlinks. You can even use a part of an image as a hyperlink.

Summary

In this chapter, you have learned:

HTML Layout Elements. HTML has several semantic elements that define the different parts of a web page:

- **<header>** - Defines a header for a document or a section
- **<nav>** - Defines a set of navigation links
- **<section>** - Defines a section in a document
- **<article>** - Defines an independent, self-contained content
- **<aside>** - Defines content aside from the content (like a sidebar)
- **<footer>** - Defines a footer for a document or a section

A start tag, some content, and an end tag define an HTML element.
The HTML element is everything from the start tag to the end tag:
<tagname>Content goes here...</tagname>
Examples of some HTML elements:

```
<h1>My First Heading</h1>
<p>My first paragraph </p>
```

Note: Some HTML elements have no content (like the <br> element). These elements are called empty elements. Empty elements do not have an end tag!

HTML attributes provide additional information about HTML elements.
HTML Attributes:

- All HTML elements can have attributes
- Attributes provide additional information about elements
- Attributes are always specified in the start tag
- Attributes usually come in name/value pairs like: name="value"

Questions

1) What is an HTML tag?
2) Do all HTML tags have an end tag?
3) What is formatting in HTML?
4) How many types of headings does an HTML contain?
5) What is an HTML element?
6) What is the difference between HTML elements and tags?
7) Explain the layout of HTML.

Exercises

1) **Exercise 1:** Create a web page that has three paragraphs.
2) **Exercise 2:** Add a heading to each paragraph.
3) **Exercise 3:** Make some words in the paragraph in bold and italics.
4) Exercise 4: Chemical Symbols "H_2O" and mathematical formulas "(a+b)2" on your web page.
5) **Exercise 5:** Create three web pages and link them together so the user can click on the link and redirect to each page.

Additional Reading:

1) https://www.w3schools.com/html/default.asp
2) https://www.codecademy.com/learn/learn-html

Chapter 11

HTML Elements, Tags and Attributes II

Learning Objective:

The objectives of this chapter are to introduce HTML Elements, tags, and attributes. It will give you a basic understanding of some elements, tags, and attributes used in HTML. This chapter will explain images, media, lists, tables, and forms in HTML.

After completing this chapter, students should be able to:

- Create a sample webpage using HTML elements, tags, and attributes
- Implement HTML Elements, Tags, and Attributes II

This chapter, you will learn about:

11.1. HTML Elements, Tags and Attributes II

11.1. HTML Elements, Tags, and Attributes II

11.1.1. Images

Images are the most common part of a website after the text. Today, almost every website you visit has images. Images improve the appearance of a website and attract more audiences.

To add an image, use the <img> tag. But, it is not always just adding an image. The image should have proper alignment, position, and size.

1) <img> tag

The <img> tag does not have a corresponding closing. The src attribute is mandatory because it holds the URL of the image. The image can be present locally, or it can be on another server. Let's discuss how to add local images in an HTML document.

```
1  <!DOCTYPE html>
2  <html>
3     <body>
4
5        <img src="./mountain.png">
6
7     </body>
8  </html>
```

The image is present in the folder. This folder is in the same location as the HTML file. It needs to be a proper path, or the image won't appear on the screen. Moreover, the image's extension should also be present after the name.

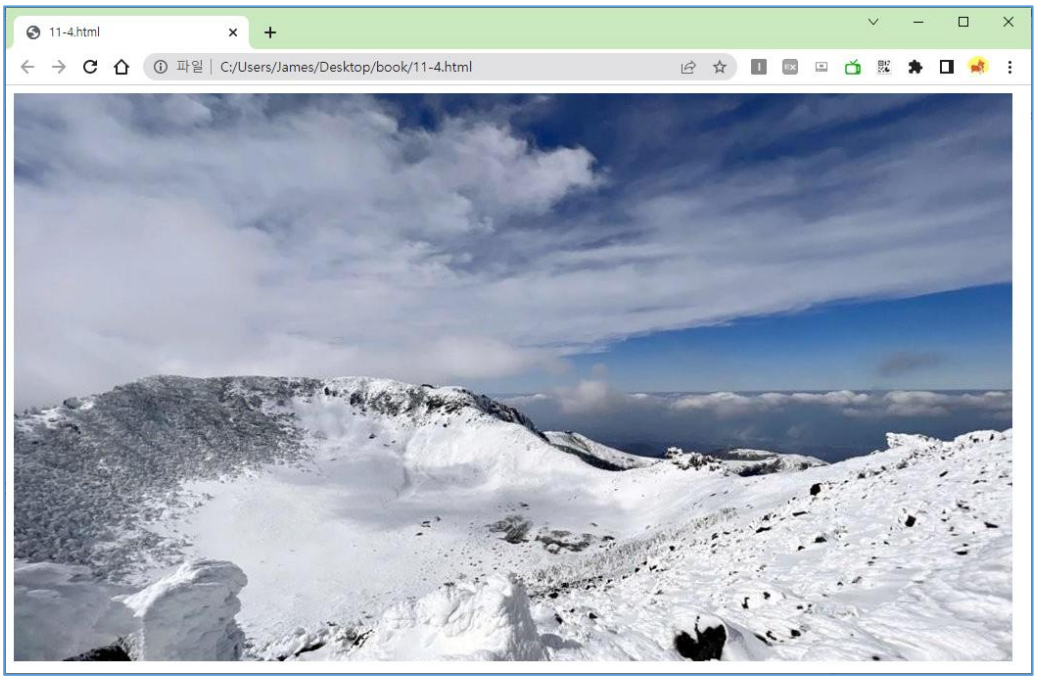


Figure 11.1: <img> Tag

Similarly, we can add images from another server.

```
<!DOCTYPE html>
<html>
   <body>

      <img src="https://google.com/image/mountain.png">

   </body>
</html>
```

Image Size

By default, the size of the image appearing on the screen is the same as its actual size. This image is huge in size, so only a portion of it appears on the screen. The whole image can be seen by scrolling up and down.

To encounter such situations, the <img> tag has two attributes to set the width and height of an image. They are called width and height.

```
<!DOCTYPE html>
<html>
   <body>

      <img src="./mountain.png" height="200" width="200">

   </body>
</html>
```

The height and width are set to 200 and 200, respectively. Similarly, we can use CSS for image styling, which we will discuss in the CSS section.

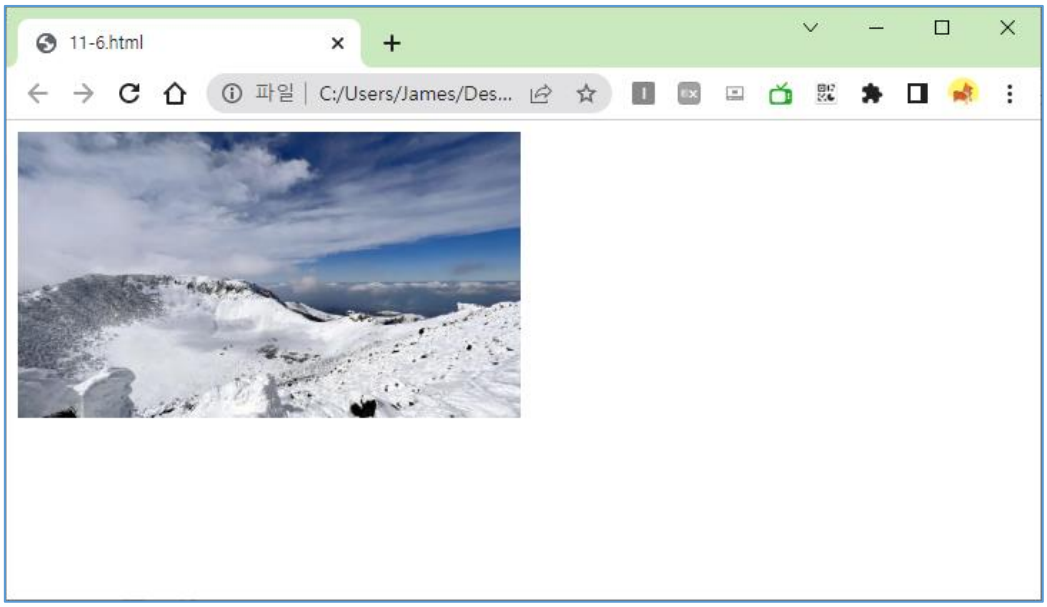


Figure 11.2: Image Size

Alt Attribute

The alt attribute is optional, but it is recommended to use alt in every <img> tag. Suppose an image fails to load for some reason. When an image fails to load, the alt attribute's value appears in its place.

```
<!DOCTYPE html>
<html>
   <body>

      <img src="./mountainfailure.png"
         height="200"
         width="200"
         alt = "could not load image"
      >

   </body>
</html>
```

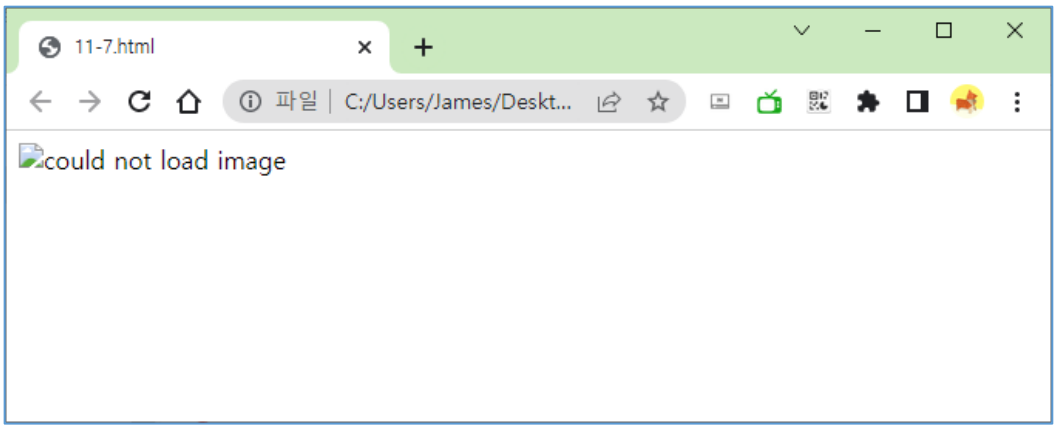


Figure 11.3: Alt Attribute

Now, the user will know if image loading has a problem.

Common Image Formats

These are the common type of image files that all browsers support:

Table 11.1: Common Image Formats

Abbreviation	File Format	File Extension
APNG	Animated Portable Network Graphics	.apng
GIF	Graphics Interchange Format	.gif
ICO	Microsoft Icon	.ico, .cur
JPEG	Joint Photographic Expert Group image	.jpg, .jpeg, .jfif, .pjpeg, .pjp
PNG	Portable Network Graphics	.png
SVG	Scalable Vector Graphics	.svg

11.1.2. Media

Multimedia has become a trend in modern websites. We may find videos and audio playing automatically when we visit a particular website, or we may find options to play the video or audio. HTML provides separate tags for video and audio with some useful attributes.

1) <video> tag

As the name suggests, the <video> tag displays videos in the browser.

```
<!DOCTYPE html>
<html>
    <body>
        <video>

        </video>
    </body>
</html>
```

2) <source> tag

The <source> tag is used to define the source of the video. It has an src attribute that holds the URL of the video. We also need to mention the type of video using the type attribute.

```
<!DOCTYPE html>
<html>
    <body>
        <video>
            <source src="sample_video.mp4" type="video/mp4">
        </video>
    </body>
</html>
```

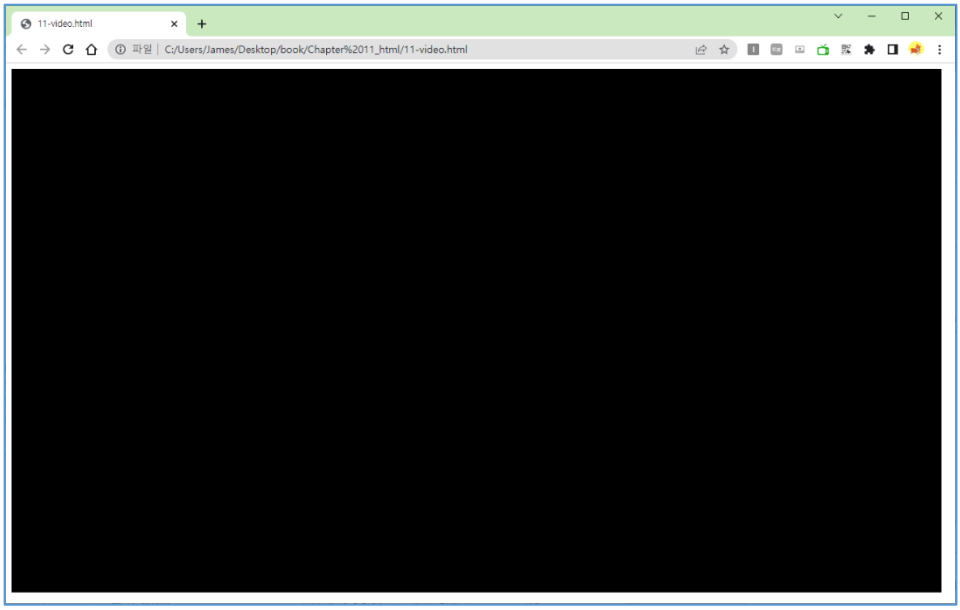


Figure 11.4: <source> Tag

The video appears on the screen. It will not play because there are no options for play or pause.

Controls Attribute

The <video> tag has a Boolean attribute called controls. This attribute provides controlling options for the video.

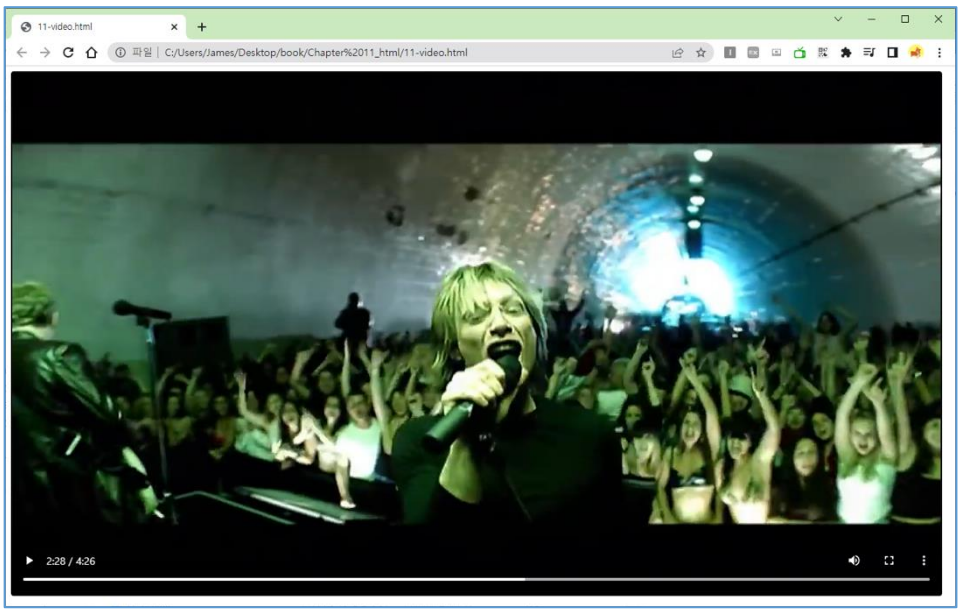


Figure 11.5: Control Attribute

You can see that options such as the play/pause button and length of the video are available now.

Autoplay Attribute

The autoplay attribute is another Boolean attribute of the <video> tag. When it is specified, the video starts playing automatically as soon as the page loads.

```
<!DOCTYPE html>
<html>
    <body>
        <video controls autoplay>
            <source src="sample_video.mp4" type="video/mp4">
        </video>
    </body>
</html>
```

3) <audio> tag

The <audio> tag is used to define audio on a web page. Similar to the <video> tag, the <source> tag is also used here. Moreover, the <audio> tag also has controls and autoplay attributes.

```
<!DOCTYPE html>
<html>
    <body>
        <audio controls autoplay>
            <source src="sample_audio.mp3" type="audio/mpeg">
        </audio>
    </body>
</html>
```

11.1.3. Tables

Data on a web page should be represented in a proper manner. There are various ways of representing data. We discussed these ways, such as the <p> and <h1> tags. But sometimes, we may need a better way to display data more accurately and clearly. Tables are considered one of the best ways to represent data.

Tables arrange data in rows and columns. In HTML, the <table> tag is used to create a table. Other tags and attributes are necessary to create a proper table in HTML. So, in this chapter, we will discuss how to create a simple table in HTML.

1) <table> tag

The <table> tag alone does not display anything.

```
<!DOCTYPE html>
<html>
   <body>

       <table>

       </table>

   </body>
</html>
```

It only defines a table. We need to create rows and columns manually. HTML has the <tr> tag and <td> tag to create a row and column, respectively.

2) <tr> and <td> tags

As mentioned, the <tr> tag creates a row. It is placed inside the <table> tag.

```
<!DOCTYPE html>
<html>
   <body>
       <table>
           <tr>

           </tr>
       </table>
   </body>
</html>
```

The above table has one row. Let's add two columns in this row using the <td> tag.

```
<!DOCTYPE html>
<html>
   <body>
      <table>
         <tr>
            <td>

            </td>
            <td>

            </td>
         </tr>
      </table>
   </body>
</html>
```

So, this is how rows and columns are created in HTML. Let's add some content in each column and see how the tables appear in the browser.

```
<!DOCTYPE html>
<html>
   <body>
      <table>
         <tr>
            <td>
               column1
            </td>
            <td>
               column2
            </td>
         </tr>
      </table>
   </body>
</html>
```

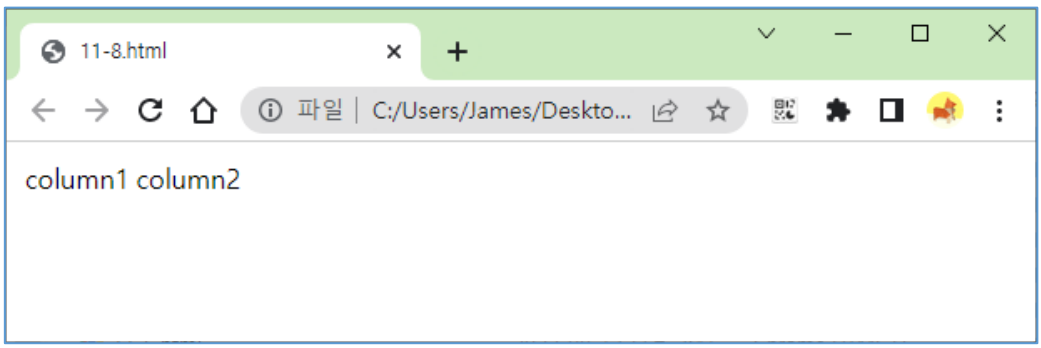


Figure 11.6: <tr> and <td> Tags

This does not look like a table. By default, a table in HTML does not have any border. The CSS is required to add a border to the table.

Table Border

We have yet to discuss CSS. But we will add borders in the table by using some CSS.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
        table, tr, td {
            border : 1px solid black;
            border-collapse : collapse;
        }
        </style>
    </head>

    <body>
        <table>
            <tr>
                <td>
                    column1
                </td>
                <td>
                    column2
                </td>
            </tr>
            <tr>
                <td>
                    column3
                </td>
                <td>
                    column4
                </td>
            </tr>
        </table>
    </body>
</html>
```

In the <head> tag, a <style> tag is added and has some CSS. Ignore this part for now. We will discuss it later in the CSS section. For now, observe the table in the browser.

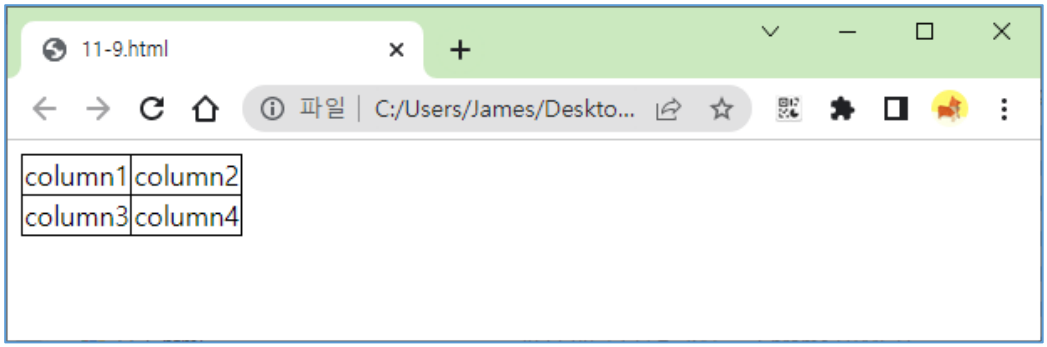


Figure 11.7: Table Border

Colspan and Rowspan Attributes

Tables depend a lot on CSS. We can create attractive and better tables with CSS, but HTML also provides some excellent attributes that could be used with tables. One of these attributes is the colspan attribute. The colspan attribute increases the span of a cell according to the value specified.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
        table, tr, td {
            border : 1px solid black;
            border-collapse : collapse;
        }
        </style>
    </head>

    <body>
        <table>
            <tr>
                <td colspan="2">
                    column1
                </td>
                <td>
                    column2
                </td>
            </tr>
            <tr>
                <td>
                    column3
                </td>
                <td>
                    column4
                </td>
            </tr>
        </table>
    </body>
</html>
```

The first cell of the first row has a colspan of 2.

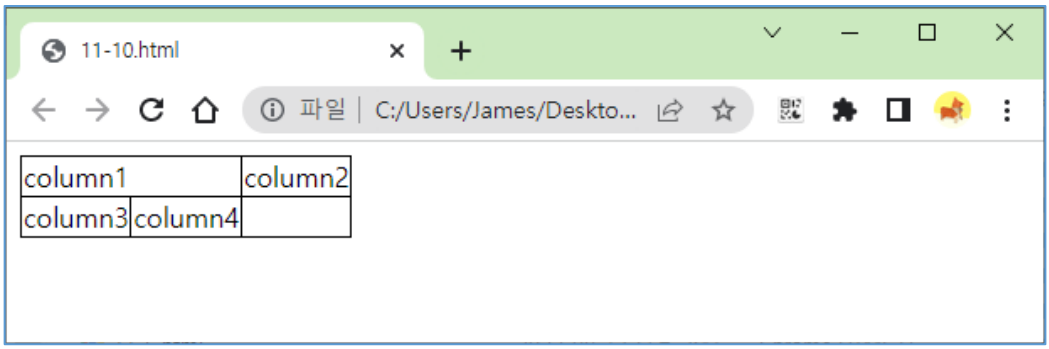


Figure 11.8: Colonspan and Rowspan Attributes

You can see that the cell now covers the area of two columns. The colspan attribute can have any value, but it should be used carefully, or the result can be an unpleasant table. Similarly, the rowspan is used to increase the span of a row.

3) <th> tag

The <th> tag is used to create a header. It behaves like the <td> tag, but the content is bold.

```
13      <table>
14          <tr>
15              <th>
16                  hearder1
17              </th>
18              <th>
19                  hearder2
20              </th>
21          </tr>
22
23          <tr>
24              <td colspan="2">
25                  column1
26              </td>
27              <td>
28                  column2
29              </td>
30          </tr>
31          <tr>
32              <td>
33                  column3
34              </td>
35              <td>
36                  column4
37              </td>
38          </tr>
39      </table>
```

Now, the first row has headers instead of normal cells. You can see that the text is bold in the headers.

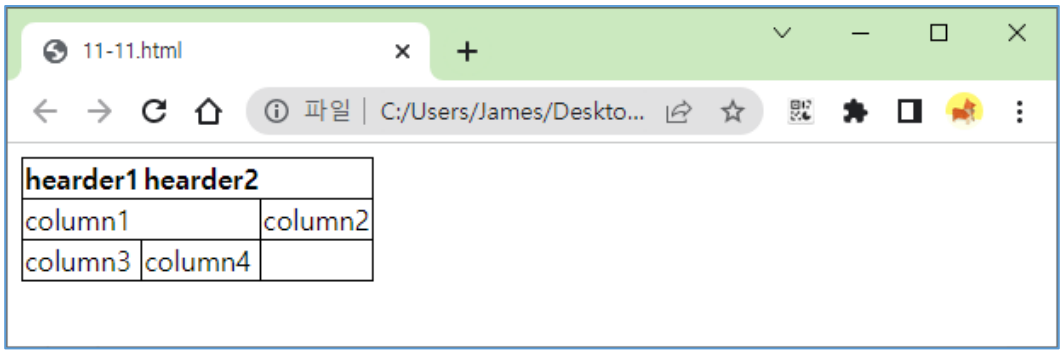


Figure 11.9: <th> Tag

11.1.4. Lists

Another way of representing data is by using lists. Lists are commonly used on web pages. Mostly, they are used to represent related data. There are three types of lists in HTML - ordered, unordered, and description.

Ordered List

An ordered list is always in some order. By default, an ordered list is numerical. But it also has other options.

The ordered list is created using the <ol> tag.

```
<!DOCTYPE html>
<html>
    <body>
        <ol>

        </ol>
    </body>
</html>
```

The <ol> tag only defines an ordered list. To insert values, we have to use the <li> tag.

```
<!DOCTYPE html>
<html>
    <body>
        <ol>
            <li> option1 </li>
            <li> option2 </li>
            <li> option3 </li>
        </ol>
    </body>
</html>
```

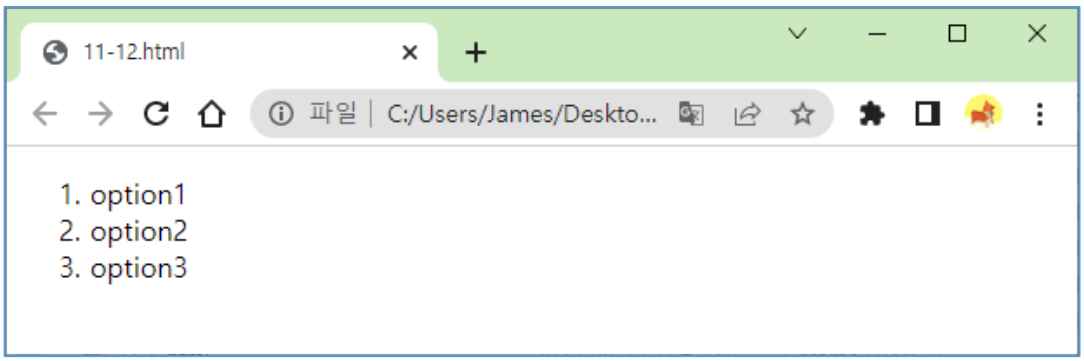


Figure 11.10: Ordered List

Type Attribute in the Ordered List

Every option starts with a number in an ordered list. We can change this to the alphabet and roman numbers - lowercase and uppercase. To do this, use the type attribute.

```
<!DOCTYPE html>
<html>
    <body>
        <ol type="a">
            <li> option1 </li>
            <li> option2 </li>
            <li> option3 </li>
        </ol>
    </body>
</html>
```

The type attribute has ‘a’ as its value.

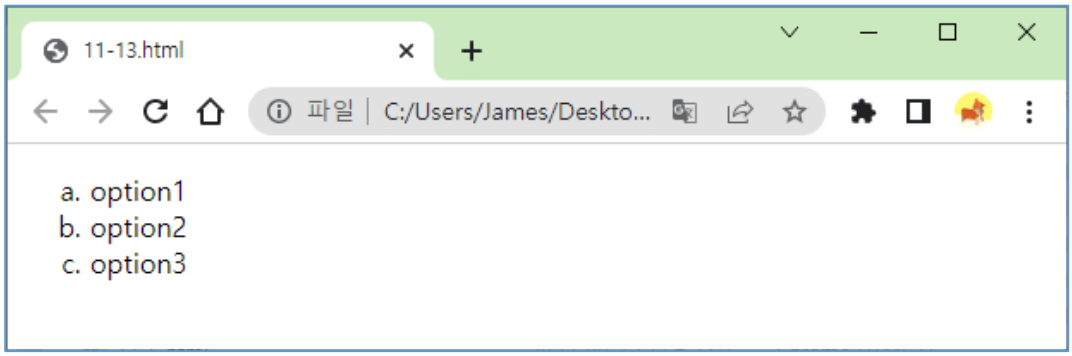


Figure 11.11: Type Attribute in the Ordered List

Lowercase alphabets replace the numbers. Similarly, use ‘i’ for lowercase roman numbers.

```
1  <!DOCTYPE html>
2  <html>
3      <body>
4          <ol type="i">
5              <li> option1 </li>
6              <li> option2 </li>
7              <li> option3 </li>
8          </ol>
9      </body>
10 </html>
```

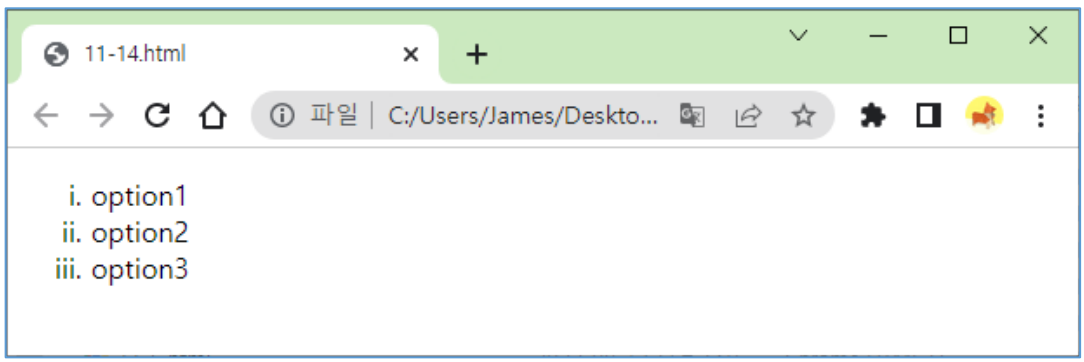


Figure 11.12: Type Attribute in the Ordered List

Other options are: ‘A’ for uppercase alphabets and ‘I’ for uppercase roman numbers.

Strat Attribute

A numerical list always starts from 1. Similarly, an alphabetic list starts from ‘a’ or ‘A’. Using the start attribute, we can also control the starting point of an ordered list.

```
<!DOCTYPE html>
<html>
    <body>
        <ol start="20">
            <li> option1 </li>
            <li> option2 </li>
            <li> option3 </li>
        </ol>
    </body>
</html>
```

The value of the start attribute is 20.

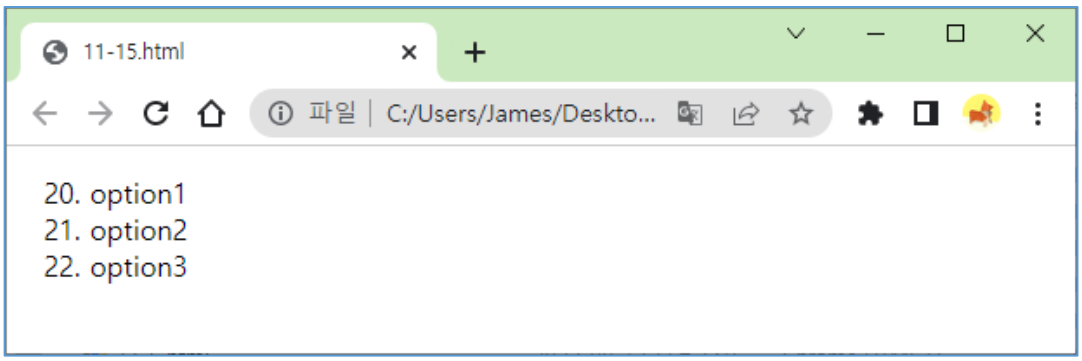


Figure 11.13: Strat Attribute

The list starts with 20. Similarly, we can use the start attribute for any type.

Unordered List

An unordered list does not have any order and is a bulleted list. The <ul> tag is defined using the <ul> tag, and the <li> tag is used for options just like the ordered list.

```
<!DOCTYPE html>
<html>
    <body>
        <ul>
            <li> option1 </li>
            <li> option2 </li>
            <li> option3 </li>
        </ul>
    </body>
</html>
```

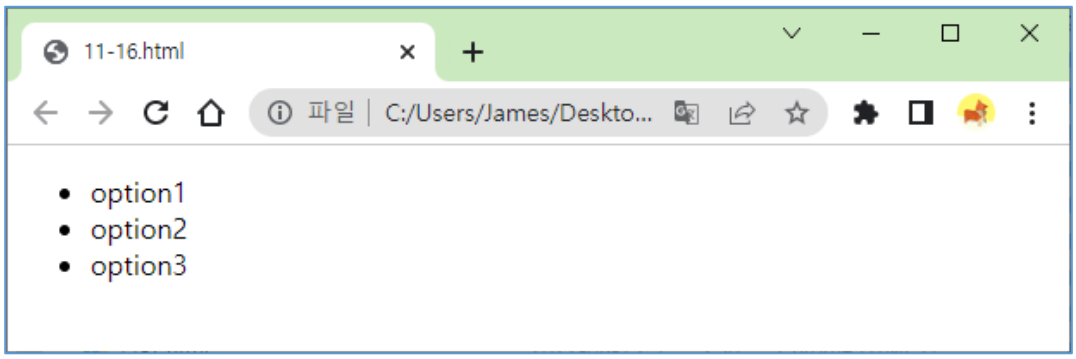


Figure 11.14: Unordered List

You can see that each option starts with a bullet.

Type Attribute in the Unordered List

The type attribute in the unordered list has four values: disc, circle, square, and none. By default, the type of unordered list is a disc.

```
<!DOCTYPE html>
<html>
    <body>
        <ul type="circle">
            <li> option1 </li>
            <li> option2 </li>
            <li> option3 </li>
        </ul>
    </body>
</html>
```

The type is "circle" for the unordered list.

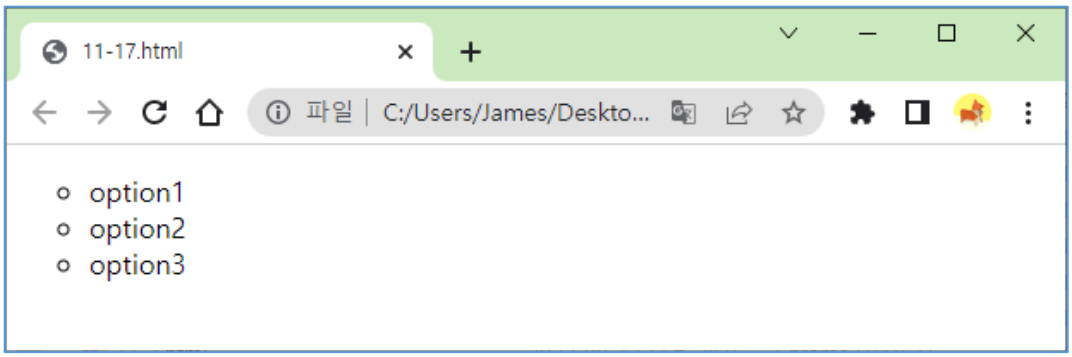


Figure 11.15: "Circle" for the Unordered List

If we do not want any symbol, we can use "none" as the type.

Description List

The description list is used to create a list in which each option has a description.

The <dl> tag defines a description list.

```
<!DOCTYPE html>
<html>
    <body>
        <dl>


        </dl>
    </body>
</html>
```

There are two additional tags - <dt> and <dd>. The <dt> tag defines a term, and the <dd> label describes it.

```
<!DOCTYPE html>
<html>
    <body>
        <dl>
            <dt> term1 </dt>
            <dd>- description1 </dd>
        </dl>

        <dl>
            <dt> term2 </dt>
            <dd> - description2 </dd>
        </dl>

        <dl>
            <dt> term3 </dt>
            <dd> - description3 </dd>
        </dl>
    </body>
</html>
```

There are three terms in the list, each having its description.

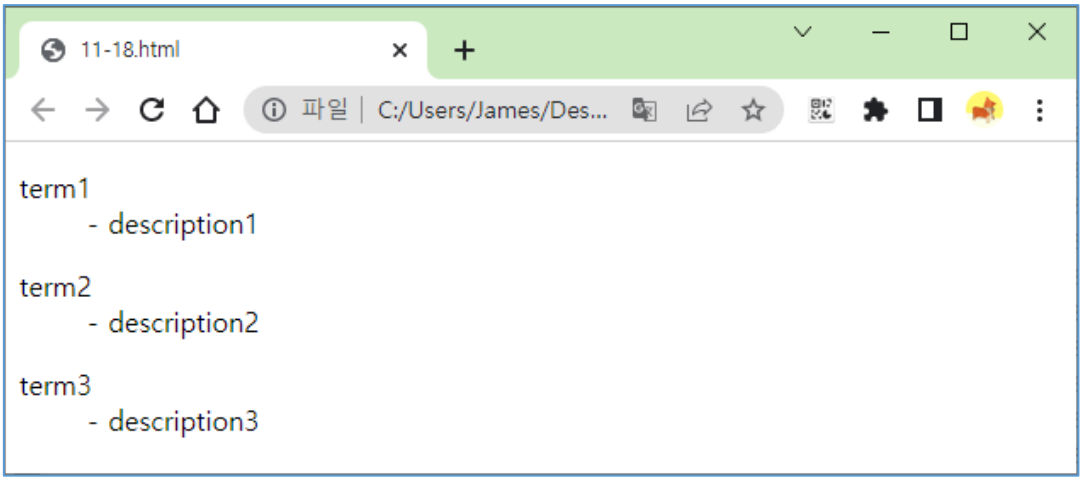


Figure 11.16: Description List

11.1.5. Forms

Forms are one of the most important parts of a web page because they are used for user interaction. We need to create a form if we want information from a user. There are various ways of getting input from the user, such as input fields, text areas, radio buttons, and checkboxes. They all come under the HTML forms.

1) <form> tag

The <form> tag defines a form in HTML. Everything is written inside it.

```
1  <!DOCTYPE html>
2  <html>
3      <body>
4          <form>
5
6          </form>
7      </body>
8  </html>
```

Form Action Attribute

The action attribute in a form defines which URL will invoke when the form is submitted. The input values are delivered to the specified URL.

```
<!DOCTYPE html>
<html>
    <body>
        <form action="/action_asp.asp">

        </form>
    </body>
</html>
```

The value of the action attribute should be a URL.

Form Method Attribute

Specifying the HTTP method when a form is submitted is also necessary. The method attribute is used to specify the method. It can be either POST or GET.

```
<!DOCTYPE html>
<html>
    <body>
        <form action="/action_asp.asp" method="POST">

        </form>
    </body>
</html>
```

The following table compares the two HTTP methods: GET and POST.

Table 12.1: HTTP Methods – GET and POST

	GET	POST
BACK button/Reload	Harmless	Data will be re-submitted (the browser should alert the user that the data are about to be re-submitted).
Bookmarked	Can be bookmarked	Cannot be bookmarked
Cached	Can be cached	Not cached
Encoding type	application/x-www-form-urlencoded	application/x-www-form-urlencoded or multipart/form-data. Use multipart encoding for binary data.
History	Parameters remain in browser history	Parameters are not saved in browser history.

Restrictions on data length	Yes, when sending data, the GET method adds the data to the URL; and the length of a URL is limited (maximum URL length is 2048 characters)	No restrictions
Restrictions on data type	Only ASCII characters allowed	No restrictions. Binary data is also allowed
Security	GET is less secure compared to POST because data sent is part of the URL Never use GET when sending passwords or other sensitive information!	POST is a little safer than GET because the parameters are not stored in browser history or in web server logs
Visibility	Data is visible to everyone in the URL	Data is not displayed in the URL

Form Novalidate Attribute

The <input> tag has a few attributes for validation, such as the required attribute. The form will only submit once everything in the form is validated. But we can also ignore the validations by using the novalidate attribute.

```
1  <!DOCTYPE html>
2  <html>
3      <body>
4          <form action="/action_asp.asp" method="POST" novalidate>
5
6          </form>
7      </body>
8  </html>
```

novalidate is a boolean attribute, so it does not require any value.

2) <input> tag

The <input> tag is the most important tag in HTML forms. This tag defines how the user will provide the input. It all depends on the type attribute of the <input> tag.

Input Text Field

To create an input text field, set the type attribute's value as "text".

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <input type="text">
        </form>
    </body>
</html>
```

The <input> tag does not have a corresponding closing tag.

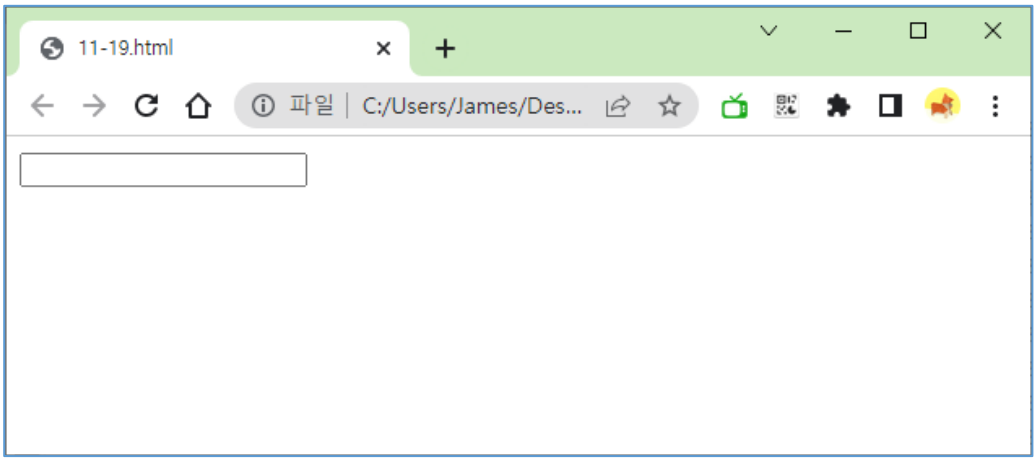


Figure 11.17: Input Text Field

You can see the input field in the browser. Let's make it more clear using the <label> tag.

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <label> Name : </label> <input type="text">
        </form>
    </body>
</html>
```

The <label> tag has the information regarding the input. It can be used with any input.

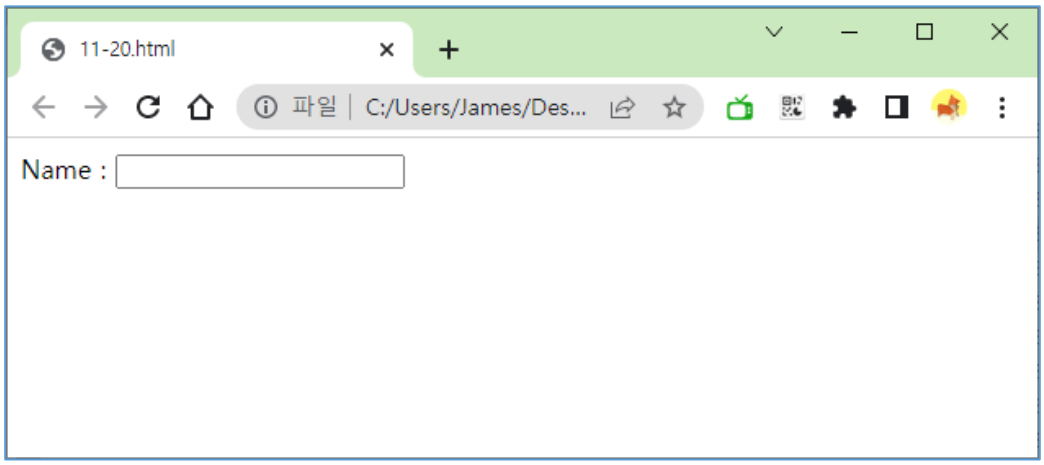


Figure 11.18: <label> Tag

To disable an input field, use the disabled attribute. Disable means the user is not allowed to use the input field.

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <label> Name : </label> <input type="text"><br>
            <label> Age : </label> <input type="text" disabled>
        </form>
    </body>
</html>
```

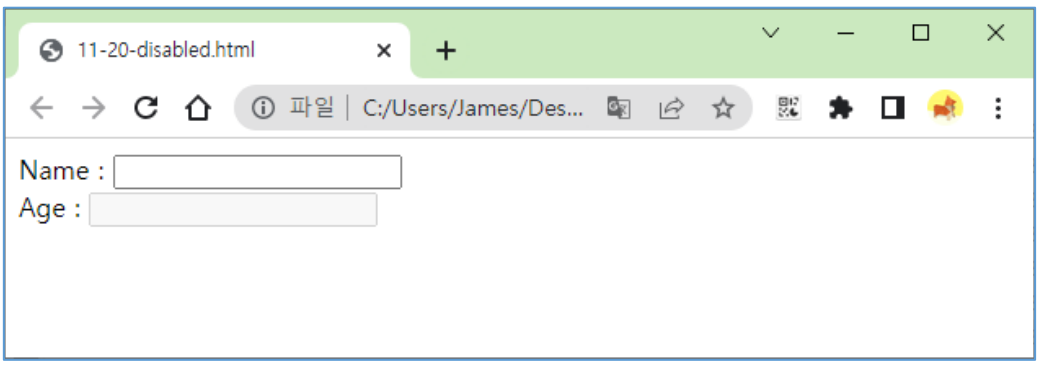


Figure 11.19: Input Text Field

The value attribute gives a pre-defined value to any input type.

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <label> Name : </label> <input type="text" value="Kompheak"><br>
            <label> Age : </label> <input type="text" disabled>
        </form>
    </body>
</html>
```

The value of the input text field is “Kompheak.” Let’s see in the browser.

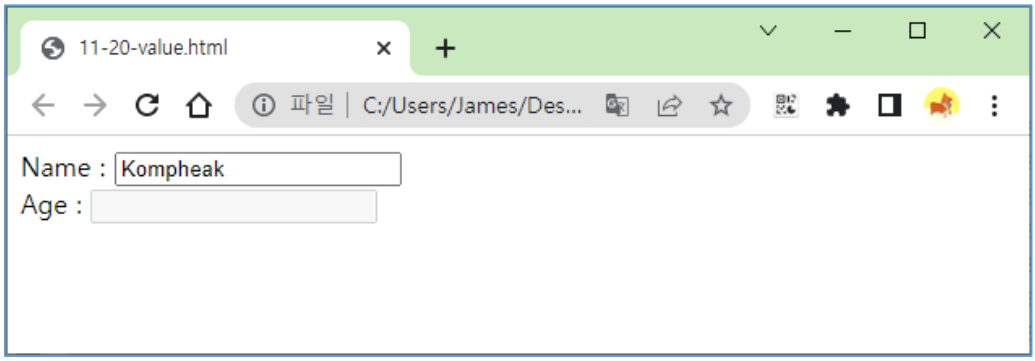


Figure 11.20: Value.html

Radio Button

If there are multiple choices and the user can only select one, use the radio buttons in such situations.

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <label> Gender : </label> <br>
            <input type="radio"> <label> Male </label>
            <input type="radio"> <label> FeMale </label>
        </form>
    </body>
</html>
```

There are two radio buttons.

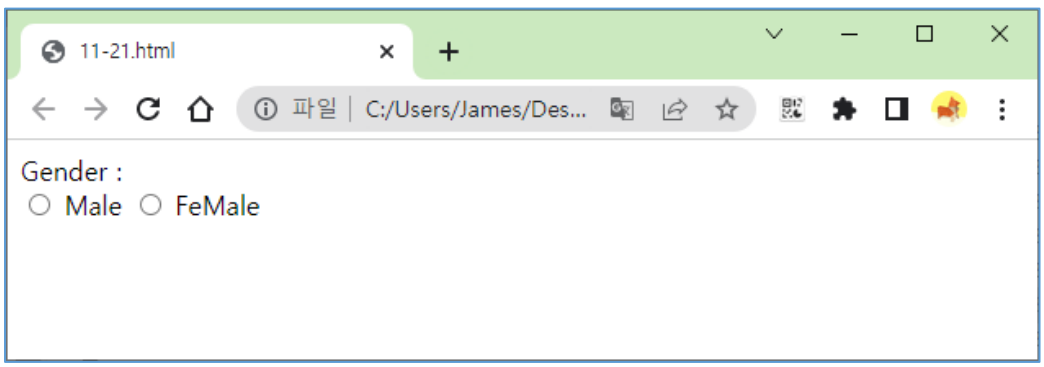


Figure 11.21: Radio Button

The checked attribute is used with radio buttons. This attribute does not have any value. It is only placed in the input tag.

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <label> Gender : </label> <br>
            <input type="radio" checked> <label> Male </label>
            <input type="radio"> <label> FeMale </label>
        </form>
    </body>
</html>
```

Similarly, the checked attribute can also be used with the checkboxes.

Checkbox

Checkboxes are used where a user can select multiple options.

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <label> Location : </label> <br>
            <input type="checkbox"> <label> Seoul </label>
            <input type="checkbox"> <label> CheongJu </label>
            <input type="checkbox"> <label> DaeJeon </label>
        </form>
    </body>
</html>
```

There are three checkboxes.

Figure 11.22: Checkboxes

Date

To get a date as user input, set the type attribute's value as a date.

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <label> My Birthday : </label> <br>
            <input type="date">
        </form>
    </body>
</html>
```

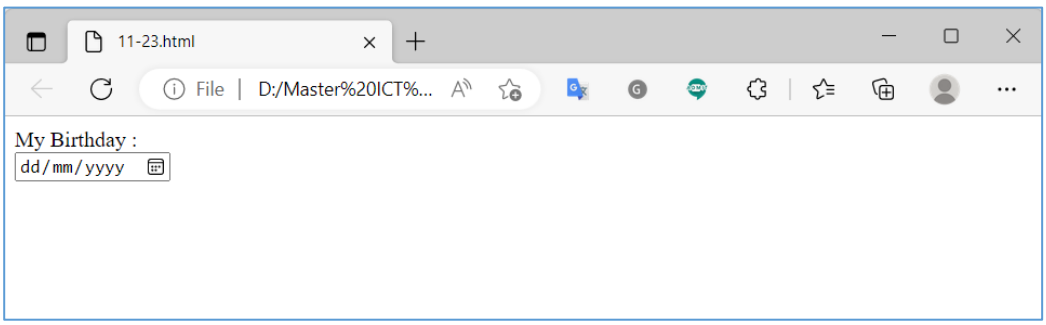


Figure 11.23: Date

Email

The email type is an input field that only accepts when the input is a valid email.

```
<!DOCTYPE html>
<html>
    <body>
        <form>
            <label> Email : </label> <br>
            <input type="email">
        </form>
    </body>
</html>
```

Others

There are several other input types, such as:

- **“file”:** allows user to upload a file
- **“color”:** allows user to pick a color
- **“number”:** text input that accepts only numbers.
- **“month”:** allows the user to select a month and year.
- **“time”:** allows the user to select the time.

Summary

In this chapter, you have learned:

The HTML <img> tag embeds an image in a web page.
Images are not technically inserted into a web page; images are linked to web pages.
The <img> tag creates a holding space for the referenced image.
The <img> tag is empty; it contains attributes only and does not have a closing tag.
The <img> tag has two required attributes:

- src - Specifies the path to the image
- alt - Specifies an alternate text for the image

Multimedia elements (like audio or video) are stored in media files. The most common way to discover the file type is to look at the file extension. Multimedia files have formats and extensions like: .wav, .mp3, .mp4, .mpg, .wmv, and .avi.

HTML tables allow web developers to arrange data into rows and columns. A table cell can contain all sorts of HTML elements: text, images, lists, links, other tables, etc.

HTML lists allow web developers to group a set of related items in lists. An unordered list starts with the <ul> tag. Each list item starts with the <li> tag. An ordered list starts with the <ol> tag. Each list item starts with the <li> tag.

An HTML form is used to collect user input. The user input is most often sent to a server for processing. The HTML <form> element is used to create an HTML form for user input. The <form> element is a container for different types of input elements, such as text fields, checkboxes, radio buttons, submit buttons, etc.

Questions

1) How do you insert an image in HTML?
2) How can you make a numbered list?
3) What is the correct HTML element for playing video files?
4) What is the correct HTML element for playing audio files?
5) Which HTML element defines navigation links?
6) What are the new <input> types for form validation in HTML5?
7) What are the different media types and formats supported by HTML?

Exercises

1) **Exercise 1:** Write HTML code to insert three images.
2) **Exercise 2:** Write HTML code to insert sound and video.
3) **Exercise 3:** Write HTML code to create a table using colonspan and rowspan attributes.
4) **Exercise 4:** Write HTML code to create types of lists in HTML – ordered, unordered, and described.
5) **Exercise 5:** Write HTMK code to create types of Forms in HTML – Input Text Field, Radio Buttons, Checkbox, Date, and Email.

Additional Reading:

1) https://www.w3schools.com/html/default.asp
2) https://www.codecademy.com/learn/learn-html

Chapter 12

Introduction to CSS

Learning Objective:

The objective of this chapter is to introduce CSS. It will give you a basic understanding of CSS, syntax, and ways of using CSS. This chapter will explain why we use CSS.

After completing this chapter, students should be able to:

- Explain what CSS is
- Implement syntax and ways of using CSS
- Explain how CSS works on a webpage

In this chapter, you will learn about:

12.1. Understand CSS

12.1. Understand CSS

We can create a basic structure of a web page with HTML tags. Almost everything, from text to images, can be created using these tags. But these tags provide a structure that is not appealing or attractive.

On the modern web, websites are attractive. Everything is appropriately presented with a lot of neatness and clarity. We can find text in different sizes, colors, or styles, backgrounds with different colors and images, and many more features. All of these presentations are done using CSS.

12.1.1. CSS, and Why We Use It

CSS stands for Cascading Style Sheets. It is another technology of the World Wide Web that is used to present an HTML document in a better way.

So, CSS is a stylesheet language that is used with HTML for formatting. It is another important part of web development because no website is complete with CSS today.

Have a look at eBay's homepage.

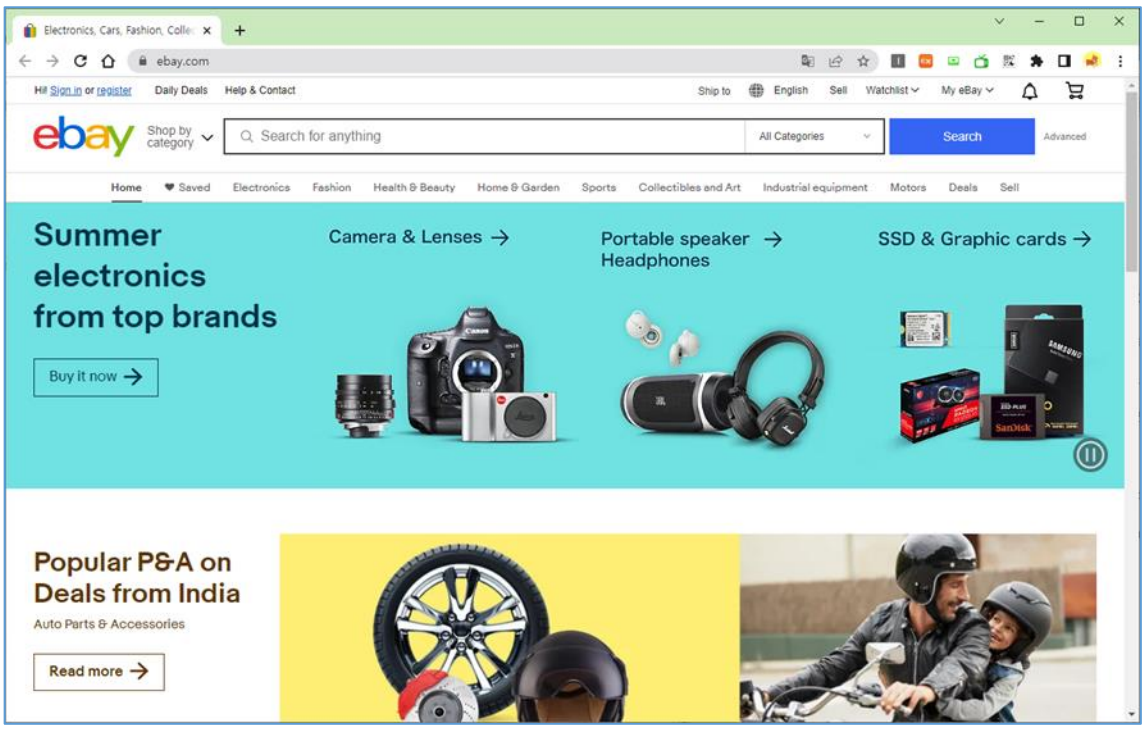


Figure 12.1: eBay's Homepage

Now, observe it again, this time with no CSS. (F12 ➔ console "document.head.parentNode.removeChild(document.head)"

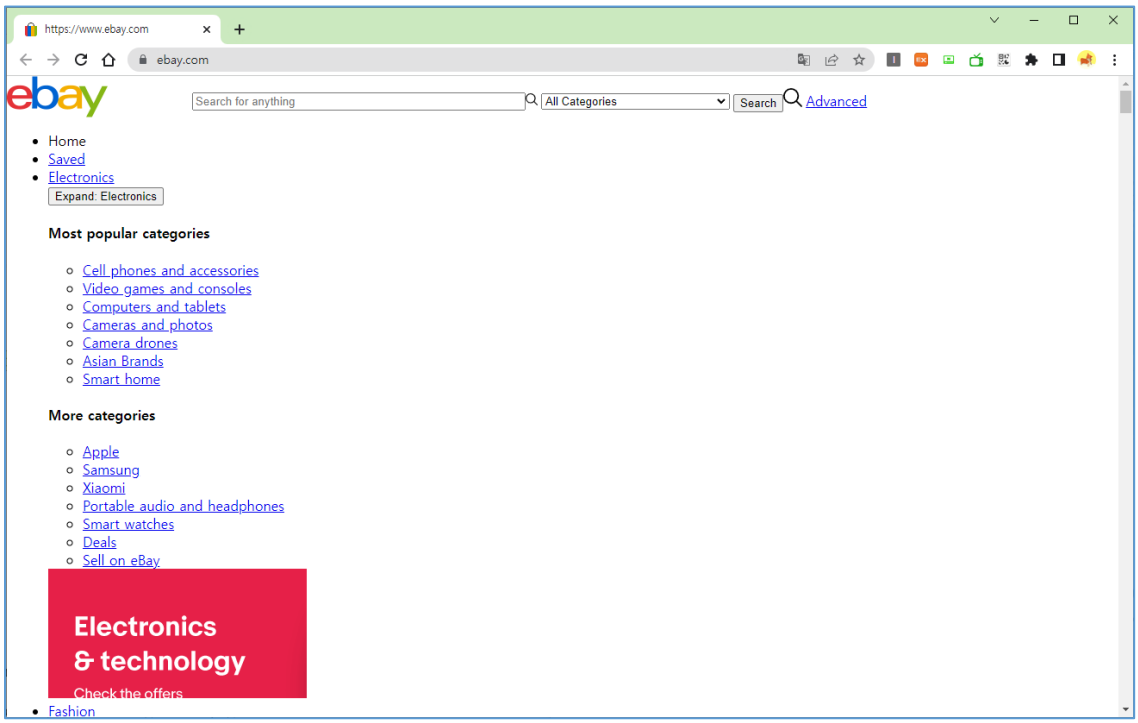


Figure 12.2: Example Page with no CSS

It is understandable how important CSS is. CSS not only turns a boring HTML page into an attractive one but also helps in placing the elements in proper positions.

12.1.2. Syntax and Ways of Using CSS

1) Syntax of CSS

So let's start with the syntax. There are two parts in the CSS rule set-selector and declaration.

CSS is applied to a particular HTML element or a group of HTML elements. But first, we need something to find these elements. A selector in CSS is used to find the HTML elements. The declaration block has the CSS. A single declaration has a key-value pair. The key is the CSS property and is separated from the value by a colon.

```
1  p {
2      color : red;
3  }
```

Here, p is the selector that selects the <p> tags in the document. There are several types of CSS selectors, and we will discuss them in a separate chapter.

The declaration block has one declaration, where “color” is the property, and “red” is its value. We can also have multiple declarations, and a semicolon should separate each declaration.

2) Ways of Using CSS

There are three ways of using CSS - External, Internal, and Inline.

External CSS

The external CSS is the right way when we have a lot of CSS, and the CSS is common in multiple HTML documents. As the name suggests, the CSS is written in a separate file with a .css extension.

```
p {
    color : red;
}

h1 {
    color : blue;
}
```

The name of this file is **example.css**. To use it in an HTML file, we need to include a reference to it in the head section of the HTML using the <link> tag.

```
<!DOCTYPE html>
<html>
    <head>
        <link rel="stylesheet" type="text/css" href="example.css">
    </head>

    <body>
        <p> This is red paragraph </p>

        <h1> This is red paragraph </h1>
    </body>
</html>
```

Observe the <link> tag. It has three mandatory attributes:

- **rel:** Specifies the relationship between the linked file and the current file. As the linked file is a CSS file, we have to specify “stylesheet” as its value.
- **type:** Specifies the media type of the file linked with the HTML file. The type of a CSS file is “type/CSS.”

- **href:** Specifies the location of the linked file.

This is how the <link> tag links the external CSS file with an HTML file.

Figure 12.3: External CSS

The paragraph's color and heading are red and blue, respectively.

Internal CSS

So external CSS should be preferred if CSS is common for multiple pages. But if there is a special CSS for a single page, use the internal CSS. In this way, the CSS is placed inside the <style> tag, which, in turn, is placed inside the head section.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            p {
                color : red;
            }

            h1 {
                color : blue;
            }
        </style>
    </head>

    <body>
        <p> This is red paragraph </p>

        <h1> This is red paragraph </h1>
    </body>
</html>
```

Inline CSS

The third way is a bit different. Every HTML tag has an attribute known as the style attribute. This attribute is used to specify CSS for a single tag.

```
<!DOCTYPE html>
<html>
    <body>
        <p style="color : red;"> This is red paragraph </p>

        <h1 style="color : blue;"> This is red paragraph </h1>
    </body>
</html>
```

3) Priority Order

The priority among the internal and external CSS depends upon the order in which they are placed inside the head section. The CSS, which is set later in the head section, has more priority.

12.1.3. CSS Selector

Selectors are one of two parts of the CSS rule-set. We discussed how to select an HTML element using its tag name. For example, the following CSS example sets all the <p> tag in the HTML file.

```
p {
    color : red;
}
```

It does not matter if there is only a single <p> tag in the HTML file or their hundreds; this CSS will be applied to all of them. But we do not want to use the same CSS for all the paragraphs. We can use red color for one section and blue for another. Similarly, there can be various other scenarios where CSS is needed only on some elements. There are different selectors for such scenarios.

1) Id Selector

Observe the following HTML code.

```
<!DOCTYPE html>
<html>
    <body>
        <p> This is red paragraph </p>
        <p> This is blue paragraph </p>
        <p> This is green paragraph </p>
    </body>
</html>
```

There are three paragraphs, but no CSS is applied to them. We have to give different colors to each paragraph. How can we do it? We must select a particular paragraph and apply a specific color. To do this, the id selector is used. Every element has an "id" attribute. Id given to an element should be unique.

```
<!DOCTYPE html>
<html>
    <body>
        <p id="redp"> This is red paragraph </p>
        <p id="bluep"> This is blue paragraph </p>
        <p id="greenp"> This is green paragraph </p>
    </body>
</html>
```

Each paragraph has a unique id, and unique CSS can be applied to each of them using this id. To select an element using the id, use the hash (#) sign followed by the id name.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #redp {
                color : red;
            }
        </style>
    </head>

    <body>
        <p id="redp"> This is red paragraph </p>
        <p id="bluep"> This is blue paragraph </p>
        <p id="greenp"> This is green paragraph </p>
    </body>
</html>
```

The CSS is applied to the paragraph whose id is "redp."

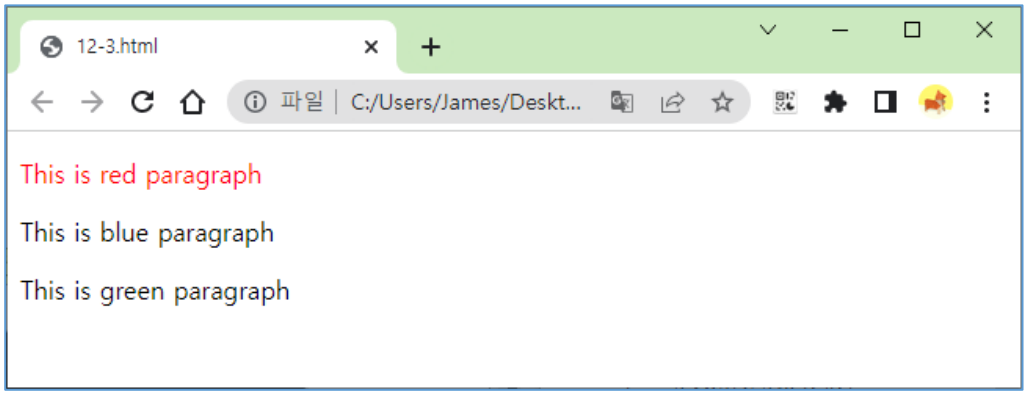


Figure 12.4: Id Selector

The color of the paragraph with the id “redp” is changed to red. Others are not affected. This is how the id selector is used to apply unique CSS to a particular element.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #redp {
                color : red;
            }
            #bluep {
                color : red;
            }
            #greenp {
                color : red;
            }
        </style>
    </head>

    <body>
        <p id="redp"> This is red paragraph </p>
        <p id="bluep"> This is blue paragraph </p>
        <p id="greenp"> This is green paragraph </p>
    </body>
</html>
```

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #redp {
                color : red;
            }
            #bluep {
                color : blue;
            }
            #greenp {
                color : green;
            }
        </style>
    </head>

    <body>
        <p id="redp"> This is red paragraph </p>
        <p id="bluep"> This is blue paragraph </p>
        <p id="greenp"> This is green paragraph </p>
    </body>
</html>
```

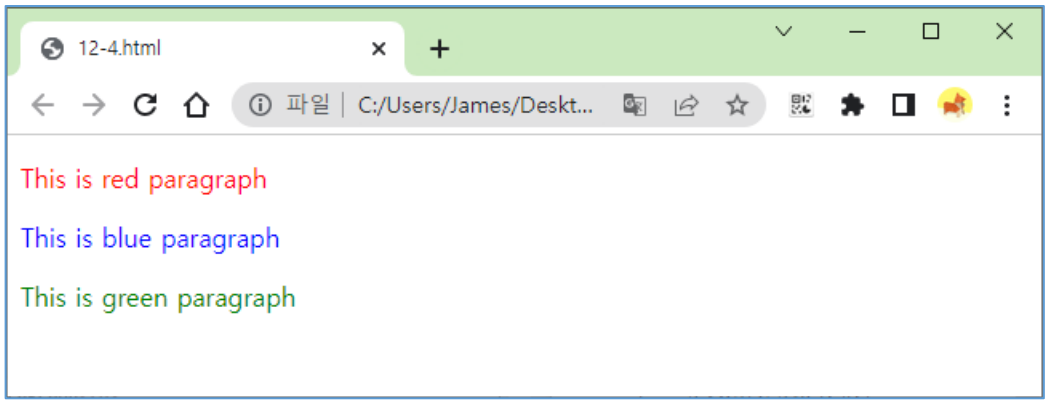


Figure 12.5: Color Paragraph

An id can never start with a number.

2) Class Selector

The id is usually unique for an element. But what if we need the same CSS for a group of elements? Not all, but some of them. Observe the following HTML file. Observe the following HTML code.

```
<!DOCTYPE html>
<html>
    <body>
        <p> This is red paragraph </p>
        <p> This is red paragraph </p>
        <p> This is red paragraph </p>

        <p> This is a paragraph </p>
        <p> This is a paragraph </p>
        <p> This is a paragraph </p>
    </body>
</html>
```

Out of all the six paragraphs, first, three should be red in color. We can give the same ids to them, and it will work. But it is not recommended at all. For such cases, we have another attribute known as the “class” attribute.

The class selector is used to give the same CSS to multiple elements. To use this type of selector, use a dot (.) followed by the class name. The same class is assigned for the first three <p> tags.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            .redp {
                color : red;
            }
        </style>
    </head>
    <body>
        <p class="redp"> This is red paragraph </p>
        <p class="redp"> This is red paragraph </p>
        <p class="redp"> This is red paragraph </p>

        <p> This is a paragraph </p>
        <p> This is a paragraph </p>
        <p> This is a paragraph </p>
    </body>
</html>
```

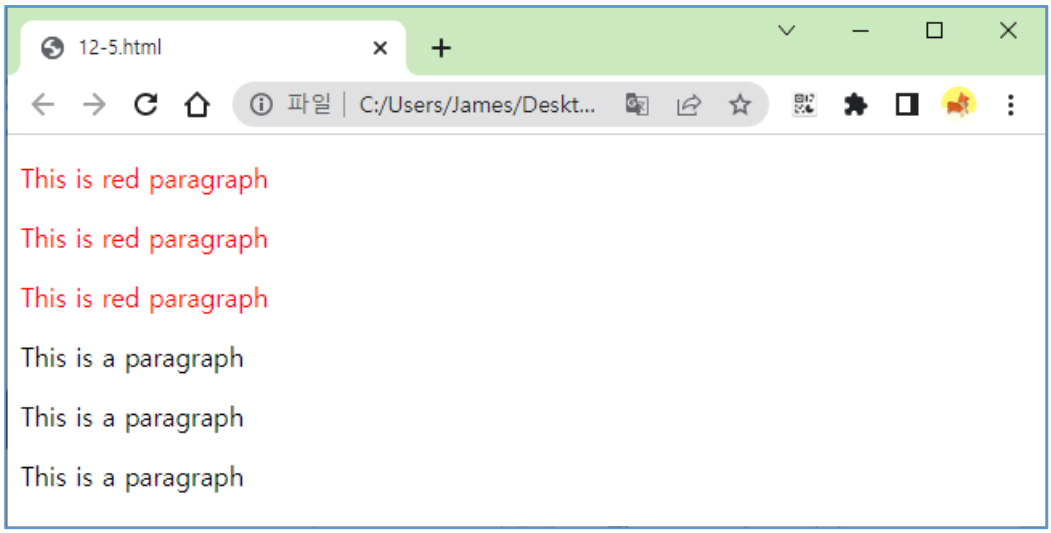


Figure 12.6: Class Selector

The CSS is applied to the first three paragraphs, while others are unaffected. Like id, a class name can also not start with a number.

3) Grouping Selector

Suppose there are a few elements with the same definition, and we want the same CSS.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            p {
                color : red;
            }
            h1 {
                color : red;
            }
            h4 {
                color : red;
            }
        </style>
    </head>

    <body>
        <p> This is a paragraph </p>

        <h1> This is a large heading </h1>

        <h4> This is a small heading </h4>
    </body>
</html>
```

The <p>, <h1>, <h4> tag have same definitions. Observe the code above. Each of them

has the same CSS defined separately. But why write separate code for each of them when the CSS is the same? We can use the class selector, but the class selector should be used for the same type of HTML element. In such a case, use the CSS grouping selector.

The CSS grouping selector is used to group different elements so that the same CSS can be applied to them. Just use the element names and separate them with commas.

```
1  <!DOCTYPE html>
2  <html>
3      <head>
4          <style>
5              p, h1, h4 {
6                  color : red;
7              }
8          </style>
9      </head>
10
11     <body>
12         <p> This is a paragraph </p>
13
14         <h1> This is a large heading </h1>
15
16         <h4> This is a small heading </h4>
17     </body>
18 </html>
```

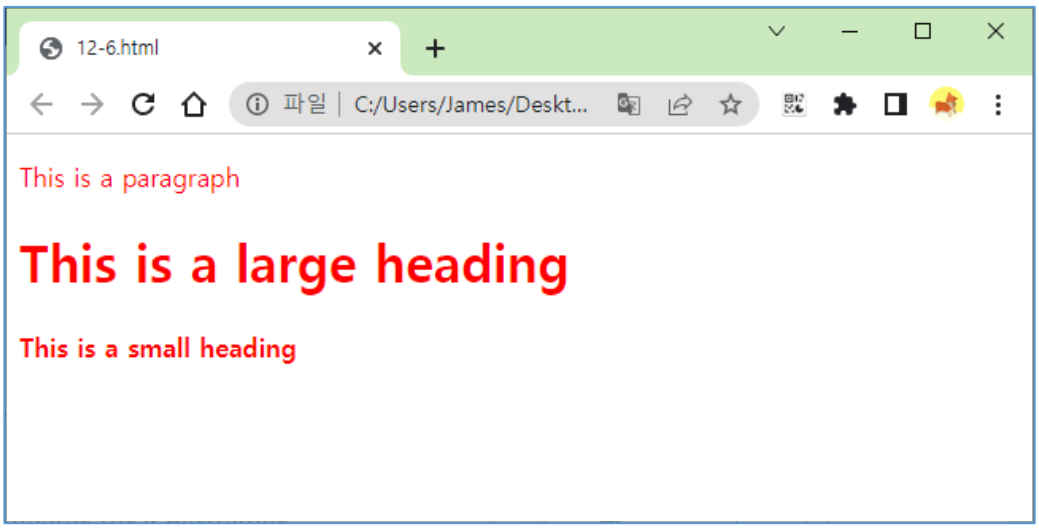


Figure 12.7: Grouping Selector

4) Universal Selector

So far, we have discussed using the id selector for a particular element, the class selector for multiple elements, and the grouping selector for different grouping elements with the exact definition. But what if we need the same CSS for every component of the HTML file? There is another selector called a universal selector for such cases.

Use the asterisk (*) sign to apply CSS to every element.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            * {
                color : red;
            }
        </style>
    </head>

    <body>
        <p> This is a paragraph </p>

        <h1> This is a large heading </h1>

        <h4> This is a small heading </h4>

        <p> This is a paragraph </p>

        <h6> This is an extra small heading </h6>
    </body>
</html>
```

The universal selector will apply CSS to every element.

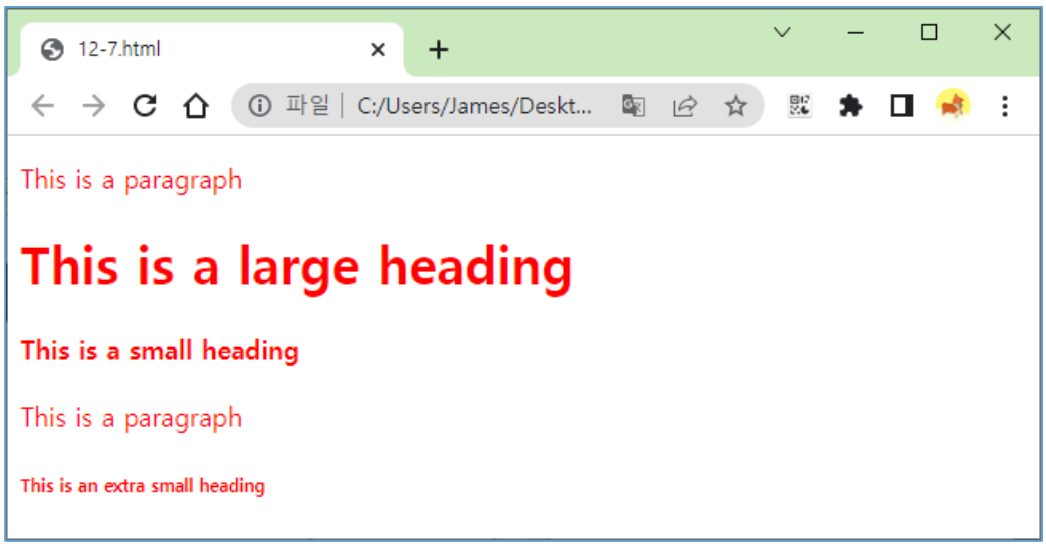


Figure 12.8: Universal Selector

12.1.4. CSS Text and Font

Without CSS, the text is boring. CSS has several properties that can be applied to any text, such as paragraphs and headings. The CSS properties for text are simple yet very important. We must do more than just add boring text on a web page. We must make enhancements such as adding color, setting alignment, etc.

The font is another very useful part. We can add text with different font styles and sizes using CSS fonts.

1) Color with CSS

In the recent CSS chapters, we saw how text color could be changed using the “color” property. The color property can have three values: color name, HEX value, and RGB value. Observe the following HTML code.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            p {
                color : red;
            }
        </style>
    </head>

    <body>
        <p> This is red paragraph </p>
    </body>
</html>
```

We can also change the background color of the text using the “background color” property.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            p {
                background-color : black;
                color : red;
            }
        </style>
    </head>

    <body>
        <p> This is red paragraph </p>
    </body>
</html>
```

Similar to the “color” property, the “background color” can also have the color name, HEX value, or RGB value as its value.

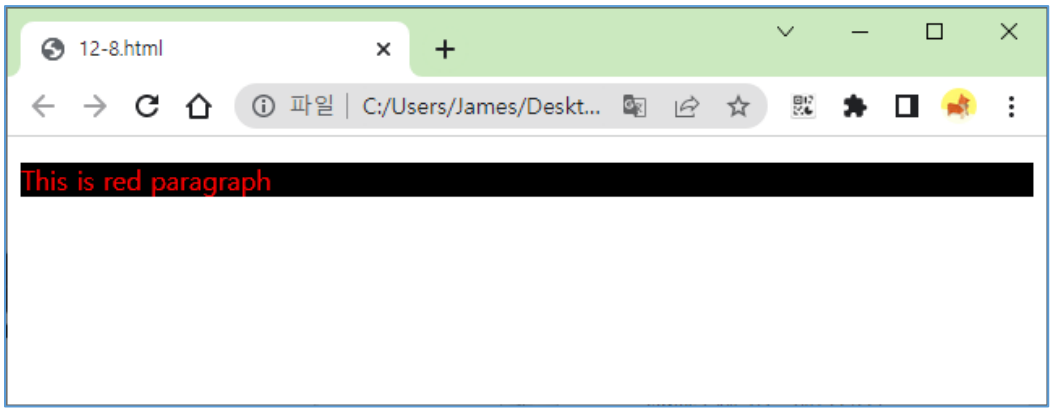


Figure 12.9: Color with CSS

2) Text Decoration

Generally, text in HTML does not have any decorations. Use the “text-decoration” property to add decorations or remove the default ones. The “text-decoration” property can have four values: underline, line-through, overline, and none. The first three values add decorations, while the last remove the default decoration.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #firstp {
                text-decoration : underline;
            }
            #secondp {
                text-decoration : line-through;
            }
            #thirdp {
                text-decoration : overerline;
            }
        </style>
    </head>

    <body>
        <p id="firstp"> First paragraph </p>
        <p id="secondp"> Second paragraph </p>
        <p id="thirdp"> Third paragraph </p>
    </body>
</html>
```

All three <p> tags have different text decorations - underline for the first, line-through for the second, and overline for the third.

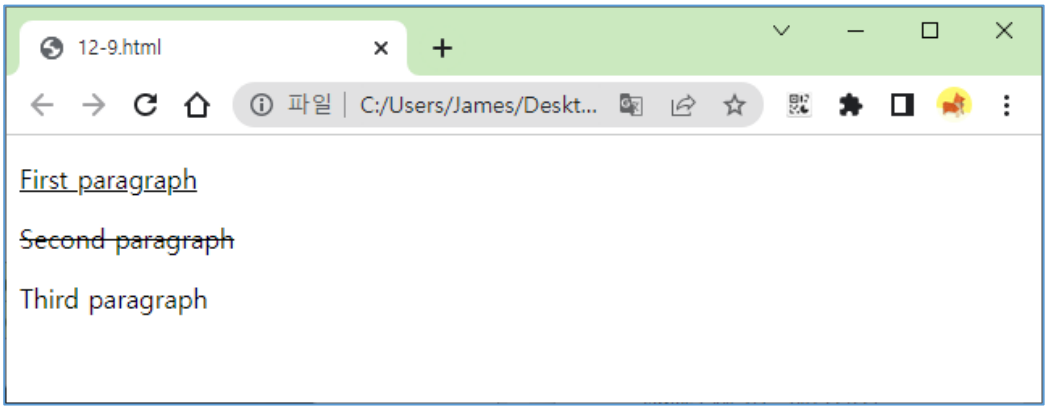


Figure 12.10: Text Decoration

If there is some default decoration, we can remove it using “none” as the value of “text-decoration.” For example, hyperlinks in HTML are underlined by default. Let's remove the underline using the “text-decoration” property.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #seconda {
                text-decoration : none;
            }
        </style>
    </head>

    <body>
        <a href="#" id="firsta"> Link with defalult decoration </a>
        <br>
        <a href="#" id="seconda"> Link without defalult decoration </a>
    </body>
</html>
```

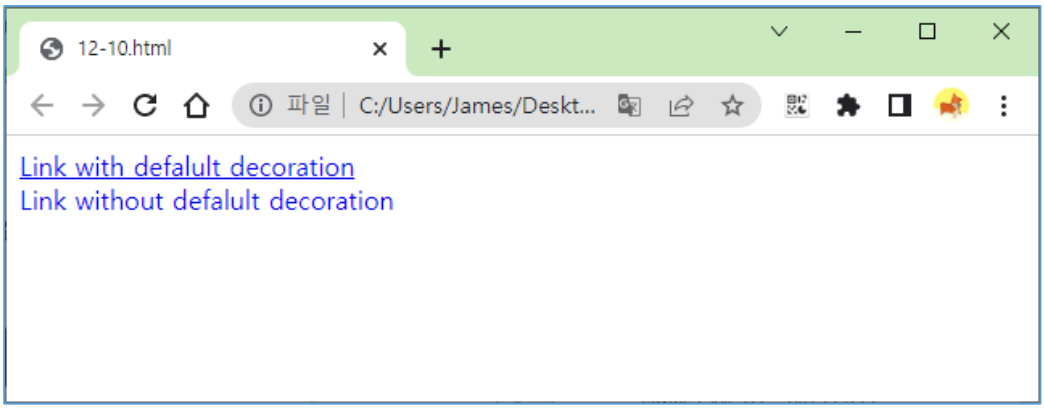


Figure 12.11: Link with Default Decoration

3) Aligning Text

By default, the text is always aligned to the left side of the container. But we can also change the alignment using CSS. The “text-align” property sets the horizontal alignment. It can have four values: left, right, and center.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #firstp {
                text-align : left;
            }
            #secondp {
                text-align : right;
            }
            #thirdp {
                text-align : center;
            }
        </style>
    </head>

    <body>
        <p id="firstp"> First paragraph </p>
        <p id="secondp"> Second paragraph </p>
        <p id="thirdp"> Third paragraph </p>
    </body>
</html>
```

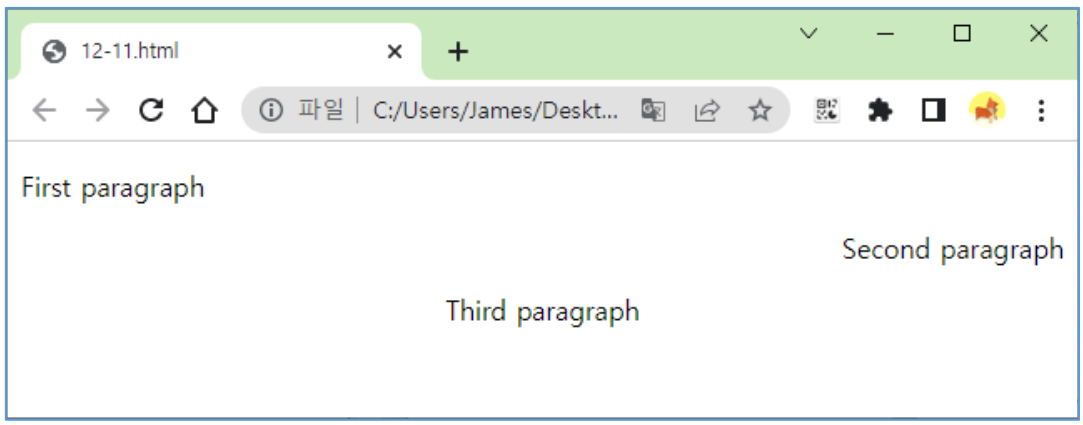


Figure 12.12: Aligning Text

4) CSS fonts

We can change the font family, size, style, and more by using CSS font properties.

- **font family:** To change the font family, use the “font-family” property. Sans-serif, Impact, and Courier are some of the most commonly used fonts in CSS.
- **font size:** The default size of a <p> tag is 16px (1em). To change the size, use the “font-size” property. The value can be in pixels, Em, or percentages.
- **bold font:** To make the font bold, use the “font-weight” property.

- **Italic font:** To make the font italic, use the “font-style” property.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #firstp {
                font-family : sans-serif;
            }
            #secondp {
                font-family : xxxx, impact;
            }
            #thirdp {
                font-size : 40px;
            }
            #fourthp {
                font-weight : bold;
            }
            #fifthp {
                font-style : italic;
            }
        </style>
    </head>

    <body>
        <p id="firstp"> First paragraph </p>
        <p id="secondp"> Second paragraph </p>
        <p id="thirdp"> Third paragraph </p>
        <p id="fourthp"> Fourth paragraph </p>
        <p id="fifthp"> Fifth paragraph </p>
    </body>
</html>
```

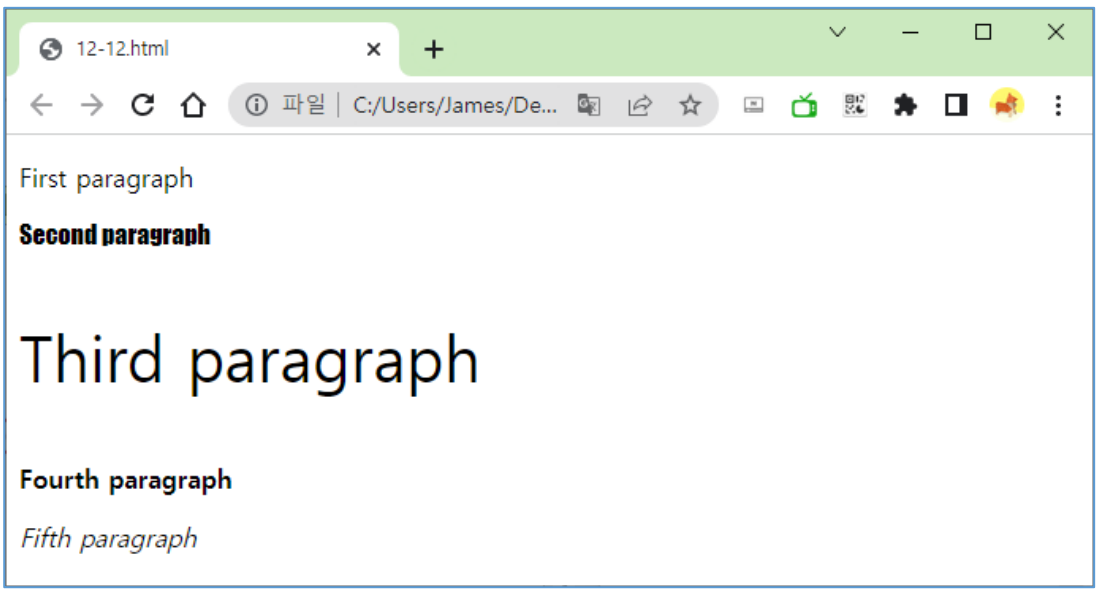
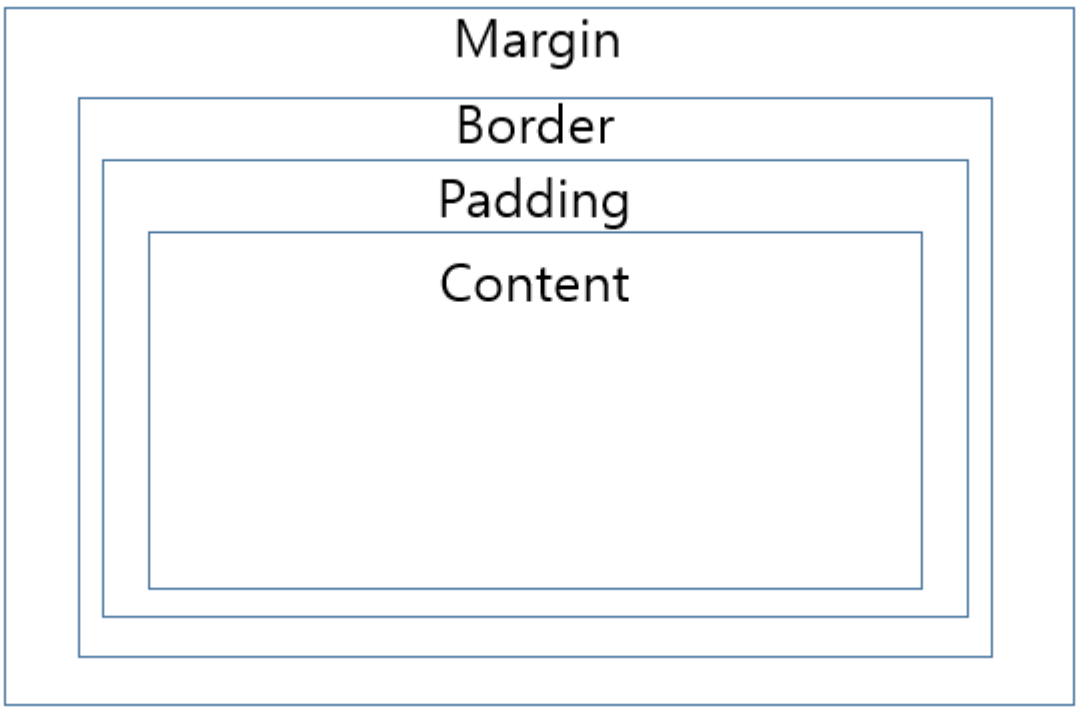


Figure 12.13: CSS Font

12.1.5. CSS borders, margin, and padding

Every HTML element has a border, margin, and padding. These three terms are important because the presentation depends on them. The border, margin, and padding are used for clarity and better looks. But before moving to them, you need to understand the CSS box model.

The HTML elements are enclosed inside a box. This box is knowns as the “CSS Box Model.” This model has four parts: the border, margin, padding, and content. By default, only content is visible, while the border is not, and the margin and padding are zero.



- The content can be text, images, etc.
- The border surrounds the content.
- The area between the content and the border is padding.
- The area outside the border is the margin.
- The border can be visible, depending on the CSS. But margin and padding are invisible.

1) Border

So as mentioned above, by default, there is no border for HTML elements. The “border-width” property defines the width of the border. Its value can be in px, cm, pt, em, or the three pre-defined values: thin, thick, or medium. Along with border width, we also need to define the style of the border using the “border-style” property. The border-style property can have solid, dotted, and dashed values.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #firstp {
                border-width : 2xp;
                border-style : solid;
            }
        </style>
    </head>

    <body>
        <p id="firstp"> First paragraph with border </p>
    </body>
</html>
```

The <p> tag has a "border-width" of 2px and a solid "border-style."

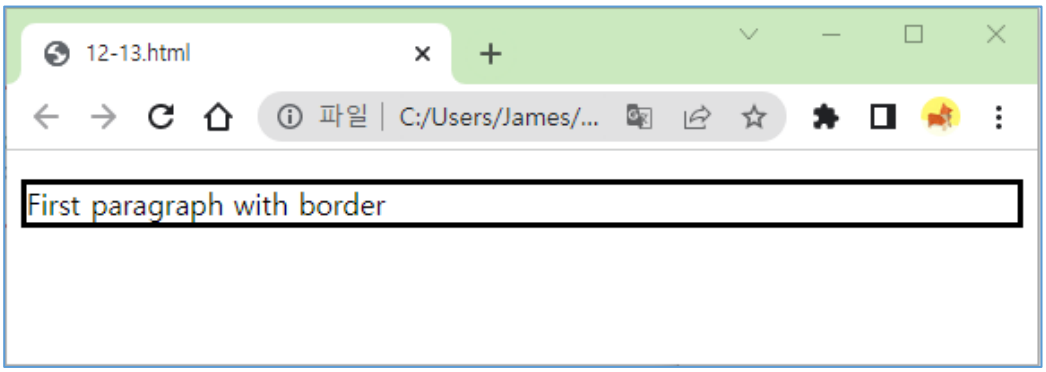


Figure 12.14: CSS Border

Let’s try some other variants.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #firstp {
                border-width : 2xp;
                border-style : solid;
            }
            #secondp {
                border-width : 5xp;
                border-style : dashed;
            }
            #thirdp {
                border-width : thin;
                border-style : dotted;
            }
        </style>
    </head>

    <body>
        <p id="firstp"> First paragraph with border </p>
        <p id="secondp"> Second paragraph with border </p>
        <p id="thirdp"> Third paragraph with border </p>
    </body>
</html>
```

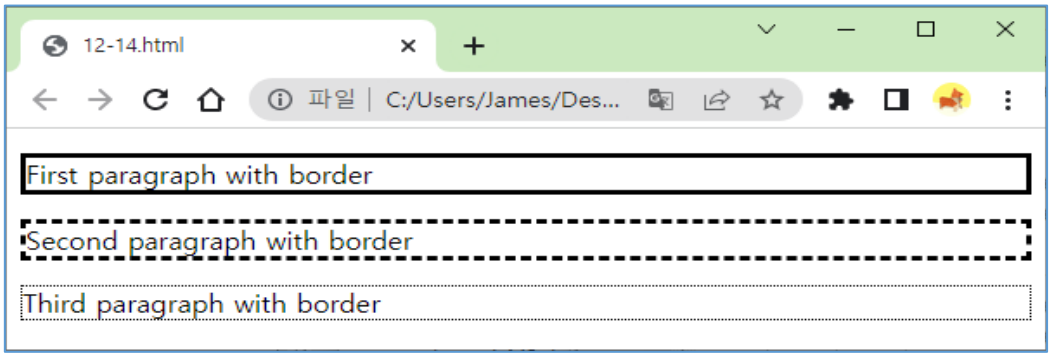


Figure 12.15: CSS Border

By default, the color of the border is black. But it can be changed using the “border-color” property. The value of the “border-color” property can be a color name, HEX value, RGB value, HSL value, or transparent.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            #firstp {
                border-width : 2xp;
                border-style : solid;
                border-color : blue
            }
        </style>
    </head>

    <body>
        <p id="firstp"> First paragraph with border </p>
    </body>
</html>
```

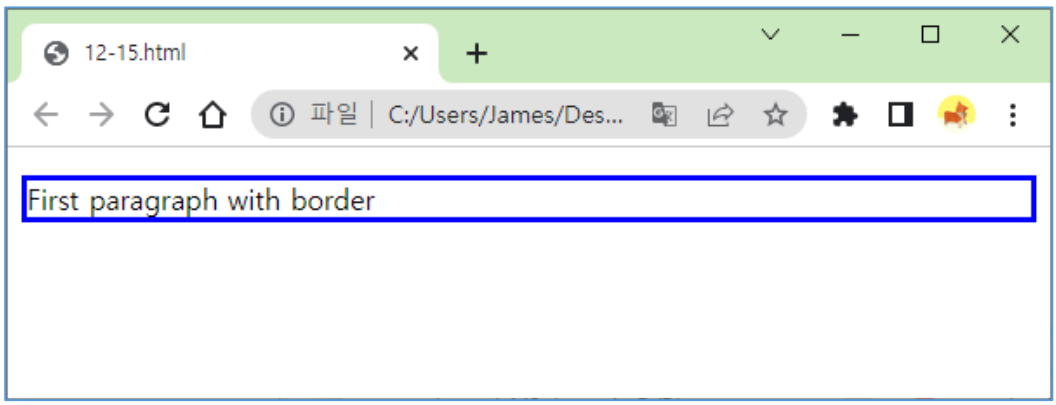


Figure 12.16: CSS Color Border

2) Tables with Border

To add the border, we can use any property we discussed. Let's go with the "border" property. To create a proper border on a table, we must apply CSS to the <table> tag and the <td> tag.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            table, td {
                border : 2px solid blue;
            }
        </style>
    </head>

    <body>
        <table>
            <tr>
                <td> column1 </td>
                <td> column2 </td>
            </tr>
            <tr>
                <td> column1 </td>
                <td> column2 </td>
            </tr>
        </table>
    </body>
</html>
```

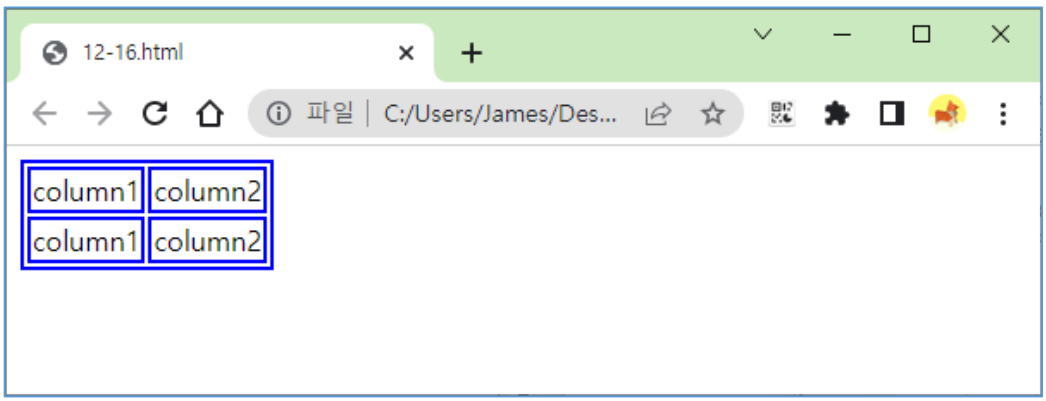


Figure 12.17: Table with Border

3) Margin

To understand, we need to create the content inside a tag. This tag defines a section or division in an HTML document. Both <p> and tags have a border of 2px.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            div {
                border : 2px solid black;
            }
            p {
                border : 2px solid red;
            }
        </style>
    </head>

    <body>
        <div>
            <p> This is a prargraph </p>
        </div>
    </body>
</html>
```

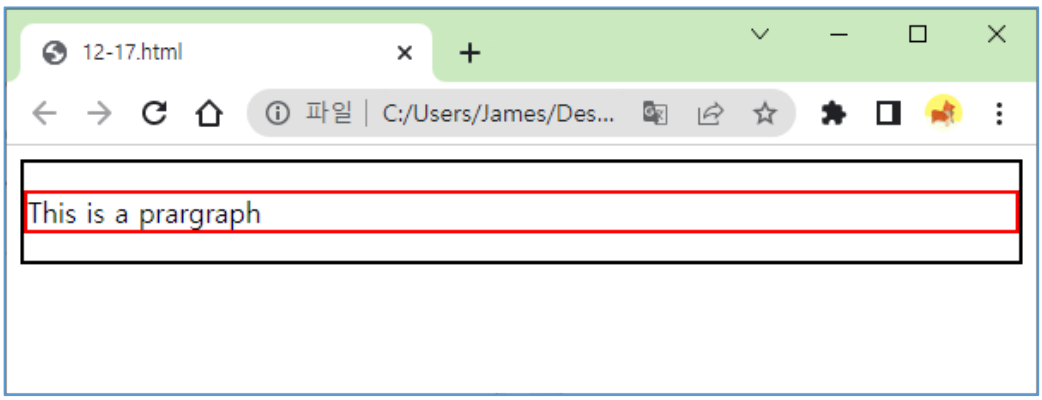


Figure 12.18: CSS Margin

The area between the red line and the black line is the margin for the <p> tag. We can use the "margin" property to set the margin in all directions. Let's remove the default margin by setting its value to 0px.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            div {
                border : 2px solid black;
            }
            p {
                border : 2px solid red;
                margin : 0px;
            }
        </style>
    </head>

    <body>
        <div>
            <p> This is a prargraph </p>
        </div>
    </body>
</html>
```

There is no margin now.

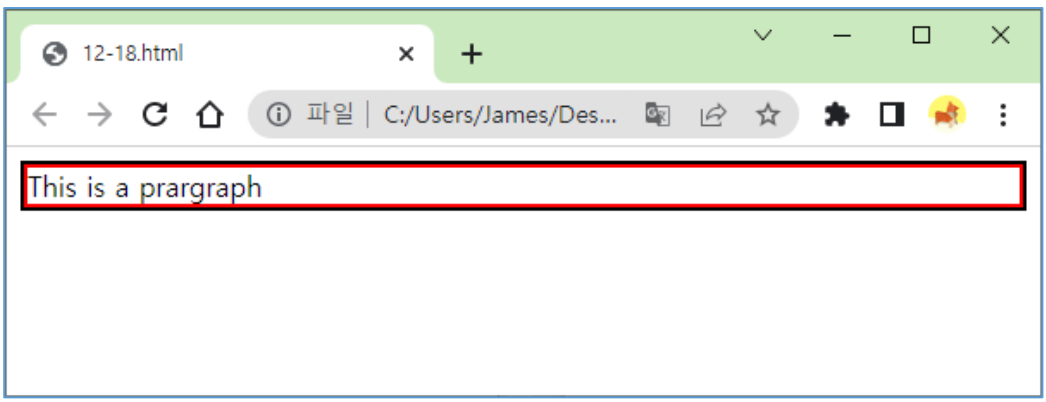


Figure 12.19: CSS Margin

To set the margin in a particular direction, we have four different properties: “margin-top,” “margin-bottom,” “margin-right,” and “margin-left.”

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            div {
                border : 2px solid black;
            }
            p {
                border : 2px solid red;
                margin-top : 10px;
                margin-bottom : 20px;
                margin-left : 30px;
                margin-right : 40px;
            }
        </style>
    </head>

    <body>
        <div>
            <p> This is a prargraph </p>
        </div>
    </body>
</html>
```

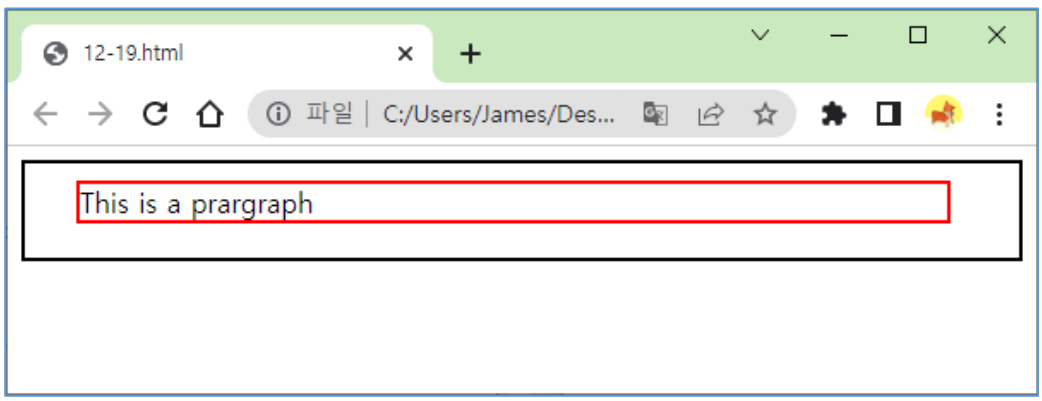


Figure 12.20: CSS Margin

The “margin” property is a shorthand property. We can also use the “margin” property to set different margins for each direction. Here, the margin on top is 10px, the right is 20px, the bottom is 30px, and the left is 40px.

```
4       <style>
5           div {
6               border : 2px solid black;
7           }
8           p {
9               border : 2px solid red;
10              margin : 10px 20px 30px 40px;
11          }
12      </style>
```

Another way to use the margin property is by giving only two values.

```
4       <style>
5           div {
6               border : 2px solid black;
7           }
8           p {
9               border : 2px solid red;
10              margin : 10px 20px;
11          }
12      </style>
```

Here, the value for the top and bottom margins is 10px, while the value for the right and left is 20px.

4) Padding

For padding, we also have properties like “padding-top,” “padding-bottom,” “padding-right,” and “padding-left.” Moreover, the “padding” property is shorthand, like the "margin" property.

12.1.6. CSS Backgrounds

By default, every HTML page has a white background. It is boring. There are a few CSS properties that can be used to manipulate backgrounds. We can change the background color or add an image to the background.

1) Backgrounds

We can change the background color of any HTML element using the “background color” property. The <p> tag has a red background color.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            p {
                background-color : red;
            }
        </style>
    </head>

    <body>
        <div>
            <p> This is a prargraph </p>
        </div>
    </body>
</html>
```

But generally, the “background-color” property is used to set the background of the entire page. To do this, we have to add the “background-color” property to the body of the page. Remember, any CSS added to the body will affect the entire HTML page. Other than the color name, we can assign the HEX or RGB value as the “background color” property value.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            body {
                background-color : red;
            }
        </style>
    </head>

    <body>


    </body>
</html>
```

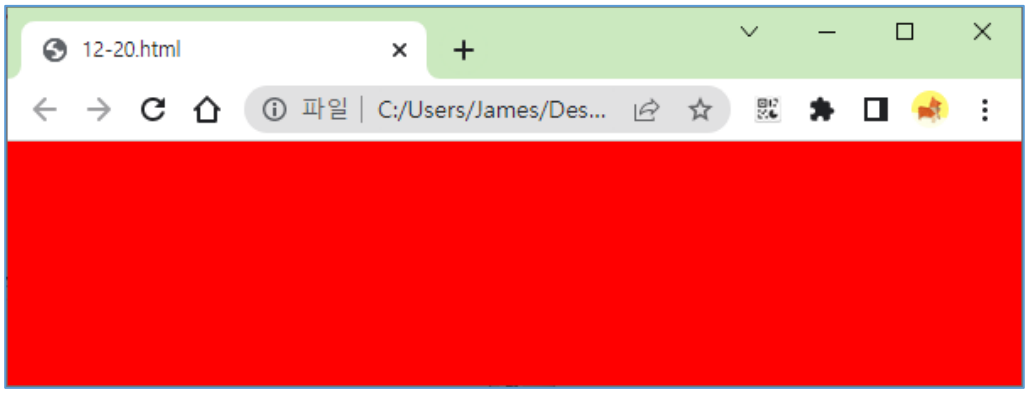


Figure 12.21: CSS Background

2) Background Image

Apart from color, we can also set an image as the background using the background-color property. Use the url () method as its value and pass the link of the image as an argument.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            body {
                background-image : url("./mountain.png");
            }
        </style>
    </head>

    <body>


    </body>
</html>
```

The image appears in the background, but it needs to be in the proper way. To adjust the image properly, we have additional CSS properties.

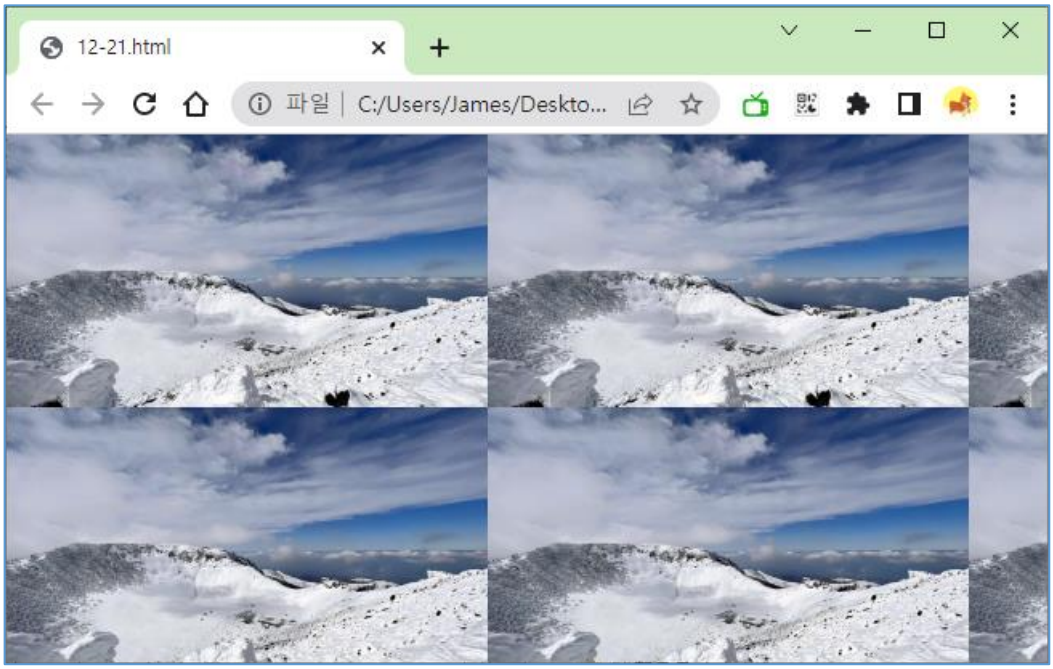


Figure 12.22: CSS Background Image

3) Background repeat

In the above example, the background image is repeated. This happens because the image is set according to its actual size. To prevent the image from repeating, use the background-repeat property and set no-repeat as its value.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            body {
                background-image : url("./mountain.png");
                background-repeat : no-repeat;
            }
        </style>
    </head>

    <body>


    </body>
</html>
```

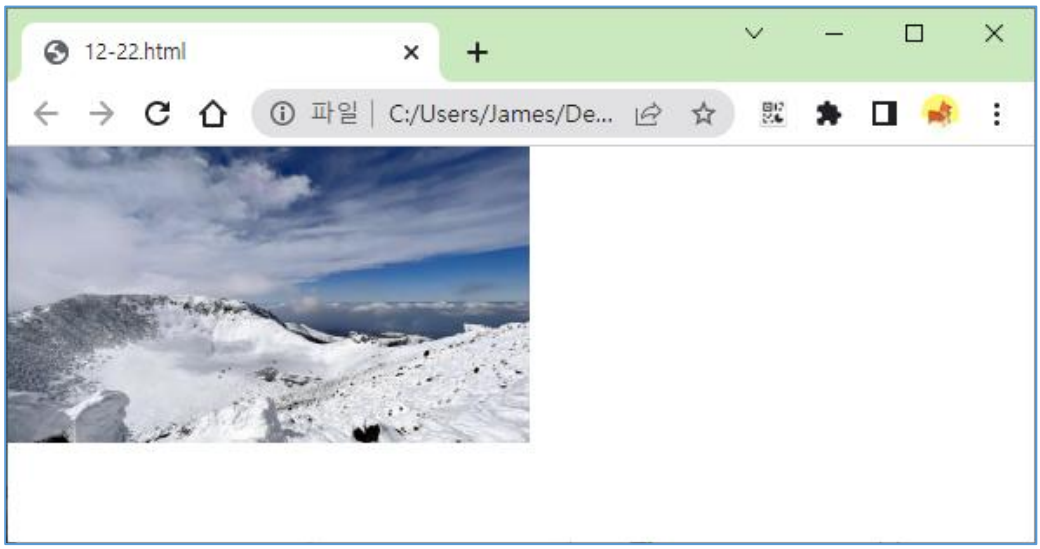


Figure 12.23: Background Repeat

The background image is not repeated now. Apart from no-repeat, we can use repeat-x and repeat-y to repeat the background horizontally and vertically, respectively.

4) Background Cover

Still, the background image does not appear as property. It should cover the whole window; to do this, use the background-size property and set cover as its value.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            body {
                background-image : url("./mountain.png");
                background-repeat : no-repeat;
                background-size : cover;
            }
        </style>
    </head>

    <body>


    </body>
</html>
```

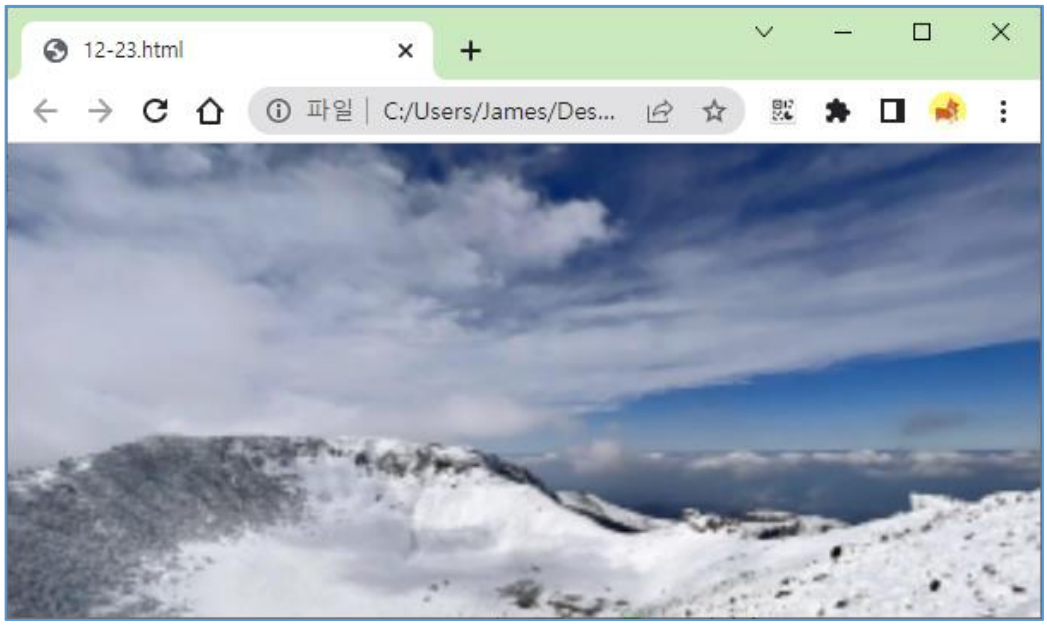


Figure 12.24: Background cover

There are other properties such as “background-attachment”, which is used to specify if the image is fixed or scrollable, and “background-position” to set the position of the image.

Summary

In this chapter, you have learned:

CSS stands for Cascading Style Sheets. Cascading Style Sheets (CSS) are used to format the layout of a webpage. With CSS, you can control the color, font, size of text, spacing between elements, how elements are positioned and laid out, what background images or background colors are to be used, different displays for different devices and screen sizes, and much more.

CSS can be added to HTML documents in 3 ways:

- **Inline** - by using the style attribute inside HTML elements
- **Internal** - by using a <style> element in the <head> section
- **External** - by using an <link> element to link to an external CSS file

An inline CSS is used to apply a unique style to a single HTML element. An inline CSS uses the style attribute of an HTML element. The following example sets the text color of the <h1> element to blue and the text color of the <p> element to red:

Example:
```
<h1 style="color:blue;">A Blue Heading</h1>
<p style="color:red;">A red paragraph.</p>
```

An internal CSS is used to define a style for a single HTML page. An internal CSS is defined within an HTML page's <head> section within an <style> element.

An external style sheet is used to define the style for many HTML pages. The exterior style sheet can be written in any text editor. The file must not contain any HTML code and must be saved with a .css extension.

Every HTML element has a border, margin, and padding. These three terms are important because the presentation depends on them. The border, margin, and padding are used for clarity and better looks.

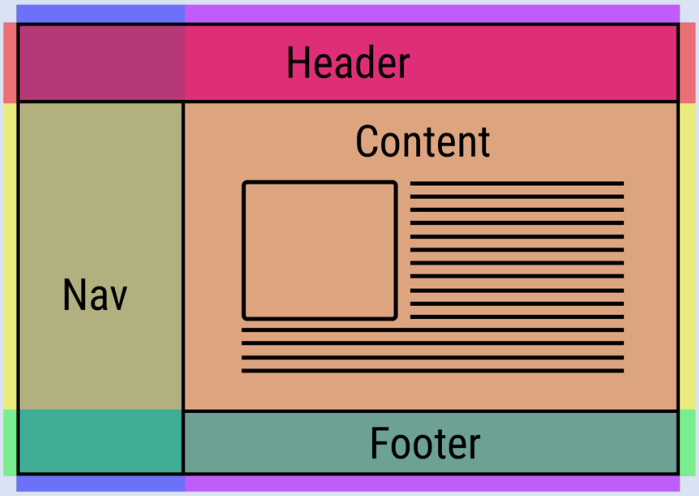
- CSS border properties allow you to specify the style, width, and color of an element's border.
- CSS margins are used to create space around elements outside any defined borders.
- CSS padding is used to create space around an element's content inside of any defined borders.

Questions

1) What is CSS? Why do we need CSS on our websites?
2) Describe the general syntax of CSS.
3) How can we apply CSS to HTML?
4) What is different between Inline, Internal and External CSS?
5) What is a selector? How many types of selectors are there? What are they?
6) What is different between the padding, border, and margin properties?

Exercises

Create your own website with the following layout by using HTML and CSS:



Additional Reading:

1) https://www.w3schools.com/css/default.asp
2) https://www.codecademy.com/learn/learn-css

Chapter 13

JavaScript and DOM

Learning Objective:

The objective of this chapter is to introduce JavaScript. It will provide you with a basic understanding of what JavaScript is. This chapter will explain the syntax of writing JavaScript and some functions.

After completing this chapter, students should be able to:

- Explain what JavaScript is
- Implement JavaScript
- Implement HTML events and JavaScript

In this chapter, you will learn the following:

13.1. JavaScript

So far, we have discussed HTML and CSS, and now we know how to create a web page and give it styles. But still, everything is just a presentation. For example, we can create a button using the <button> tag and apply any CSS to it. But nothing happens when the button is clicked. This is static, and today, websites are dynamic.

Things change on a website without reloading the page. JavaScript is used to make these HTML elements dynamic. JavaScript is a vast programming language. It has too many concepts. There is so much in JavaScript, from the beginner to the advanced level. Then, we have node.js and various frameworks and libraries. As mentioned, it is vast and immense. But we don't need to go this far because this is an introduction.

The main focus of this section is to explain how to use JavaScript with HTML and CSS. We will start with the basics of JavaScript, such as declaring variables and operating functions. Then, we will move to DOM and how to use JavaScript with HTML and CSS. But before proceeding further, let's discuss JavaScript and history briefly.

13.1.1. What is JavaScript?

The web was young in the early to mid-1990s, and everything was static. HTML was the only web at that time. People soon realized that the web could not be static only; it needed to be dynamic, and features like animations and interactions should exist. To make the web dynamic, DOM manipulation was required, and a scripting language was needed. But at that time, Java was emerging in the web community. So the developers decided to create a simple scripting language for designing while the heavy tasks were left for Java. Brendan Eich created JavaScript in the year 1996 when he was working at Netscape communication. JavaScript was created in only ten days. It was not supposed to be what it is today.

By definition, JavaScript is a high-level, multi-paradigm programming language. It is one of the core technologies of the World Wide Web (WWW), the other two being HTML and CSS. JavaScript is a crucial and essential part of web application development. HTML creates a basic structure, and CSS transforms it into an attractive version. A website with only HTML and CSS is a static website without use. But a web application

is not about structure and presentation. The main focus of a website is user interaction. Suppose there is a beautiful button on a web page, but it is useless if nothing happens when clicked. You can make a button work by applying JavaScript to it. If you need a dynamic website, use JavaScript with HTML and CSS.

1) Basics of JavaScript

JavaScript is a vast programming language that covers several concepts and, most importantly, many of these concepts in different ways. We are not learning JavaScript in this course, but discussing some basics, such as variables and functions, is necessary. Before starting JavaScript with HTML and CSS, let's go through some basics of JavaScript programming language.

Variables

Let's start with one of the most basic terms used in programming - variable. A variable is defined as a container that is used to hold values.

```
1  var x;
2  var y;
3  var z;
```

x, y, and z are three variables that are declared using the "var" keyword. Two other keywords can also be used to declare variables - let and const.

As of now, these variables do not hold any values. To initialize them, we use the assignment operator (=).

```
1  var x = 1;
2  var y = 2;
3  var z = 3;
```

Declaring a variable with values is called initializing. We can also change these values later by using the assignment operator.

```
1  var x = 1;
2  var y = 2;
3  var z = 3;
4
5  x = 100;
```

Data Type

A variable holds data. Several types of data can be stored in a variable. In the above example, all the variables had numerical values. We can also store single-precision numbers, double-precision numbers, strings, boolean values, objects, dates, etc., in a variable. These are different data types used in the programming world. A data type indicates the characteristics of the data stored in a variable.

In other programming languages, such as Java, it is mandatory to specify the data type of a variable while declaring. Moreover, a variable can hold only that type of data. But there are no such restrictions in JavaScript. Data types in JavaScript are divided into two categories - Primitive and Non-primitive.

Following is the list of Primitive data types:

- Number
- String
- Boolean
- Undefined

```
var num = 100;
var str = "Hello World";
var bool = true;
var und = undefined;
```

Following is the list of non-primitive data types:

- Object
- Array
- Date

```
var obj = {
    str : "Hello World"
}
var date = new Date();
var arr = [1,2,3,4,5];
```

If you know any popular programming language, you will quickly understand all these data types.

2) Functions

While coding, we may face situations when we need to execute the same code at different times. For example, we need to find the sum of two numbers five times in a program. The numbers are other every time (unclear). We need to write the same logic five times throughout the program. It will work fine, but is it efficient? The answer is no. It could be more efficient because writing the same part repeatedly increases the length of the code and the time and effort. Here enters the concept of functions.

Functions are called the main building blocks of a program. They provide code reusability and help reduce time and effort. For the above example, we can create a function that accepts two values and returns their sum. We can call this function anytime, anywhere we want, thus removing the need for repetition.

Functions are one of the most important parts of programming. Almost every language has the concept of functions. In this chapter, we will discuss all functions in JavaScript.

3) Declaring a Function

We need the 'function' keyword to create a function in JavaScript. Observe the following JavaScript code.

```
1  function demoFunction() {
2      console.log("This is a function");
3  }
```

A function in JavaScript is declared using the 'function' keyword followed by the name of the function and two parentheses. In the above code, the function's name is 'demoFunction.' We can also see parenthesis attached to it. These parentheses can be empty or can have parameters. We will discuss the parameters later in the lesson. Currently, there are no parameters for this function. The function's body is written inside the curly brackets, similar to if and switch statements.

4) Calling a Function

Declaring a function is not enough. Everything will happen once the function is called. To call a function, write the function's name with the parenthesis.

```
1  function demoFunction() {
2      console.log("This is a function");
3  }
4
5  demoFunction();
```

Let's execute the above code and check the output. You must have the "**node.js**" program installed on your computer.

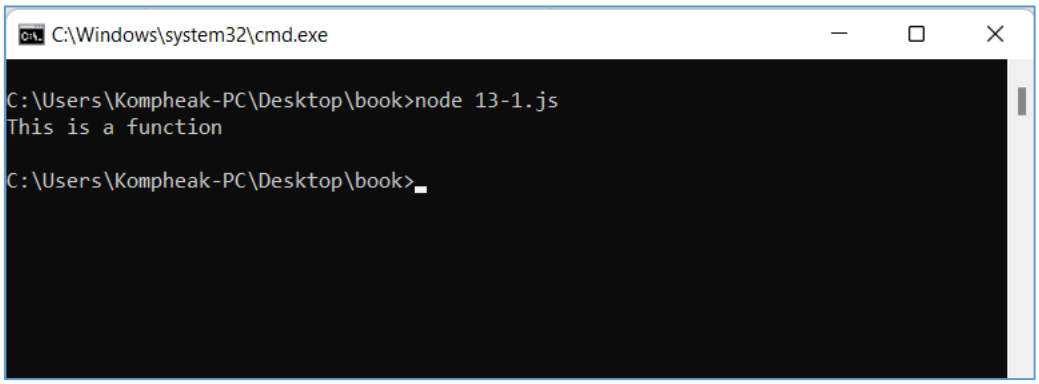


Figure 13.1: 13-1 Console

The function is executed once because I called it only a single time. The main objective of using functions is to avoid code repetition and offer better code reusability.

Let's see how this is possible with functions.

```
1  function demoFunction() {
2      console.log("This is a function");
3  }
4
5  demoFunction();
6  demoFunction();
7  demoFunction();
```

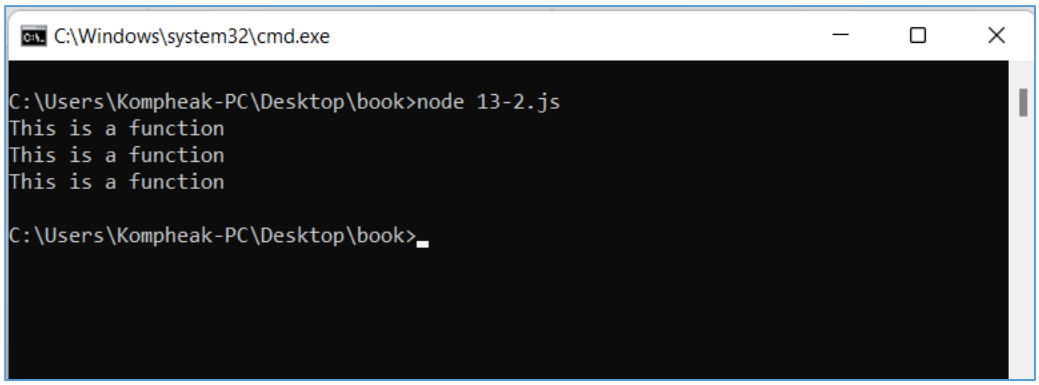


Figure 13.2: 13-2 console

The console statement inside the demoFunction() is executed three times, while it was written once. This is the benefit of using functions. Create a function and call it anytime and anywhere we want.

5) Parameters

We can always pass data to a function. The data is passed as parameters or also known as arguments. Let's go to the example we discussed earlier in this lesson.

```
1  function add(a, b)
2      console.log("Sum of a and b is: ", a+b);
3  }
```

Observe the add() function. We can see that it has two parameters - a and b, which are then used inside the function body. Similarly, we need to pass the values of these parameters while calling the function.

```
1  function add(a, b) {
2      console.log("Sum of a and b is: ", a+b);
3  }
4
5  add(10, 20)
```

The value of (a) is 10 and (b) is 20. Let's check the output.

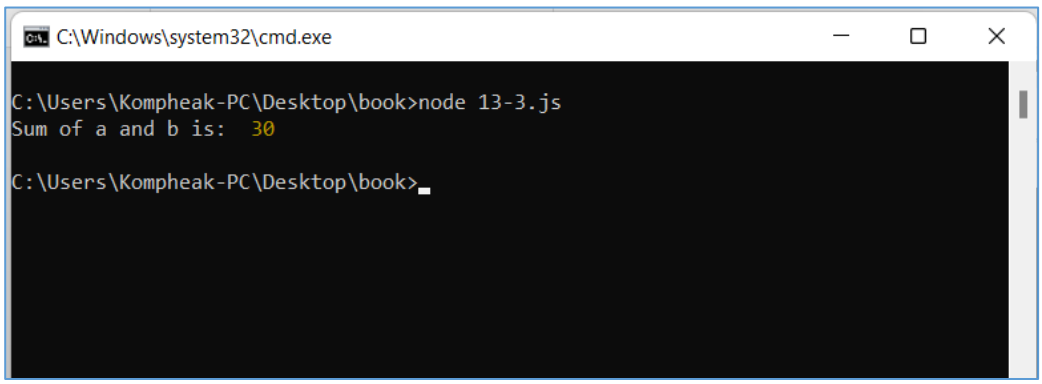


Figure 13.3: 13-3 console

13.1.2. DOM

1) What is DOM?

DOM stands for Document Object Model. It is a fundamental concept on the road to becoming a web developer. So in this chapter, we will discuss DOM and how it is used with JavaScript.

A tree-like structure is created when the HTML file is loaded into a browser. This structure has various nodes, and these nodes represent various elements of the HTML document. Things change on a website without:

```
1  <!DOCTYPE html>
2  <html>
3      <head>
4      </head>
5      <body>
6          <p>
7              This is a paragraph.
8          </p>
9      </body>
10 </html>
```

The DOM structure of the HTML document will look like the following structure.

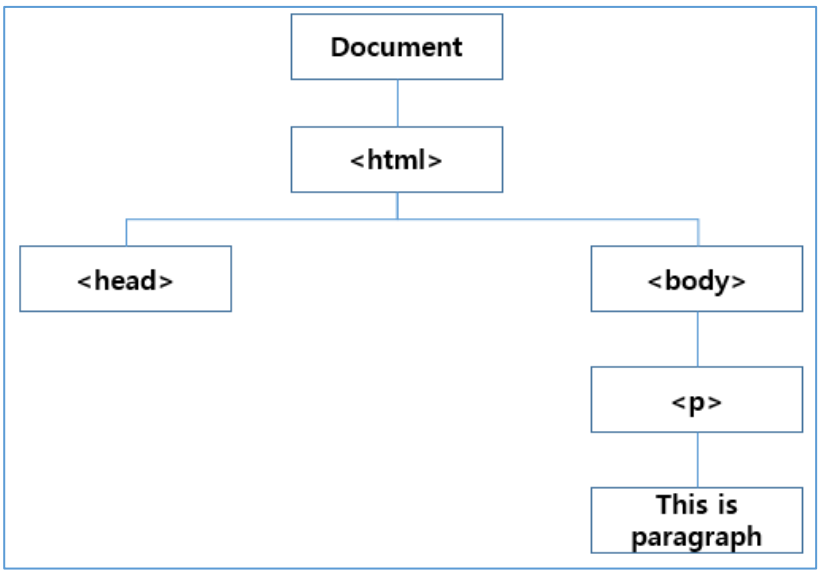


Figure 13.4: DOM Structure of the HTML

The structure starts from <html> tag, which is also the root element. Then, <head> and <body> are two different nodes. In the body, there is a <p> tag which is a node of the <body> tag. The tree structure will grow as more tags are added to the HTML document.

2) Use of DOM

So far, we have created HTML documents using various tags and then applied CSS. Everything is still static. Once loaded in the browser, nothing changes. But websites are not like that.

Suppose there is a button, and when you clicked on that button, something happened. Say the button clicked changes the text of a <p> tag. This is done by manipulating DOM with the help of JavaScript. In simple words, JavaScript creates dynamic HTML by changing the DOM tree.

Take the above example. To change the content of the <p> tag, we will use JavaScript to access that node, and then by using various DOM methods, it is manipulated accordingly. With JavaScript, we can manipulate almost everything in HTML, such as content and styles, and even add new elements and remove existing ones.

13.2. HTML Events and JavaScript

13.2.1. HTML Events

HTML events are attributes that are used to make something happen. For example, a button clicked popping a message. Another example is, popping a message when the page loads or input changes.

HTML events are significant because they convert static HTML elements into dynamic ones. One of the most important uses of these events is that JavaScript functions can be triggered using them. Although basic DOM manipulation can be done using HTML, serious manipulation is done using functions. This is why HTML events are significant.

There are several HTML events. They are divided into different categories:

- Keyboard events
- Mouse events
- Drag events

- Form events
- Windows events
- Media events
- Clipboard events

Further, there are several events in each of these categories. The main focus of this chapter is to understand how to use these events to trigger something.

1) Triggering alert()

The alert() function is a pop-up that appears on the screen with a message. Let's see how we can trigger a pop-up using the onclick mouse event.

Mouse events are one of the most commonly used HTML events. These events are triggered when the user does something with the mouse—for example, clicking on something, double-clicking on something, hovering over something, and many more.

The onclick event is the most basic HTML event. As the name suggests, this event triggers something when an element is clicked.

```
1  <!DOCTYPE html>
2  <html>
3      <head>
4      </head>
5      <body>
6          <button onclick="alert('You clicked on the button')">
7             Click here
8          </button>
9      </body>
10 </html>
```

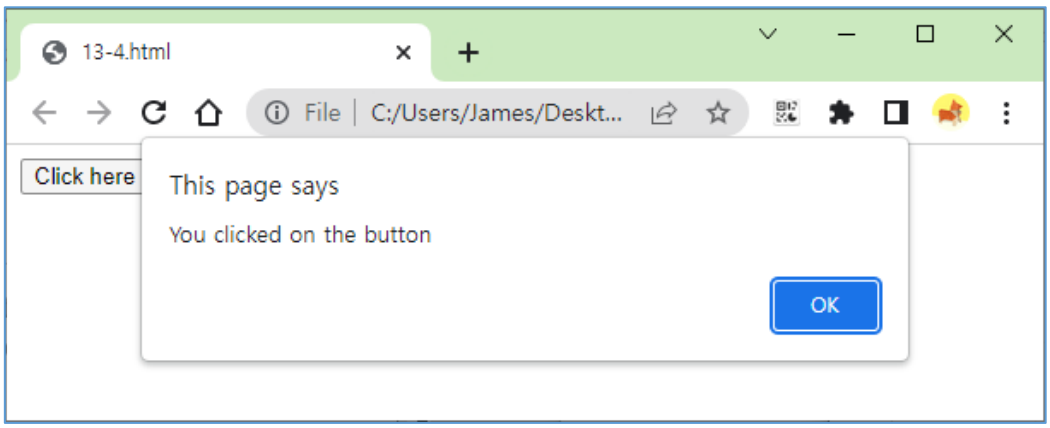


Figure 13.5: Triggering Alert

As mentioned earlier, HTML events are attributes. So the button above has an onclick event, and its value is an alert() function. Remember, the value of an HTML event is always written inside quotes. The value will be triggered when the button is clicked. The pop-up appears when the button is clicked. So this example was to give you a basic understanding of how HTML events are used.

2) Triggering a Function

In real-time, events are used to trigger JavaScript functions. Generally, complicated things such as DOM manipulation require some coding logic, and there can be multiple lines of code. So it is impossible to write all these lines in the HTML, which is why HTML functions are used.

Let's put the alert( ) into a function.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <button onclick="message()">
            Click here
        </button>
    </body>
    <script>
        function message() {
            alert('You clicked on the button');
        }
    </script>
</html>
```

The function is placed inside the <script> tag; in fact, all the JavaScript is placed inside this tag only or in a separate JavaScript file. To trigger this function, we have to give it as the value of the onclick event.

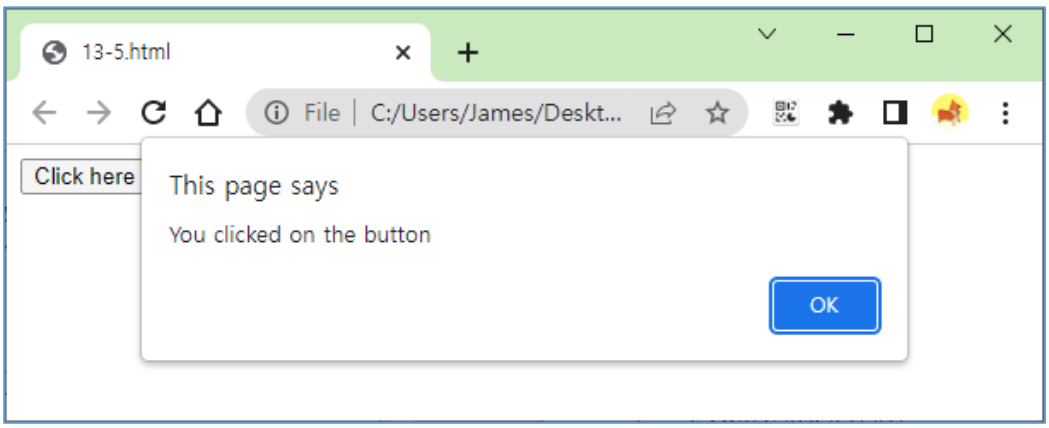


Figure 13.6: Triggering a Function

This is how we trigger a function using HTML events. We will use the same concept in the upcoming chapter to work with DOM.

3) Commonly Used HTML Events

Let's discuss some of the commonly used HTML events categorically.

Mouse Events

- onclick - triggers on the single click of the mouse.
- ondblclick - triggers on the double click of the mouse.
- onmouseover - triggers when the mouse moves over an element.
- onwheel - triggers when the wheel of the mouse moves over an element.

Keyboard Events

- onkeydown - triggers when a key is being pressed.
- onkeypress - triggers when a key is pressed.
- onkeyup - triggers when a key is released.

Window Events

- onload - triggers when a window is completely loaded.
- onunload - triggers when a window is closed.
- onresize - triggers when a window is resized.

Form Events

- onchange - triggers when the value of an element is changed.
- onsumbit - triggers when a form is submitted.

- onreset - triggers when a form is reset.

Drag Events

- ondrag - triggers when an element is dragged.
- ondrop - triggers when an element that is being dragged is dropped.

13.2.2. Finding Elements

Till now, we discussed JavaScript, DOM, and HTML events. These three concepts are necessary if you want to understand DOM manipulation properly. We will discuss two important ideas – finding elements using various methods and the innerHTML property.

1) innerHTML Property

To manipulate any HTML element or its value, we first need to find it. We can only do something if we have the link of the HTML elements in the JavaScript of the HTML file. For this, we will discuss a few methods next, but first, we need to understand the innerHTML property.

The innerHTML property is used to access the HTML elements' content. The methods will only find the element, but its value is accessed using the innerHTML property only.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <p>
            This is a paragraph.
        </p>
    </body>
</html>
```

2) Way to find innerHTML Elements

There are three ways of finding HTML elements

- in the document.getElementById()
- document.getElementsByTagName()

- document.getElementsByClassName()

document.getElementById()

The document.getElementById() method is the most common way to find HTML elements. The value is passed to the document.getElementById() method is the id of the element that we want to find.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <p id="para" onclick="demo()">
            This is a paragraph.
        </p>
    </body>
    <script>
        function demo() {
            var ele = document.getElementById("para");
            console.log(ele)
        }
    </script>
</html>
```

In the HTML, the id of the <p> tag is passed to the method, and then, the value is stored inside a variable named ele. The console statement in the next line prints the value of ele. Let's check (Paragraph click after Press F12 key).

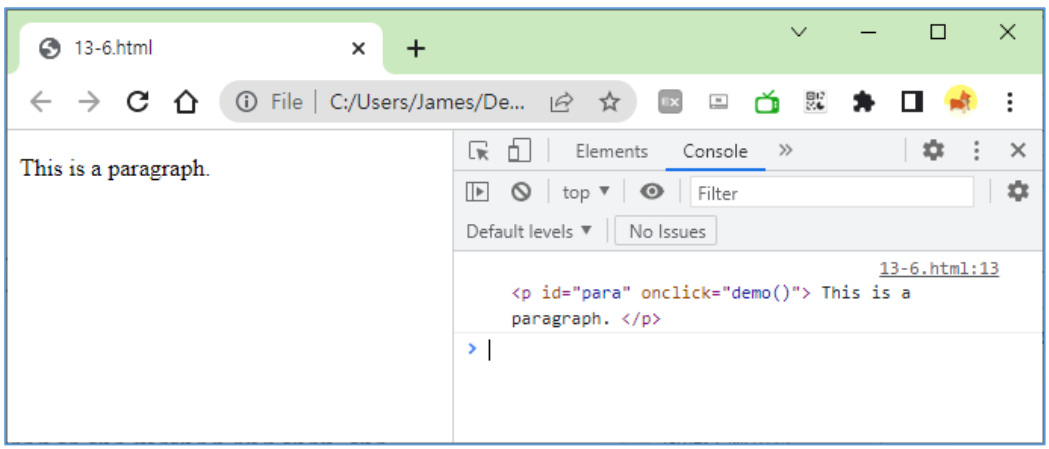


Figure 13.7: document.getElementById()

The value in the console appears after clicking the paragraph, and it is nothing but the <p> tag itself. To access the content, we will use the innerHTML property.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <p id="para" onclick="demo()">
            This is a paragraph.
        </p>
    </body>
    <script>
        function demo() {
            var ele = document.getElementById("para").innerHTML;
            console.log(ele)
        }
    </script>
</html>
```

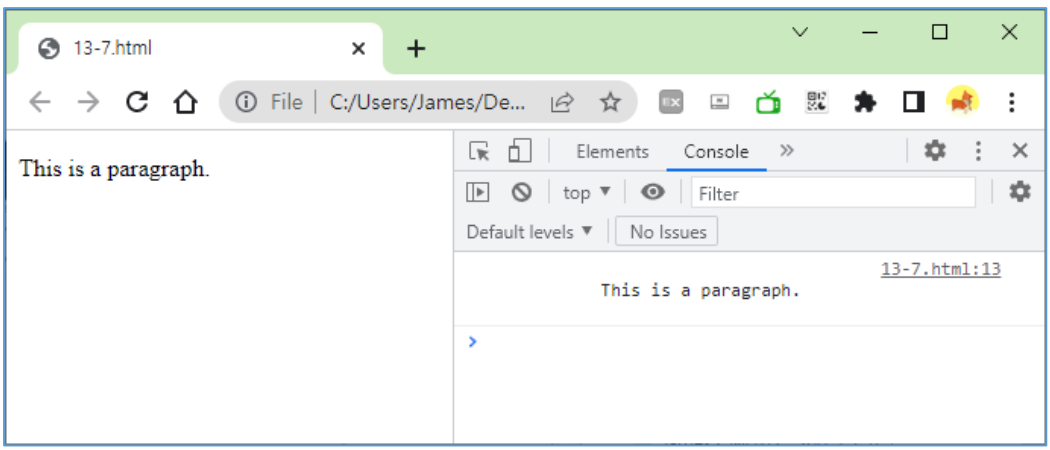


Figure 13.8: document.getElementById()

This time, the variable's value is equal to the content of the <p> tag. So, this is how a method and innerHTML are combined to get the content of an element.

document.getElementsByTagName()

The second way is to find elements by the tag name.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <p>
            This is a paragraph.
        </p>
        <p>
            This is a paragraph.
        </p>
        <p>
            This is a paragraph.
        </p>

        <button onclick="demo()">
           Click here
        </button>
    </body>
    <script>
        function demo() {
            var ele = document.getElementsByTagName("p");
            console.log(ele)
        }
    </script>
</html>
```

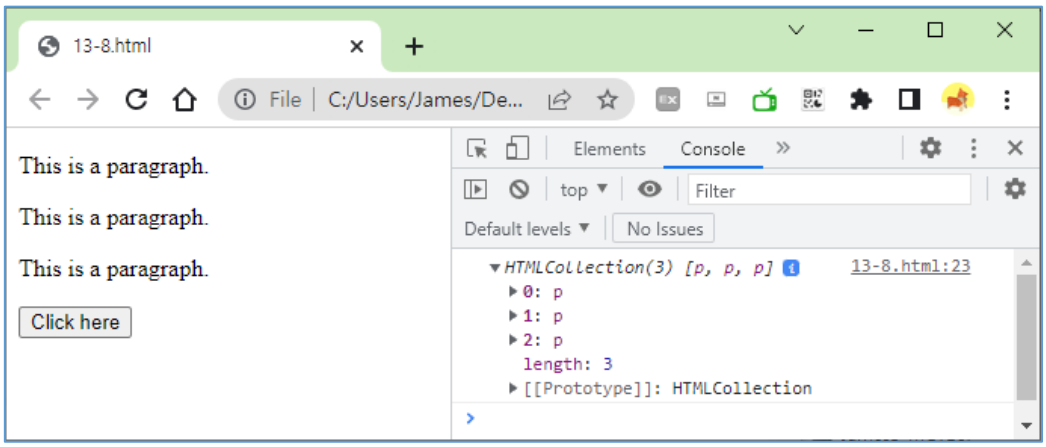


Figure 13.9: document.getElementsByTagName()

The document.getElementsByTagName() returns an array with all the elements. Similarly, the innerHTML property will also return an array with all the content.

document.getElementsByClassName()

Similar to the document.getElementsByTagName() method, the document.getElementsByClassName() method is also used to find multiple elements. It uses the class name to find elements.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <p class="para">
            This is a paragraph.
        </p>
        <p class="para">
            This is a paragraph.
        </p>
        <p class="para">
            This is a paragraph.
        </p>

        <button onclick="demo()">
           Click here
        </button>
    </body>
    <script>
        function demo() {
            var ele = document.getElementsByClassName("para");
            console.log(ele)
        }
    </script>
</html>
```

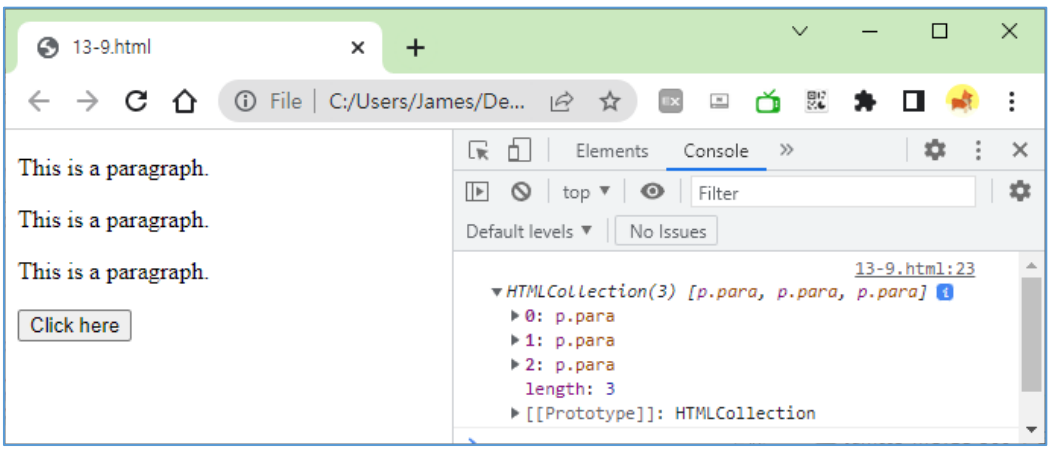


Figure 13.10: document.getElementsByClassName()

13.2.3. Content and CSS with JavaScript

Let's move further and discuss how we can change the content and CSS of HTML elements.

1) Changing Content Using innerHTML Property

The last time, we discussed how the methods like document.getElementById() could be combined with innerHTML property to access an element's content. The main usage of

this property is to change the content.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <button onclick="demo()">
           Click here
        </button>

        <p id="para">
            This is a paragraph.
        </p>

    </body>
    <script>
        function demo() {
            var ele = document.getElementById("para");
            ele.innerHTML="New text!";
        }
    </script>
</html>
```

This is a dynamic HTML page. The page has a button and a paragraph. Clicking on this button will replace the text of the paragraph. Before the button is clicked:

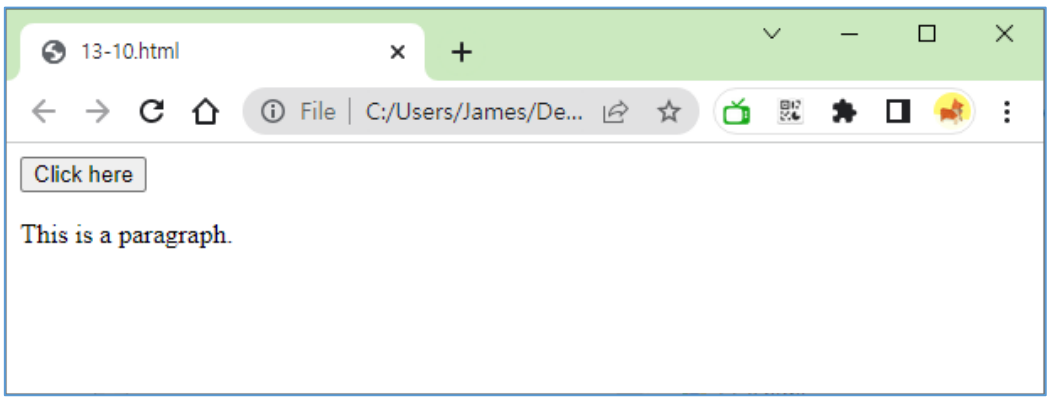


Figure 13.11: Dynamic HTML Page1

After the button is clicked:

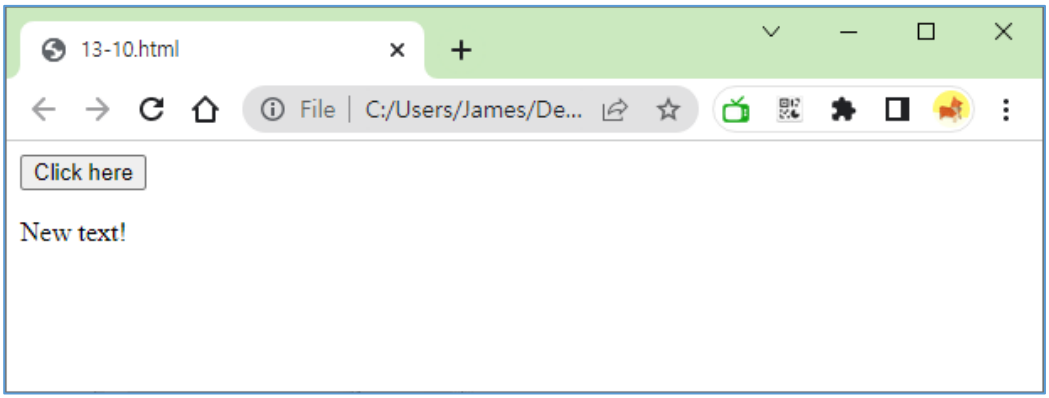


Figure 13.12: dynamic HTML Page2

Let's see what is happening here. First, the document.getElementById() method is used to find the <p> tag. Its reference is stored in a variable named ele. Then, this reference is used with the innerHTML property to assign a new value. And everything is done when the demo() function is triggered after the button clicks.

The case in the other two methods - document.getElementsByTagName() and document.getElementsByClassName() is different. The id is always unique in an HTML document, so document.getElementById() selects only a single element, but there can be multiple tags or tags with the same class name. So document.getElementsByTagName(), document.getElementsByClassName() stores the found elements in an array, and we have to access them accordingly.

Let's see how to do it.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <button onclick="demo()">
           Click here
        </button>

        <p> This is a paragraph.</p>
        <p> This is a paragraph.</p>
        <p> This is a paragraph.</p>

    </body>
    <script>
        function demo() {
            var ele = document.getElementsByTagName("p");
            ele[0].innerHTML="Text replaced!";
        }
    </script>
</html>
```

There are three <p> tags. In the demo() function, document.getElementsByTagName() method is used to find them. It will end up find all the <p> tags. We can't access them as we did in the case of documents.getElementById() method. We have to access them using the index.

The first <p> is on the 0th index, the second is on the 1st index, and it continues. In the above example, the text of the first <p> tag is replaced by using the innerHTML property on the <p> tag on the 0th index.

Before the button is clicked:

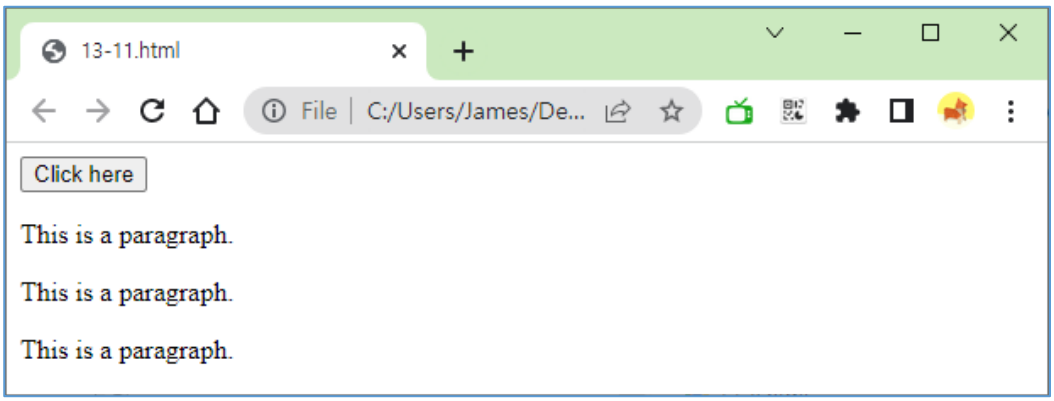


Figure 13.13: innerHTML Property

After the button is clicked:

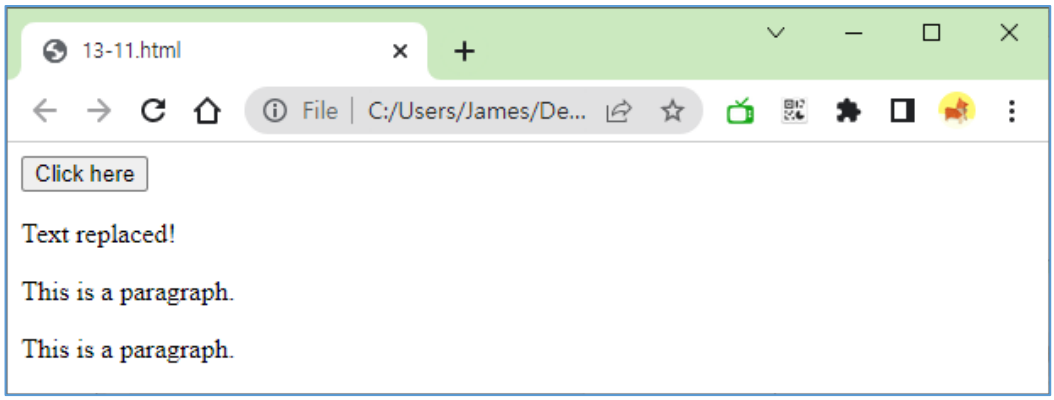


Figure 13.14: innerHTML Property

Similarly, their respective indexes can access other <p> tags.

2) Changing Values of the Attributes

It is also possible to change the value of an attribute with JavaScript. There is no special property to change an attribute's value. We can use the property name after finding the element and assign it a new value.

Suppose there is an image on the page; when we click on it, a new image replaces the old one. To do this, we need to assign a new value to the src attribute of the <img> tag.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <img src="./mountain.png" whidth="300" height="200"
             onclick="demo()"
             id = "image"
        >
    </body>
    <script>
        function demo() {
            var ele = document.getElementById("image");
            ele.src="./forest.png";
        }
    </script>
</html>
```

Here, the onclick() event is used on the <img> tag. In the demo() function, first, the <img> tag is located using the document.getElementById() method, and then the src attribute is assigned a new value.

Before clicking on the image:

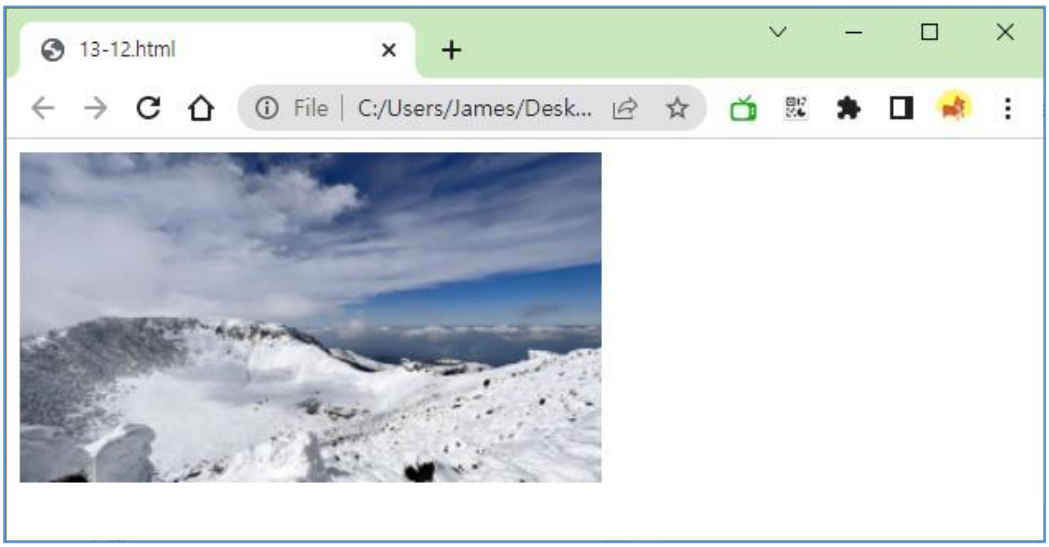


Figure 13.15: document.getElementById(image)

After clicking on the image:

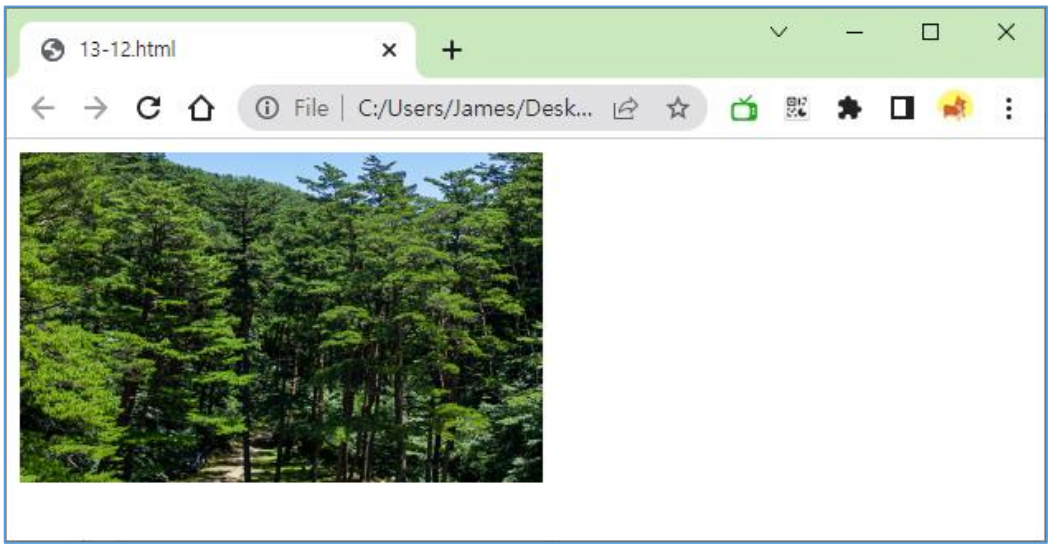


Figure 13.16: document.getElementById(image)

Similarly, we can change the value of any attribute.

3) Changing CSS

Not only can we change the content and attribute values but we can also change the CSS with JavaScript. First, we have to access the element's style attribute and then apply the required CSS property to it with the value. Suppose there is a paragraph whose color is red; when we click on it, the color changes to blue.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <p id="para" style="color : red" onclick="demo()">
            This is a paragraph.
            This is a paragraph.
            This is a paragraph.
            This is a paragraph.
            This is a paragraph.
        <p>

    </body>
    <script>
        function demo() {
            var ele = document.getElementById("para");
            ele.style.color ="blue";
        }
    </script>
</html>
```

Before clicking on the paragraph:

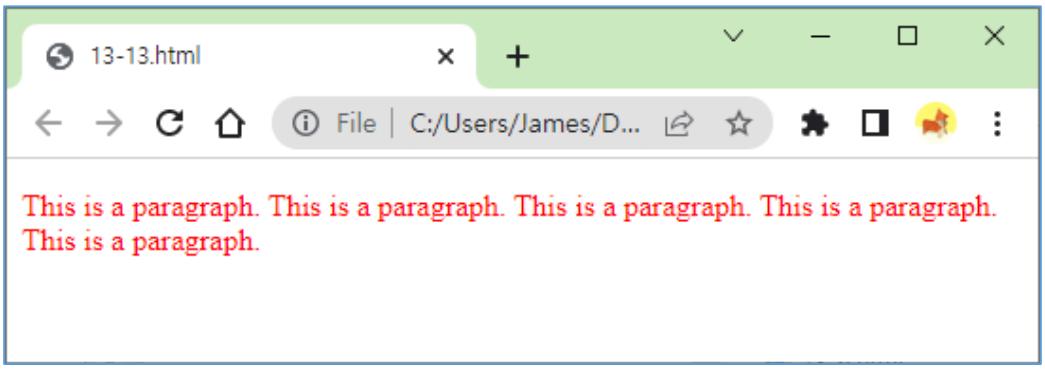


Figure 13.17: Changing CSS Text Color

After clicking on the paragraph:

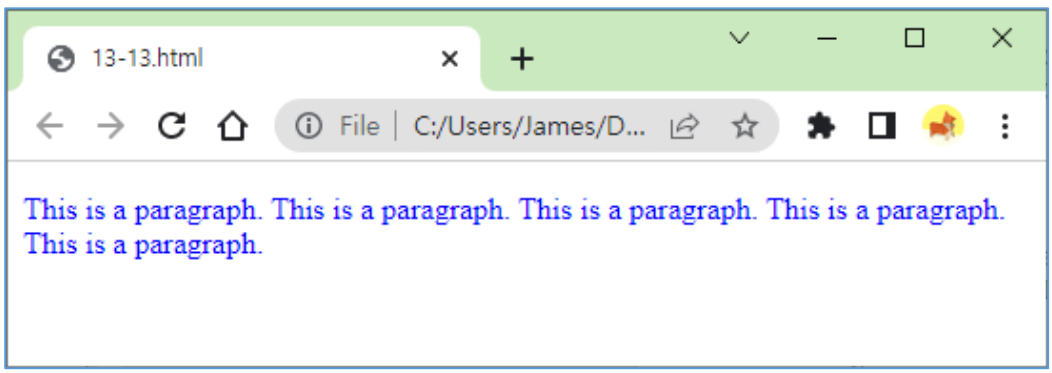


Figure 13.18: Changing CSS Text Color

13.2.4. Creating and Removing Elements

Every element in an HTML document is represented as a Node in the DOM tree. In the last chapter, we discussed how to update the content of an existing element. But with JavaScript, we can also add new elements and remove the existing ones.

There are a few methods that are used to create or remove elements. This time, we will discuss how to use these methods in JavaScript.

1) Document.createElement()

As the name suggests, the document.createElement() method is used to create an HTML element.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <div id="main">
            <button onclick="demo()"> Click here! </button>
        </div>

    </body>
    <script>
        function demo() {
            var paragraph = document.createElement("p");

            var text=document.createTextNode("This is a paragraph");
        }
    </script>
</html>
```

The document.createElement() method is used to create an <p> element. The element name should be passed to this method. Now, we have a <p> tag, but there is no content yet. The next step is to use the document.createTextNode() method to create a text node.

As of now, we have a new element and the content to be added to it. But this newly created element is not added in the HTML document. It is not present in the DOM tree. To add this to the DOM, we have a separate method.

2) appendChild()

In the last example, we created two nodes - <p> tag and the text. We have to append the <p> to the HTML document, but first, we need to append the text node to the newly created <p> tag.

The appendChild() method appends a new node as the last child node. So let's append the text node to the <p> tag, and then, we will append this whole element as one of the last child nodes in the HTML document.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <div id="main">
            <button onclick="demo()"> Click here! </button>
        </div>

    </body>
    <script>
        function demo() {
            var paragraph = document.createElement("p");
            var text=document.createTextNode("This is a paragraph");
            paragraph.appendChild(text);
        }
    </script>
</html>
```

Now, we have a complete <p> tag. But still, it is not present in the HTML document.

The <body> tag has as a node, and in turn, the tag has an <button> as its node. Now, we will append this newly created <p> tag as a child node of the tag using the appendChild() method. This means we have to invoke the appendChild() method on the tag, and for this, first, we need to find this tag.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <div id="main">
            <button onclick="demo()"> Click here! </button>
        </div>

    </body>
    <script>
        function demo() {
            var paragraph = document.createElement("p");
            var text=document.createTextNode("This is a paragraph");
            paragraph.appendChild(text);

            var div = document.getElementById("main");
            div.appendChild(paragraph);
        }
    </script>
</html>
```

First, the tag is located using the document.getElementById() method, and then the new node is appended to it using the appendChild() method.

Before the button is clicked:

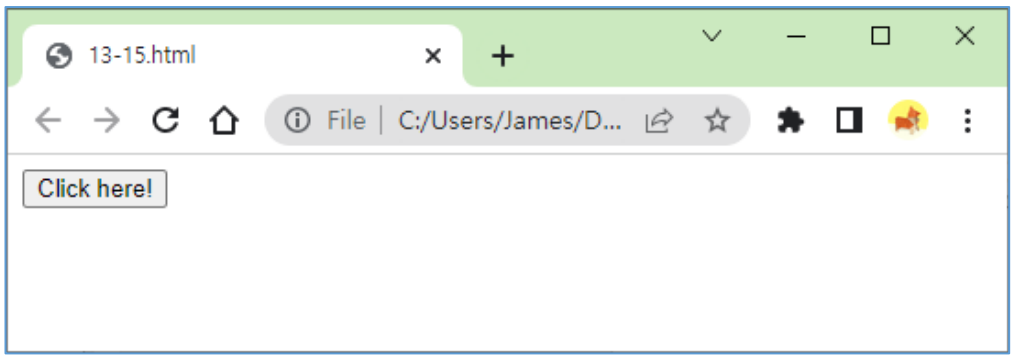


Figure 13.19: appendChild() Method

After the button is clicked:

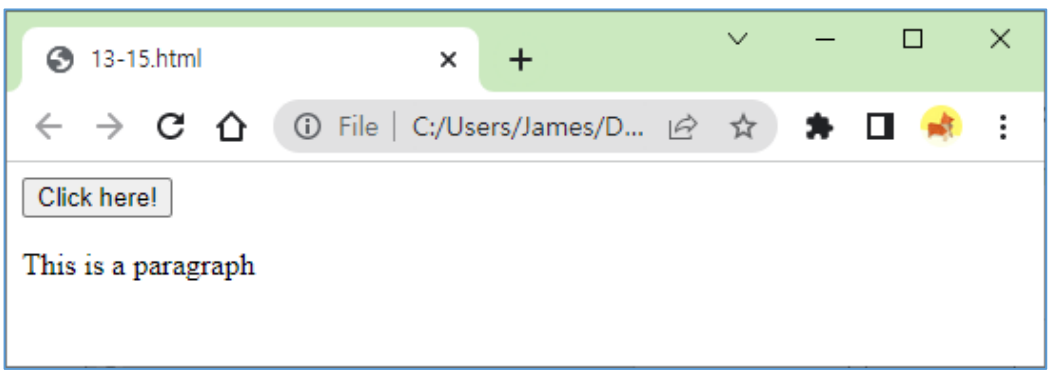


Figure 13.20: appendChild() Method

Let's discuss another example, this time using the innerHTML property.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <div id="main">
            <button onclick="demo()"> Click here! </button>
        </div>

    </body>
    <script>
        function demo() {
            var Button = document.createElement("button");
            Button.innerHTML = "New button";
        }
    </script>
</html>
```

In the example, a button is created using the document.createElement() method and innerHTML property is used on it to assign a value. Let's append this newly created element to the tag.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <div id="main">
            <button onclick="demo()"> Click here! </button>
        </div>

    </body>
    <script>
        function demo() {
            var Button = document.createElement("button");
            Button.innerHTML = "New button";

            var div = document.getElementById("main");
            div.appendChild(Button);
        }
    </script>
</html>
```

Before the button is clicked:

Figure 13.21: appendChild() Method

After the button is clicked:

Figure 13.22: appendChild() Method

3) insertBefore()

The insertBefore() method is used to insert an element right before an existing element. Suppose we have a <p> tag, and we want to add a <h1> tag before that <p> tag.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <div id="main">
            <button onclick="demo()"> Click here! </button>
            <p id="para"> This is a paragraph.</p>
        </div>

    </body>
    <script>
        function demo() {
            var heading = document.createElement("h1");
            var text = document.createTextNode("Heading");
            heading.appendChild(text);

            var div = document.getElementById("main");
            var paragraph = document.getElementById("para");

            div.insertBefore(heading, paragraph);
        }
    </script>
</html>
```

First, a new <h1> element is created. Now, we need to place this newly created element right before the <p> tag, but before it, we need to locate the tag because the <p> tag exists in it.

The insertBefore() method is invoked using the div, and both elements are passed to this method.

Before the button is clicked:

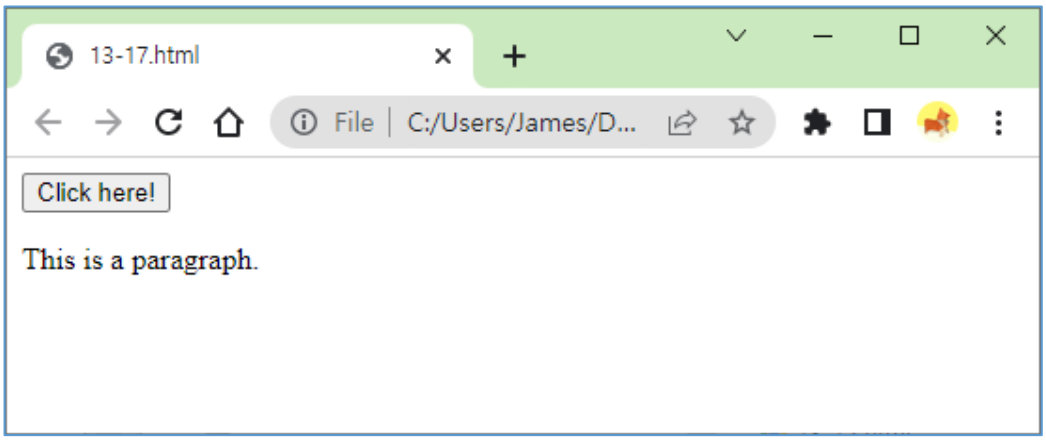


Figure 13.23: insertBefore() Method

After the button is clicked:

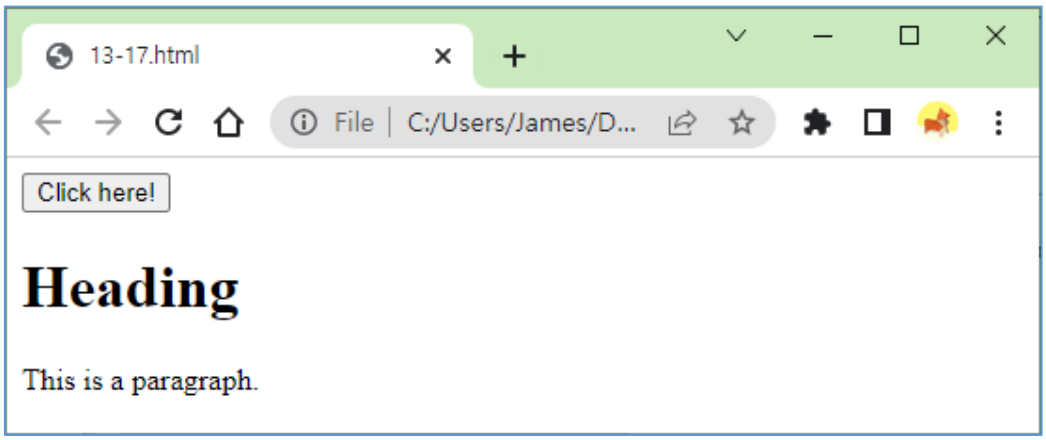


Figure 13.24: insertBefore() Method

4) document.createAttribute()

We can also create a new attribute for an existing element as well as for a newly created element.

Suppose there is a paragraph, and a class attribute with CSS is applied to it on the button click.

```
<!DOCTYPE html>
<html>
    <head>
        <style>
            .css {
                font-size : 50px;
                color : blue;
            }
        </style>
    </head>
    <body>
        <div id="main">
            <button onclick="demo()"> Click here! </button>
            <p id="para"> This is a paragraph.</p>
        </div>

    </body>
    <script>
        function demo() {
            var paragraph = document.getElementById("para");

            var attribute = document.createAttribute("class");
            attribute.value ="css";

            paragraph.setAttributeNode(attribute);
        }
    </script>
</html>
```

First, the <p> tag is located using the document.getElementById() method. Next, we create a class attribute using the document.createAttribute() method, and then assign a value to it. The class is already defined in the head section.

As of now, we have created an attribute, but it is not added to the <p> tag. To do this, we need to use the setAttributeNode() method.

Before the button is clicked:

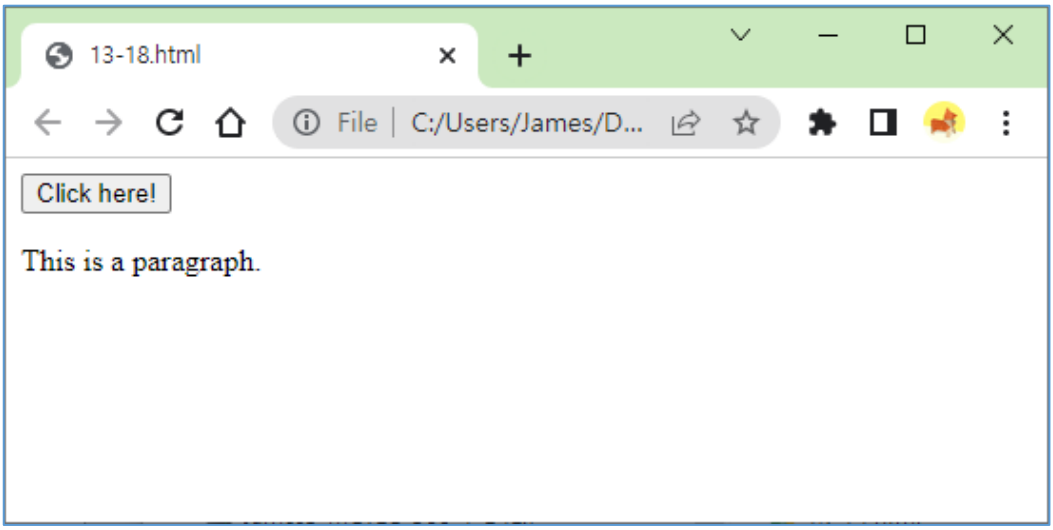


Figure 13.25: document.createAttribute()

After the button is clicked:

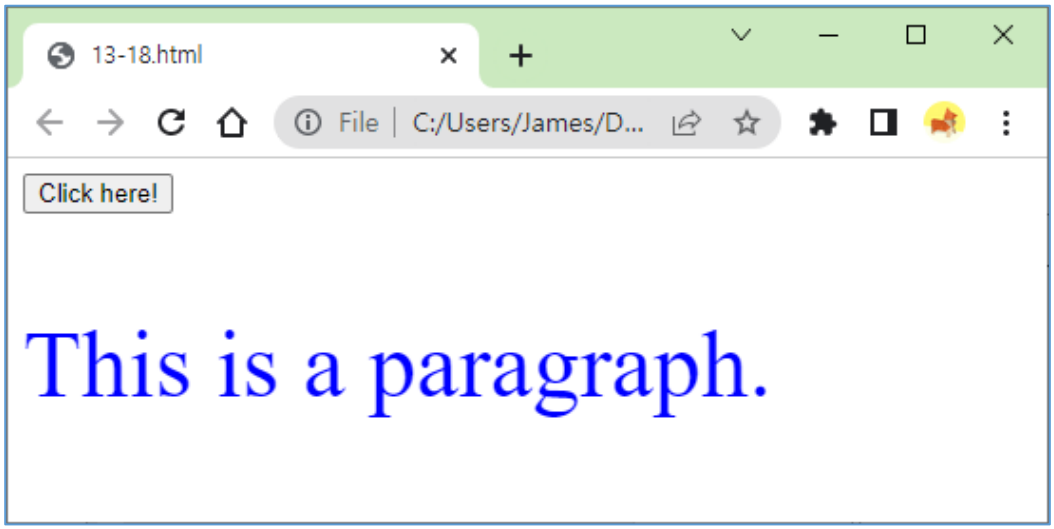


Figure 13.26: document.createAttribute()

5) remove()

The remove() method is used to remove an element from an HTML document.

```
<!DOCTYPE html>
<html>
    <head>
    </head>
    <body>
        <div id="main">
            <button onclick="demo()"> Click here! </button>
            <p id="para"> This is a paragraph.</p>
        </div>

    </body>
    <script>
        function demo() {
            var paragraph = document.getElementById("para");

            paragraph.remove();
        }
    </script>
</html>
```

The <p> tag is located using the document.getElementById() method is then used to invoke the remove() method.

Before the button is clicked:

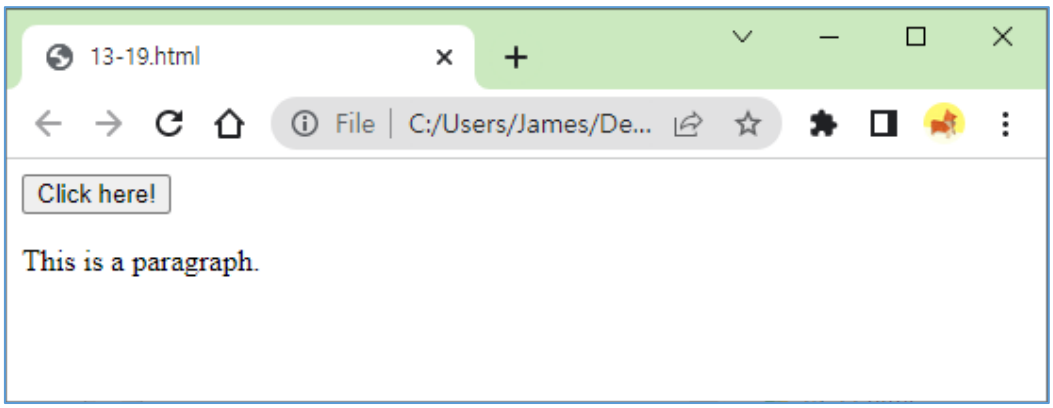


Figure 13.27: remove() Method

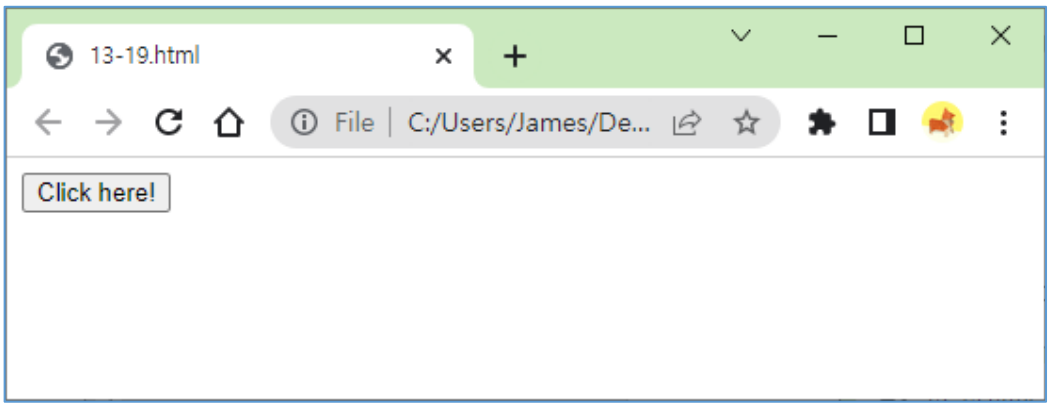


Figure 13.28: remove() Method

Summary

In this chapter, you have learned:

JavaScript is a vast programming language that covers several concepts and, most importantly, many of these concepts in different ways. We are not learning JavaScript in this course, but discussing some basics, such as variables and functions, is necessary. Before starting JavaScript with HTML and CSS, let's go through some basics of JavaScript programming language.

DOM stands for Document Object Model. It is a fundamental concept on the road to becoming a web developer.

HTML events are attributes that are used to make something happen. For example, a button click popping a message. Another example is, popping a message when the page loads or input changes.

There are several HTML events. They are divided into different categories:

- Keyboard events
- Mouse events
- Drag events
- Form events
- Windows events
- Media events
- Clipboard events

Questions

1) What is JavaScript?
2) What are JavaScript Data Types?
3) What are the differences between "=" and "==" in JavaScript?
4) Is JavaScript case sensitive? Give its example.
5) How many looping structures are in JavaScript?
6) What Boolean operators can be used in JavaScript?
7) How many methods do you use to find HTML elements?
8) How is DOM utilized in JavaScript?
9) How to use DOM and Events?

Exercises

1) **Exercise 1:** Create a variable called carName and assign the value Volvo to it.
2) **Exercise 2:** Write a JavaScript program to calculate the addition and substation of two numbers (input from the user).
3) **Exercise 3:** Use comments to describe the correct data type of the following variables:

   let length = 16; //
   let lastName = "Johnson"; //
   const x = { firstName: "John," lastName: "Doe" }; //
4) **Exercise 4:** Make the function display "Hello" in the inner HTML of an element with the ID "demo."

Additional Reading:

1) https://www.w3schools.com/js/default.asp
2) https://www.codecademy.com/catalog/language/javascript

This book has been developed with the cooperation of the Cambodia Ministry of Education, Youth and Sport (MoEYS) under the Project of ICT Capacity Building of Lower Secondary Education in Cambodia supported by KOICA.

KOICA
Korea International Cooperation Agency

Korea National University of Education