People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

Abdelhafid Boussouf University Mila

Institute of Natural and Life Sciences

Department of Biological and Agricultural Sciences

Course Handout

INFORMATICS TOOLS

(2nd Year: Biological Sciences)

Field: Biological and Agricultural Sciences

Prepared by

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Semestre: 4ème Semestre

U.E: Unité d'Enseignement Transversale

Matière : Outils informatiques

Objectif de l'enseignement

Initiation aux définitions de base du système d'exploitation des ressources informatiques. A l'issu de cet enseignement l'étudiant sera capable de concevoir des documents et des tableaux sur Word et Excel.

Connaissances préalables recommandées *(descriptif succinct des connaissances requises pour pouvoir suivre cet enseignement – Maximum 2 lignes).*

.

Contenu de la Matière

I. Découverte du système d'exploitation

- Définition d'un OS
- Différents OS existant : Windows, Linux et Mac OS.

II. Découverte de la suite bureautique

- Concevoir des documents sur WORD.
- Concevoir des tableaux avec EXCEL.
- Conception d'une présentation avec Powerpoint.
- Introduction à Latex.

III. Les logiciels et algorithmique

- Définition d'un logiciel.
- Définition de l'algorithmique.
- utilisation de l'algorithmique en biologie.

Mode d'évaluation :

Examen semestriel

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Chapter III: Exploring Microsoft Office Suite

Chapter IV: Software and Algorithms

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Preface

This Course Handout is designed for second-year students studying biological sciences. Its goals are to impart foundational knowledge of computing, computer components, and office tools such as Microsoft Office, Word, PowerPoint, Excel, and LaTeX programs. The use of these tools has become crucial and significant in the academic setting, particularly for educational advancement and remote learning.

The material is organized into four theoretical chapters, beginning with an introduction to the fundamental aspects of computer systems and components, followed by an exploration of the most essential operating systems. It then emphasizes the use and management of office programs. Lastly, it discusses the significance, functions, and applications of programs and algorithms in biology.

Chapter I: Introduction to informatics

Introduction

In modern society, informatics and computers have transformed the way we live, work, and communicate. In today's digital world, computers are essential tools that enhance productivity, facilitate access to vast amounts of information, and drive innovation across all fields (Thompson et al., 2022). Learning to use computers equips individuals with the skills needed for the modern workforce and opens up countless opportunities (Mäkelä et al., 2024). Embracing computer literacy is crucial for staying relevant and competitive in an increasingly technology-driven society (Papagiannis et al., 2024).

1. What is Informatics?

Informatics is the scientific, technical, and industrial field focused on the automatic processing of information by machines such as computers and robots (Friedman, 2012).

Informatics = a combination of the words "information" and "automatic

The term "Informatics" originally referred to theoretical informatics, which is a branch of the formal sciences focused on studying information and its automatic processing (Markova, 2018). This includes algorithmics, signal processing, computability, and information theory (Schleich & Anwer, 2020).

Note: *"Informatics is not the same as computer science, just as Astronomy is not limited to the study of telescopes."* This statement helps us distinguish between a field of study and the tools used within it (Baker et al., 2016). For instance, a telescope is a tool used in astronomy, just as a computer is a machine used in informatics to process information.

1.1 History of informatics:

Since the dawn of civilization, humanity has sought ways to calculate, count, and process information (Swade, 2022). The early methods, though seemingly rudimentary — such as etching tally marks on bones — were actually ingenious solutions that laid the foundation for an extraordinary, innovative journey. Over the centuries, these primitive techniques evolved into sophisticated machines, culminating in the modern computer —a marvel capable of executing complex logical and arithmetic operations with unparalleled precision (Nordhaus, 2007).

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At the heart of this revolution lies the computer, an electronic brain designed to manipulate information at incredible speeds. It is not just a tool, but the very backbone of computing itself, a role it has earned through pivotal milestones that marked the journey to this technological pinnacle:

- In 1642, French mathematician Blaise Pascal invented the first mechanical calculator, capable of addition and subtraction—a groundbreaking leap toward automation.
- By 1673, Gottfried Wilhelm Leibniz expanded Pascal's design, introducing multiplication and division, while Charles Babbage in 1833 pioneered the automation of machine operations, foreshadowing programmable computing.
- In the late 19th century, Herman Hollerith, founder of IBM, revolutionized data processing with punched-card machines in 1890, enabling faster large-scale calculations.
- Finally, in 1944, Howard Aiken of Harvard University unveiled the Mark 1 Automatic Calculator, the first fully functional computer, bridging mechanical and electronic computation.

These innovations did not just change the way we process information; they transformed computing from a manual, error-prone task into a seamless, automated process, ushering in the digital age we rely on today.

1.2 Applications of Informatics:

Nearly every aspect of modern life requires the use of informatics and computer technology. Computers play a crucial role in several areas below:

- **Daily Life (Internet, Telephony, Smart Devices**): Computers are the backbone of the internet, enabling services such as email, social media, video calls (like Zoom and Skype), and instant messaging (such as WhatsApp and Telegram). Similarly, mobile devices like smartphones rely on advanced computer systems not only for traditional telephony (calls and SMS) but also for a wide range of applications. These include navigation (such as Google Maps), weather updates, reminders, and countless other utilities that seamlessly integrate into our daily lives.
- **Medicine:** Medical informatics includes various interconnected sectors designed to optimize health care. Key aspects include electronic health record management, telemedicine, medical imaging, pharmaceutical inventory management, and clinical research.
- **Education:** Informatics facilitates the use of interactive tools, such as educational software and simulators, which enhance the learning experience by making it more dynamic and tailored to students' individual needs. Tools such as virtual classrooms and shared

workspaces enable teachers and students to communicate and collaborate effectively, even from a distance, promoting inclusive and flexible education.

- **Commerce (Software Point of sale, Stock, etc):** Informatics plays a vital role in modern commerce by optimizing operations and enhancing the customer experience. Point of Sale (POS) software enables businesses to record transactions, manage payments (including cards and mobile options), and generate electronic receipts. E-commerce entirely depends on informatics platforms for online shopping, secure payment processing, and efficient logistics. With these technologies, businesses can improve their efficiency and competitiveness.
- **Video games:** All aspects of game design rely on informatics, including the development of game engines and the implementation of game mechanics. Computer scientists play a crucial role in bringing games to life, especially virtual reality games, by developing software, algorithms, and complex systems. They are also responsible for creating and managing the databases, networks, and infrastructure required by games.
- **Industry:** Informatics technology is transforming industry, including programmable logic controllers that control production lines. Software-guided industrial robots perform complex tasks with precision. Informatics systems monitor machine status in real time to anticipate breakdowns.

1.3 Main branches of informatics:

Informatics, or computer science, encompasses various key disciplines focused on computing and information technology (Díaz-Herrera, 2005; Yatsko & Suslow, 2015; Volkova et al., 2023). The five primary branches are:

- **Computer Science:** The study of algorithms, computation, and theoretical foundations of computing.
- **Computer Engineering:** Combines electrical engineering and computer science to develop hardware and integrated systems.
- **Information Systems:** Focuses on designing and managing data systems for business and organizational needs.
- **Information Technology:** Deals with implementing, maintaining, and supporting computer systems and networks.
- **Software Engineering:** Applies engineering principles to software development for reliable and scalable systems.

1.4 Advantages of informatics:

Informatics offers numerous benefits, with the most significant being summarized as follows:

- **Efficiency and Time-Saving:** Computers significantly reduce processing time, completing tasks in seconds that once took hours or even days.
- **Accuracy and Reliability:** Informatics reduces human errors by ensuring accurate data management and enabling automated error-checking during calculations.
- **Cost and Space Savings:** Digital storage reduces paper waste and enables compact, organized document management.
- **Instant Communication:** Computers facilitate real-time global connectivity through emails, video calls, and messaging platforms.

1.5 Disadvantages of informatics:

While informatics offers numerous benefits, it also has its drawbacks, such as:

- Computers are often inefficient and redundant because they perform tasks that humans would never consider doing, resulting in wasted time and resources (Alamro et al., 2023).
- Informatics can improve efficiency, but it also decreases the need for human labor, resulting in unemployment in specific sectors (Soyege et al., 2025).
- Factory and business systems that are heavily reliant on informatics can face complete shutdowns due to technical failures, maintenance, or cyberattacks, causing significant disruptions (Williams et al., 2019).

2. The computer

2.1 Definition of a computer

According to Larousse dictionary, a computer is an automatic information processing machine that obeys programs composed of sequences of arithmetic and logical operations. To sum up, a computer is an electronic device that processes digital information by executing instructions from a stored program at high speed (Venugopal, 2020; Xu & Zhang, 2021).

A computer is designed to process and manipulate data based on programmed instructions. It consists of hardware components, such as the processor, memory, and input and output devices, as well as software that controls and organizes the machine's operations (Fernandes, 2022). Computers are utilized in various fields, including word processing, internet browsing, scientific computing, video gaming, and data management (Cortada, 2020).

2.2 Different categories of computers

Computers can be classified into four basic categories based on characteristics such as size, processing speed, and efficiency (Mitra, 1998):

- **Supercomputers:** These are mighty machines with vast storage capacities. They are utilized for large-scale applications, including scientific research and corporate management.
- **Minicomputers:** These are medium-sized machines with capacities smaller than those of supercomputers. They are designed for specialized applications, such as controlling complex industrial processes. However, they have been mainly replaced by microcomputers.
- **Personal Computers (PCs):** These are commonly found in offices and have sufficient power and performance to meet the demands of the average user.
- **Laptop Computers:** Laptops offer nearly the same features as personal computers, with the added advantage of portability, allowing them to be used anywhere.

2.3 Computer composition

A computer consists of two primary components (Sinclair, 2011):

- **Hardware:** The tangible, physical parts of the computer, such as the processor, keyboard, and monitor.
- **Software:** The intangible, intelligent component that includes programs and instructions that run on the hardware.

Figure 01: Two main components of a computer (Hardware and Software)

2.3.1 ***Hardware*** **(computer peripherals):** The physical components of a computer are called *hardware*. A *peripheral* refers to any hardware connected to the computer. Peripheral devices can be *external*, such as keyboards and printers, or *internal*, like hard drives and RAM.

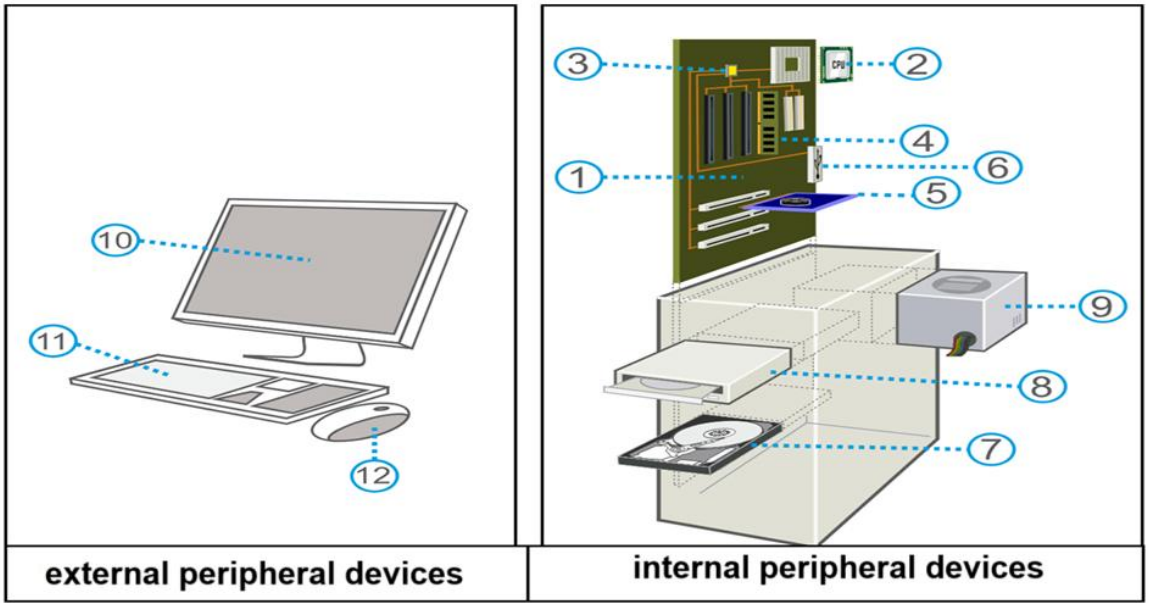


Figure 02: External and internal peripheral devices.

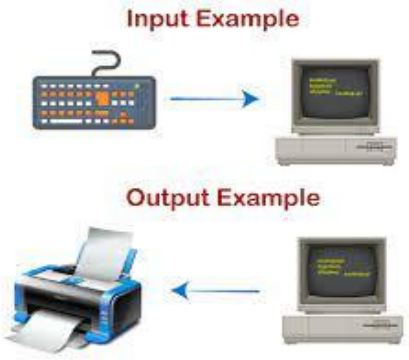
a) External peripherals: represent hardware located outside the central processing unit. A computer comprises at least a keyboard, a mouse, and a screen. Baffles can also be added. These are external peripherals, like a printer, for example.

Different types of external devices:

Figure 03: Different types of external devices.

A distinction is usually made between the following categories of peripherals:

- **Output devices:** these are peripherals that allow the computer to transmit information to the outside world, such as a screen, printer, speakers, or projector.
- **Input devices:** these are devices that can only send information to the computer, e.g., mouse, keyboard, scanner, microphone, webcam.
- **Storage devices**: which store data processed by the computer (hard drives, flash drives, etc.)



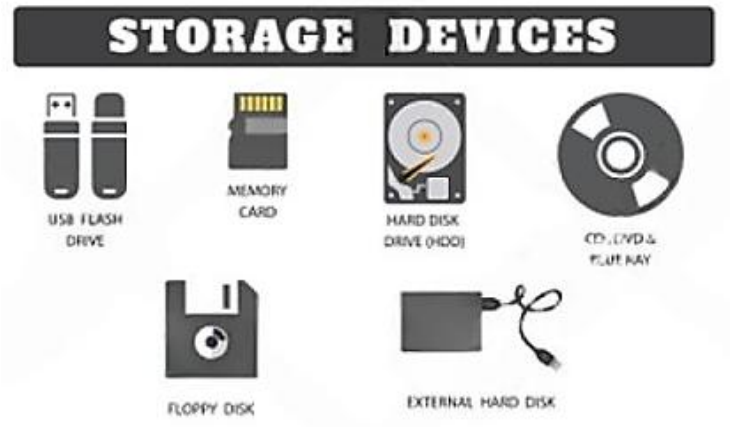


Figure 04: Computer peripheral devices.

b) Internal peripherals:

The term' internal' refers to a device located inside the computer case, as opposed to external peripheral devices. For instance, RAM and processors are examples of internal devices.

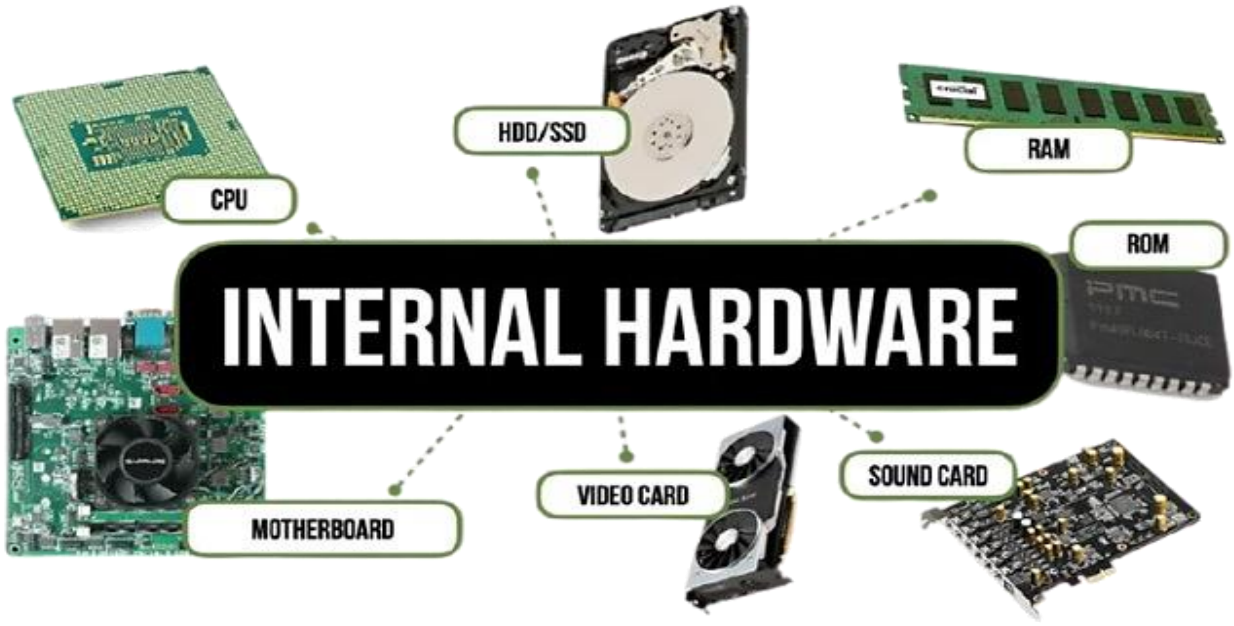


Figure 05: Computer Internal Peripherals.

c) Examples of *computer peripherals:*

Here are a few common examples of *External* and *Internal* computer devices:

- **The keyboard:**

  The keyboard is a device for writing text and communicating with the computer. A computer keyboard includes:

  - The 26 letters of the alphabet (A ... Z)
  - Special characters (accents, parentheses, brackets, + - * / operations, etc.
  - Function keys (F1 to F12)
  - Numbers from 0 to 9
  - Arrow keys for moving the cursor

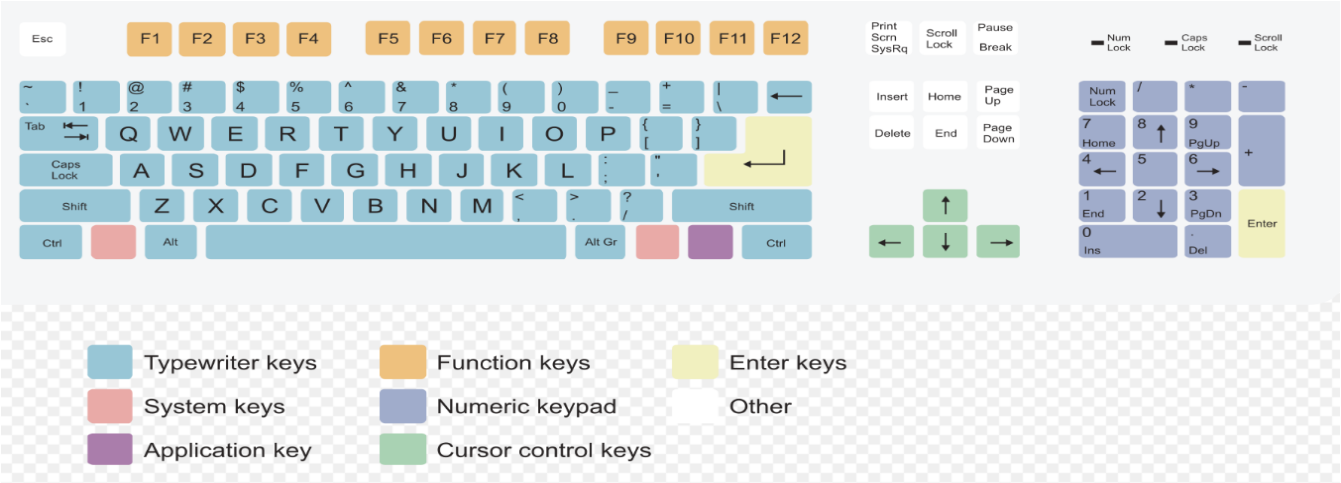


Figure 06: The keyboard.

There are two main keyboard families in our alphabet (Michaels, 1971):

- ***"QWERTY" keyboards*** include layouts commonly used in Anglo-Saxon and Dutch languages.

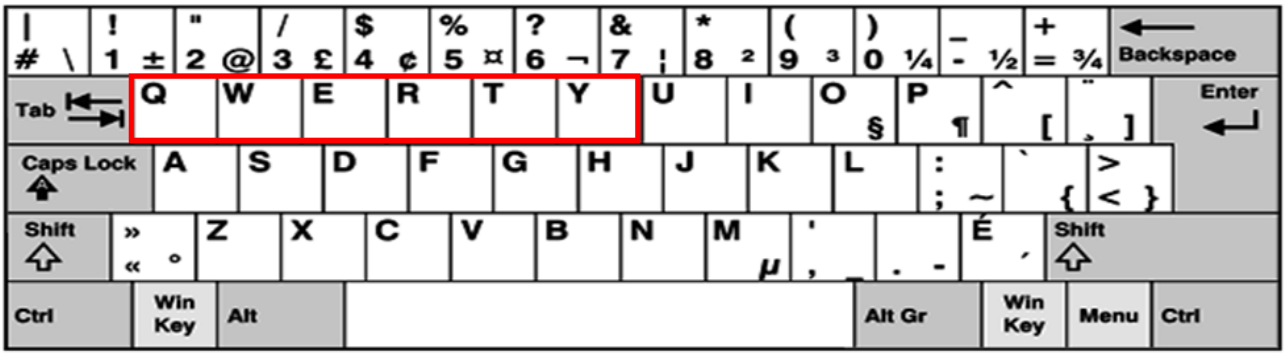


Figure 07: QWERTY keyboard.

- ***"AZERTY" keyboards*** are commonly used in French-speaking regions.

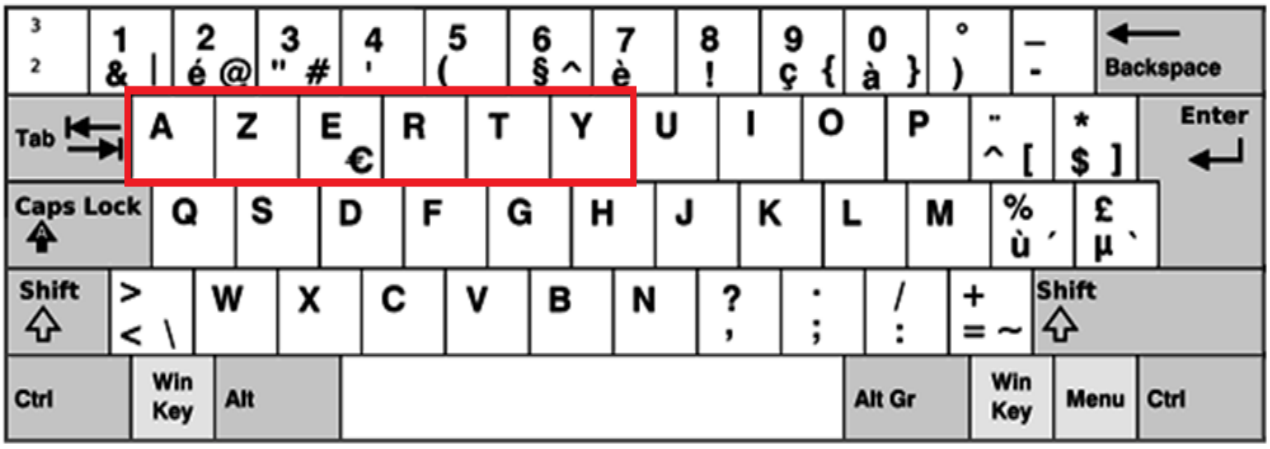


Figure 08: AZERTY keyboards

- **The Mouse:**

The mouse is a pointing device used to **move a cursor** on the screen and to **select, move, and manipulate objects using buttons.**

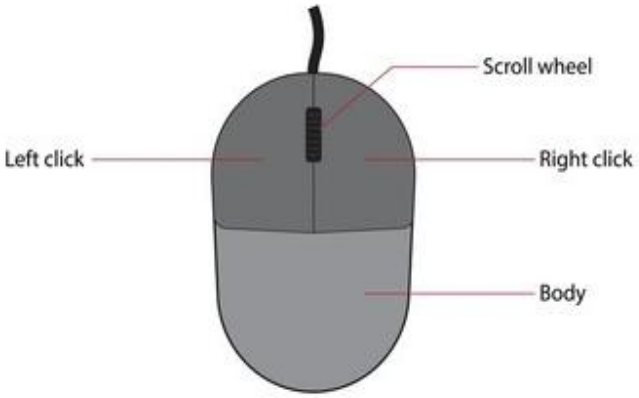


Figure 09: Parts of the Mouse

There are two types of computer mouse: *wired* and *wireless*.

- **The wired mouse:** A wired mouse directly connects to your desktop or laptop via a USB port and transmits information through the cord.
- **Wireless mouses** are very popular because they can be used without being physically connected to the computer, giving a feeling of freedom. They are connected to the computer via Bluetooth.

Figure 10: types of computers mouse.

- **The Motherboard**

The motherboard is the backbone of every computer system and an essential component of all computers. It is a printed circuit board that connects the components of a microcomputer

(Austerlitz, 2003). The motherboard allows different components to communicate with one another, such as the processor, memory, keyboard port, serial and parallel ports, and expansion cards.

The various components of the motherboard are:

- Processor
- Graphics card
- Sound card
- RAM
- Network card
- USB controller board
- Internal hard disk + drive DVD

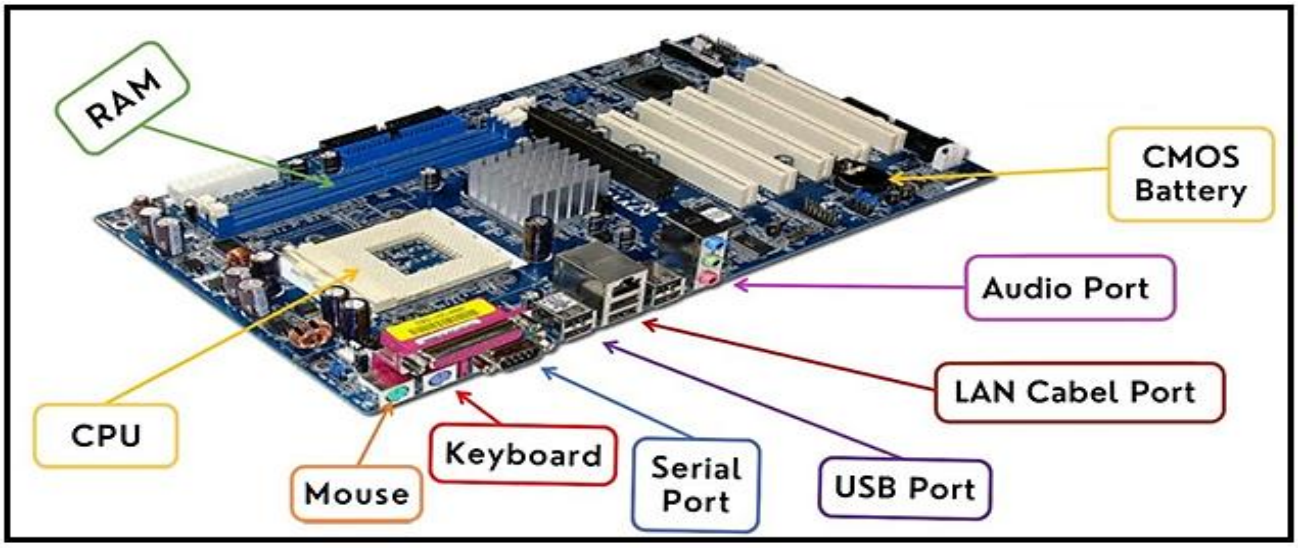


Figure 11: The different components of a motherboard.

- **The processor (also called "CPU": Central Processing Unit)**

It is the primary component of a computer, often called "*the brain of the computer*." It is responsible for processing information and executing instructions to deliver the expected results.

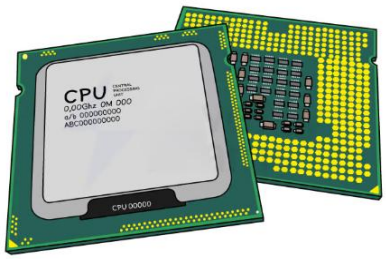


Figure 12: The processor

The speed of a computer is influenced by its processor frequency, which indicates how quickly it performs operations. This speed is measured in Hertz (Hz):

1Khz (KiloHertz) = 10^3Hz

1Mhz (MegaHertz) = 10^6 Hz.

1Ghz (GigaHertz) = 10^9 Hz.

Modern computers often have multiple processor cores, enabling them to execute tasks more efficiently and rapidly. A processor with only one core is called a *unicore processor*. In contrast, a processor with two or more cores is called a *multicore processor*. The cores in a multicore processor can read and execute program instructions simultaneously, thereby enhancing program execution speed and enabling parallel computing (Anil Sethi, 2015).

Intel and *AMD* are the two dominant manufacturers of computer processors (Tabors & Pēteris, 2016). Intel offers a range of processors, including the Core i3, i5, i7, and i9 series. In contrast, AMD offers its Ryzen 3, 5, 7, and 9 processors. Both brands compete on performance, energy efficiency, and price. Intel typically dominates the professional market, while AMD is often favored for its strong price-to-performance ratio (Jarus et al., 2013). The choice between the two depends on the user's specific needs, whether for gaming, office work, or creative tasks.

Figure 13: Intel and AMD processors.

- **RAM memory:**

RAM, which stands for *Random Access Memory*, is a temporary storage system for data that the processor needs to perform operations, such as calculations and displaying information. It is where your computer's processor stores data to run applications and open files.

One distinct characteristic of RAM is that it stores data temporarily. This means that any data held in RAM is lost when your computer restarts or turns off.

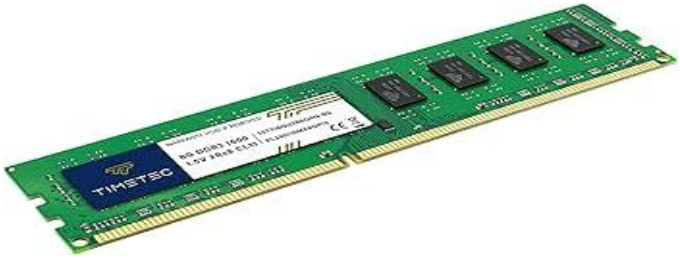


Figure 14: Random Access Memory (RAM)

- **The Hard Disk:**

In most computers and electronic devices, the hard drive serves as the primary storage device for data and programs. It stores the operating system, applications, and personal files, enabling users to access and use this information even when the device is powered off.

There are two primary types of hard disks: *HDD (Hard Disk Drives)* and *SSD (Solid State Drives)*. HDD stores data on rotating disks, while SSD use flash memory chips. Generally, SSD are faster, smaller, lighter, and more durable than HDD; however, they tend to be more expensive (Wang, 2024).

Figure 15: Solid State Drives (SSD) and Hard Disk Drives (HDD).

3. The storage units:

The storage unit is a computer system component that stores information and instructions for processing. A storage device is an essential piece of computer hardware that stores data to complete tasks. Without a storage device, a computer would not be able to run or even boot up. A storage device can store information both temporarily and permanently.

In informatics, the fundamental unit of measurement is the bit, which can represent either 0 or 1. The next unit is the byte, which is named because it consists of 8 bits. This grouping allows for 256 different combinations (Li et al., 2002).

A single 1 or 0 in a computer is known as a bit. The next unit is called a byte, which consists of 8 bits. Following that is the kilobyte; 1 kilobyte equals 1,024 bytes. The next unit is the megabyte, which equals 1,024 kilobytes. Next is the gigabyte, which is equal to 1,024 megabytes. A terabyte consists of 1,024 gigabytes, and 1 petabyte equals 1,024 terabytes.

This table illustrates the relationships between the different units:

Storage unit	Equivalent
Bit	1 or 0
Byte	8 bits
Kilobyte	1024 bytes
Megabyte	1024 kilobytes
Gigabyte	1024 megabytes
Terabyte	1024 gigabytes
Petabyte	1024 terabytes

Figure 16: The computer storage units.

4. Software

The term "*software*" refers to the set of programs and instructions that enable computers to perform their functions. Software is crucial for the smooth functioning of a computer. There are two main types of software: application software and system software.

- **Application Software:** Application software refers to programs specifically designed to perform tasks for the user. It is also known as end-user software because it enables users

to achieve desired results (Tiako, 2009). Examples of application software include word processing programs, database management systems, and presentation software.

- **System Software:** System software consists of programs that manage the various operations of a computer. Its primary function is to control hardware operations and facilitate interaction with application software to execute specific tasks (Gautam et al., 2023). System software includes operating systems such as Windows, macOS, and Linux.

Figure 17: Application software and System software.

5. Data

Data consists of raw facts and information that users input into a computer system to produce the desired results. In this system, data is processed by programs that contain various instructions. Depending on requirements, data can be presented in two forms: *quantitative* and *qualitative*.

- **Qualitative data:** Data that is represented in the form of words or text is referred to as qualitative data. This type of data can also include images, videos, and audio used for graphic presentation.
- **Quantitative data:** Data that is represented in numerical form is called quantitative data. This data type comprises various numbers and symbols used to describe a particular quantity. Data entered by a user into the computer system may be in numeric or text form.

6. User

Computer systems are designed by people, for people. People, therefore, include those who design and build hardware and software (known as *systems people*) and those who use computer systems (known as *users*).

- **Systems people** include hardware engineers, software engineers, programmers, etc.
- **Users** such as end users and application developers can include people working in different application fields, like education, business, entertainment, training, etc.

7. Computer system:

For a computer system to operate effectively, it must integrate four essential subsystems, regardless of its size:

1. ***Hardware:*** *The physical components of the computer.*
2. ***Software:*** *The instructions or programs that guide the processing of data.*
3. ***Data:*** *The raw facts that the computer processes.*
4. ***User:*** *The individuals who operate or interact with the computer system.*

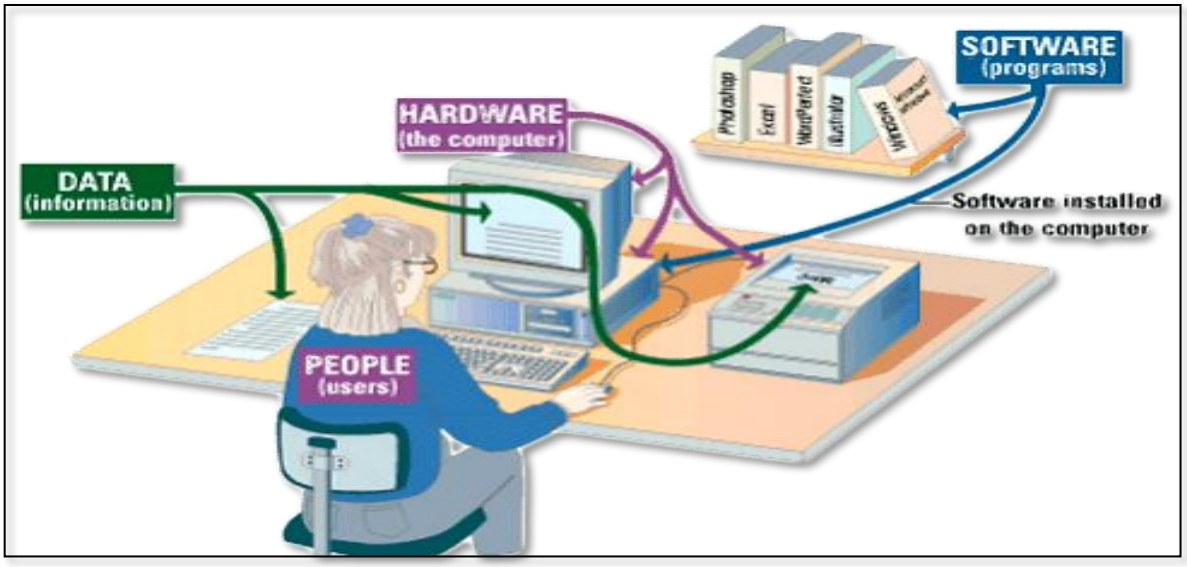


Figure 18: General architecture of a computer system.

Chapter II: Exploring Operating Systems

Introduction

Computer software is a long list of instructions that a computer can execute. Many programs contain millions of instructions, some of which are repeated. Today, a personal computer can perform several billion instructions every second.

An operating system (often called an OS for Operating System) is a set of programs that uses a computer's capabilities for application software (Gautam et al., 2023). It receives requests from the application software to use computer resources, including memory, hard disks, and processor capacity (Browne, 1980). The operating system accepts or rejects such requests and then reserves the resources in question to avoid their use interfering with other software requests (Kabiraj et al., 2018).

The operating system is an indispensable part of any computer system. It acts as an intermediary between the user and the computer hardware. The purpose of the operating system is to provide an environment that allows the user to operate their computer (Rahalkar, 2016). It provides the means to properly use memory space, processor time, and other resources of a computer system; in other words, it acts as a manager of these resources and allocates them to programs and human users to perform their tasks (Bazuku et al., 2023).

1. What is an operating system? *«The abbreviation 'OS' stands for Operating System. »*

An Operating System (OS) is the most essential part of a Computer System. It consists of *a set of programs acting as an interface between the user and the hardware* (Holtsnider & Jaffe, 2007). Its primary purpose is to make the computer system easier to use and to work efficiently and optimally. In simpler terms, the operating system is an *intermediary* between hardware and Software.

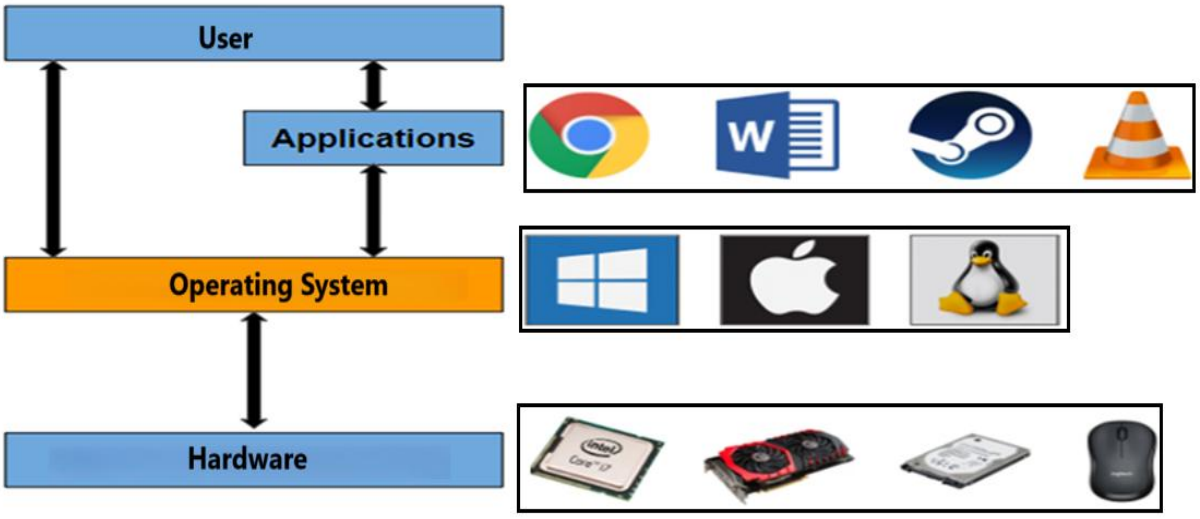


Figure 19: Operating System Overview

2. Objectives of Operating System

The operating system serves as a bridge between the user and the computer hardware. All applications that allow your programs to interact with the hardware are built on top of the operating system.

The main objectives of an operating system are as follows:

- **Efficiency:** The operating system enhances production efficiency by reducing the time required for system configuration (Chapin & Worringen, 2001). By default, it manages system tasks such as allocating resources to processes and resolving conflicts between programs and users. This not only saves users time but also improves overall system efficiency.
- **Hardware Abstraction:** The operating system effectively hides the computer's complex details. Users can fully leverage the hardware without encountering challenges. It manages communication between user applications and computer hardware.
- **Convenience:** Without an operating system, users would need to interact directly with the hardware, lacking access to the pre-configured utility packages that an operating system provides. This would make using a computer very inconvenient. Operating systems enable users to focus immediately on their tasks without the hassle of setting up the system in advance.
- **System Resource Management:** The operating system serves as a neutral mediator and manages resources equitably among different operations and users (Darmawan & Aedi, 2024).

3. A Brief history of operating systems:

Operating systems have undergone substantial development from ancient times to today. This section offers an overview of the history and evolution of early operating systems from the 1950s to the present:

- ***In the 1940s***, programs were directly input onto machine hardware through a series of micro switches (O'Regan, 2018).
- ***Until the 1950s,*** computers were mainly used by programmers who interacted directly with the hardware. During this period, there was often confusion between the roles of programmers and operators, and operating systems had not yet been developed (Bullynck, 2018). The first operating systems began to emerge around this time.
- ***By 1960,*** the focus shifted to optimizing computer usage through the implementation of task-scheduling functions, which helped to clarify and separate the roles of programmers and operators (O'Regan, 2018; Bullynck, 2018).
- ***In the 1970s,*** the development of operating systems progressed, focusing on maximizing computer efficiency. These systems were created to manage hardware resources, enabling multiple programs to run simultaneously (Adekotujo et al., 2020).

- ***From 1980 onward,*** operating systems continued to evolve significantly. The widespread adoption of computers in both offices and homes shifted the focus towards creating more user-friendly systems (Spinellis & Avgeriou, 2019). This led to the introduction of graphical elements, such as menus. During this decade, several notable operating systems were developed, including:
  - *MS-DOS*: Developed by Microsoft for IBM PCs.
  - *Mac OS*: A system for Macintosh computers developed by Apple Inc., launched in 1984.
- ***The 1990s*** saw the emergence of many operating systems, such as GNU/Linux and Microsoft Windows, which influence the modern versions we use today (Malallah et al., 2021).
- ***In the first decade of the 21st century***, new operating systems continued to emerge. In 2010, with the rise of smartphones, we witnessed the popularity of several operating systems, including Android, developed by Google, and iOS, created by Apple (Hall & Anderson, 2009; Malakhov et al., 2024).

4. Types of operating systems:

Operating systems can be classified into many categories, depending on the number of users, tasks, and display:

a) Depending on the number of users, there are two types of operating systems:

- ***Single-user operating systems,*** also known as single-tasking operating systems, are designed especially for home computers (Chapin & Worringen, 2001). They allow a single user to access a personal computer at a time. Examples: MS-DOS.
- ***Multi-user operating systems*** involve multiple users working on a single computer system simultaneously from their own devices. Examples include Windows 2000 and Windows XP Server, Unix, macOS X, and Linux (Malallah et al., 2021).

b) Depending on tasking, each operating system must be single-tasking or multitasking**:**

- ***A single-task operating system*** allows the running of only one application simultaneously. Example: MS-DOS.
- **A multitasking operating system** that allows running multiple applications at once. Example: Windows.

c) Depending on the display mode, the operating system can be text-based or graphical.

- ***Operating system in text mode*** *(Commands and text instructions)*: Example: MS-DOS.
- ***Operating system in graphical mode*** *(Drawings, icons, taskbar)*:Example: WINDOWS 7.

5. Components of the Operating System:

The operating system comprises a set of software that manages interactions with the hardware. This software package typically includes the following components:

a) **The kernel:** the kernel performs essential operating system functions, such as memory management, process management, file management, main I/O, and communication (Shacklette, 2004).

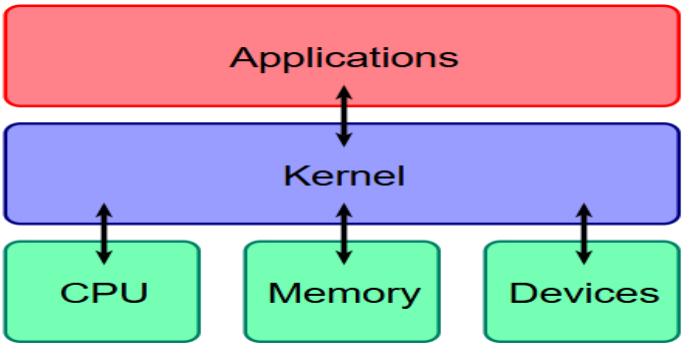


Figure 20: The function of the kernel.

b) **Shell command interpreter:** It allows users to communicate with the operating system through a command language, enabling control of peripherals while disregarding the specific hardware characteristics (Khlestkin et al., 2024).

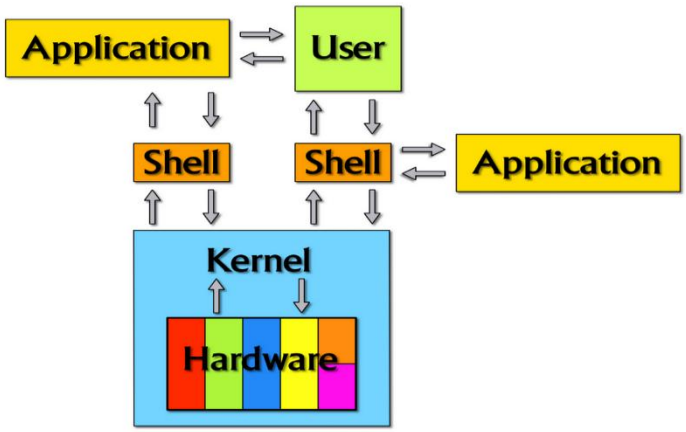


Figure 21: The function of the Shell in the OS.

c) **A File system** (often abbreviated as **FS**) is used for storing and managing files.

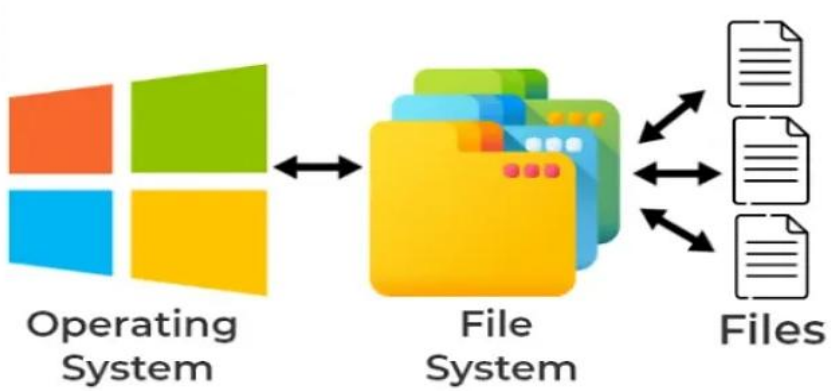


Figure 22: File System in Operating System.

6. Open Source and closed source Operating Systems

a) Open-Source Operating Systems:

- *Definition:* The Open-Source Operating System is publicly available, allowing anyone to view, modify, and distribute (Golam & Ar, 2019).
- *Exemple :* Linux distributions (e.g., Ubuntu, Fedora, Debian)
- *Open Source* is ideal for developers, tech enthusiasts, and organizations that value transparency, customization, and cost savings.

b) Closed Source Operating Systems:

- *Definition:* The Closed Source Operating System is proprietary and not available to the public. Only the company or organization that owns it can modify it (Adekotujo et al., 2020).
- *Example:* Microsoft Windows et macOS.
- *Closed Source* is better for general users and businesses that prioritize ease of use, official support, and compatibility with commercial software.

7. The three most popular operating systems

Currently, the main operating systems are Windows, macOS, and Linux. These operating systems have evolved, resulting in various versions.

- **Microsoft created Windows,** which is currently the most widely used**.** The version presently sold is Windows 11, but you may encounter older versions, such as Windows 10, Windows 8, Windows 7, Windows Vista, or even Windows XP.

- **Apple developed macOS**. This operating system is only present on computers of the Apple brand (Macintosh), which are easily recognizable thanks to the Apple logo. The currently available version is macOS Sierra; macOS High Sierra is scheduled for release in autumn 2017.

- **Linux** is the least known of the three operating systems. It is rarely installed by default on a computer. Free and free, it is mainly used by those with good computer science knowledge.

7.1 Windows:

The **Windows operating system** is one of the most widely used in the world, offering a flexible and user-friendly platform for users of all levels. Its popularity ranges from personal computers to business environments.

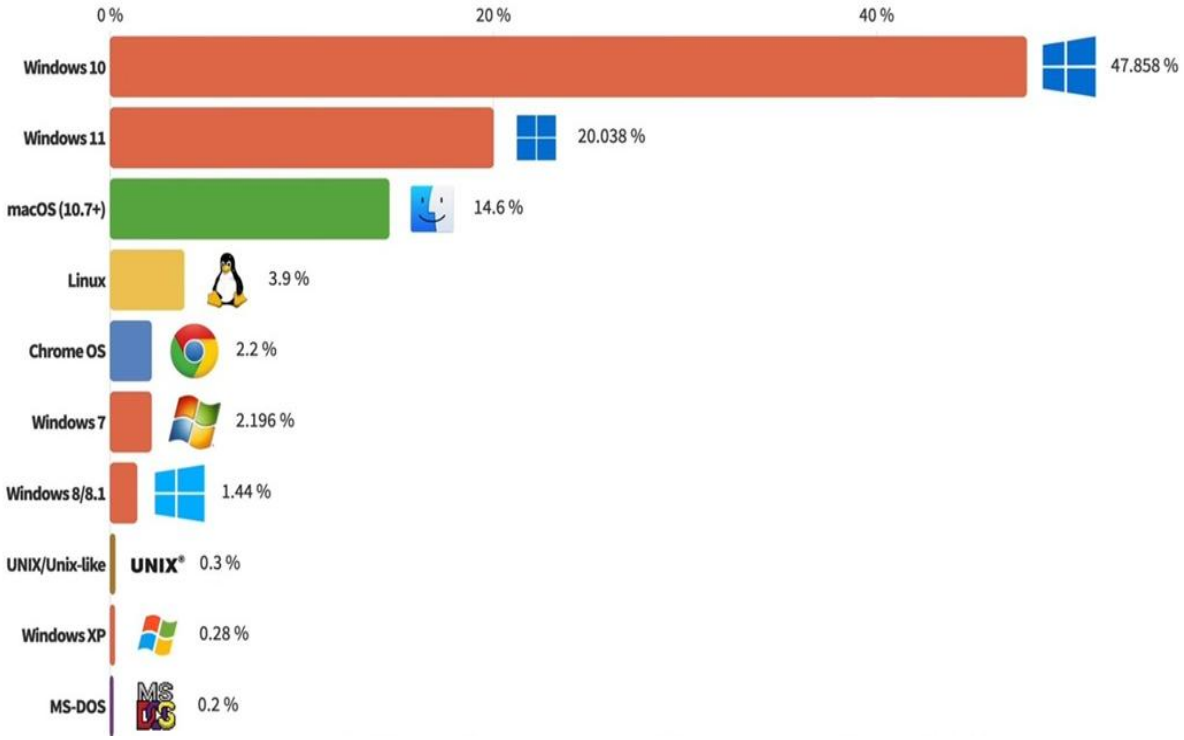
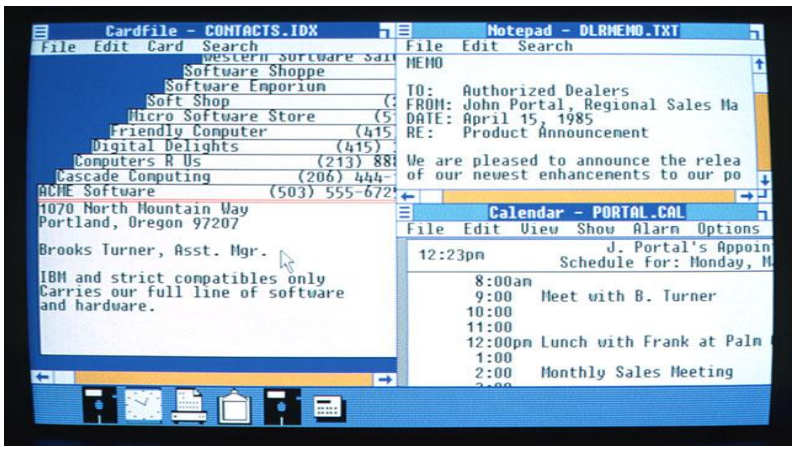
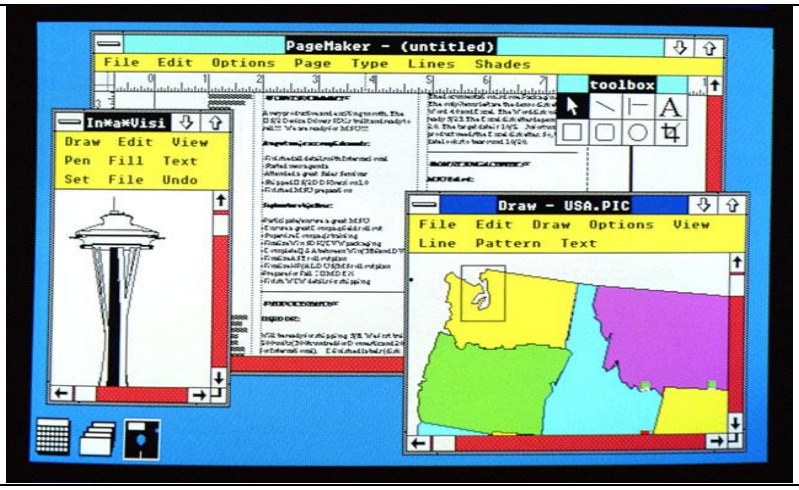
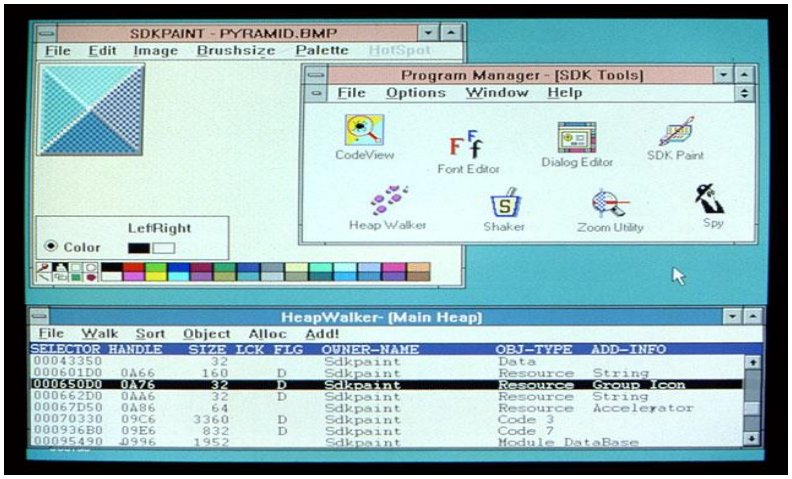
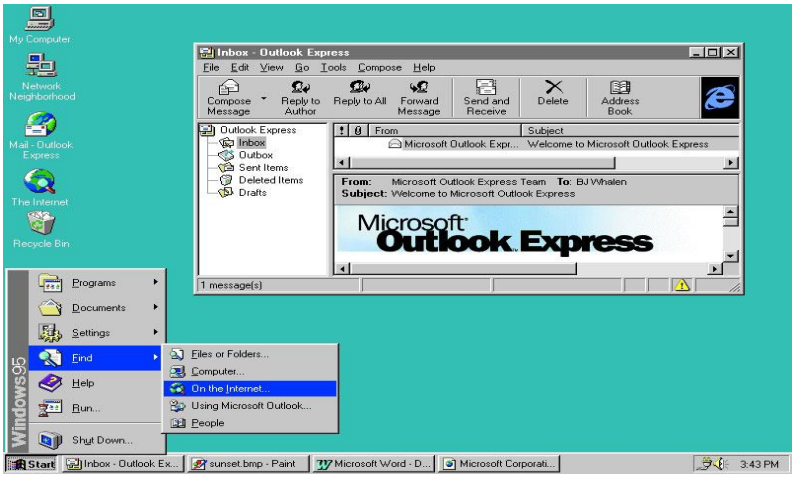
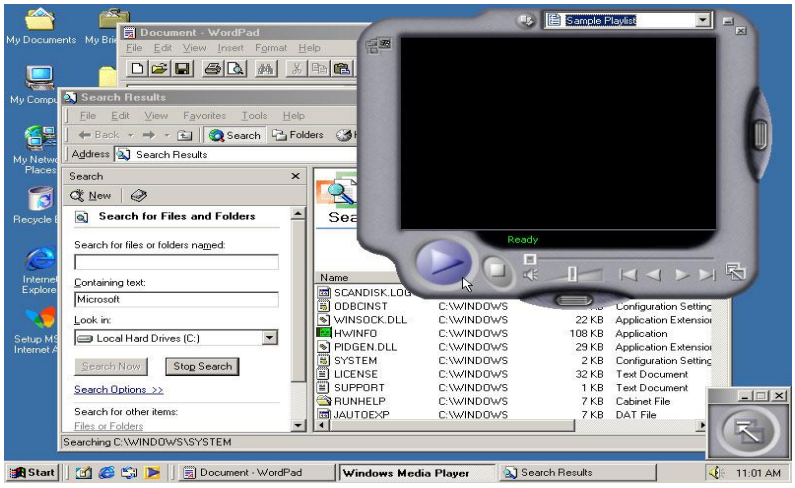


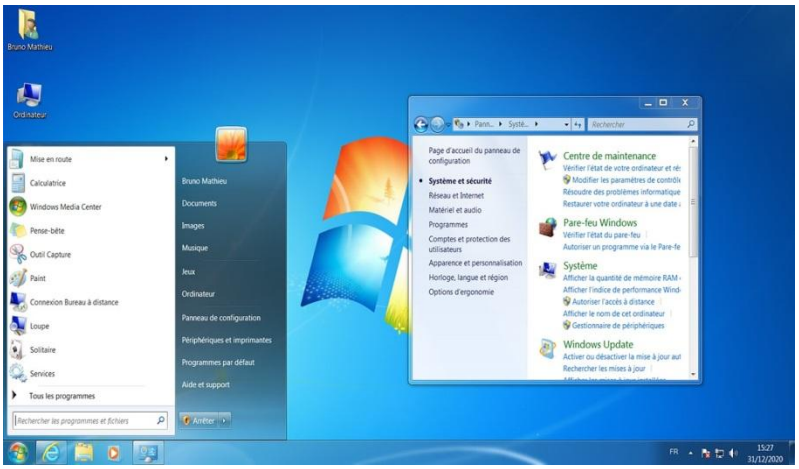
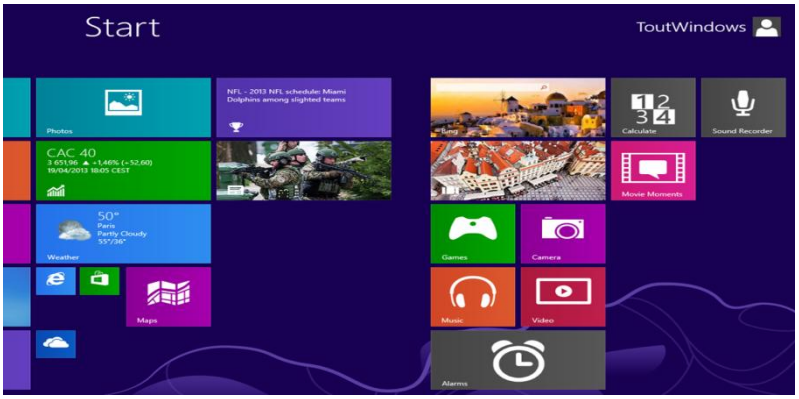
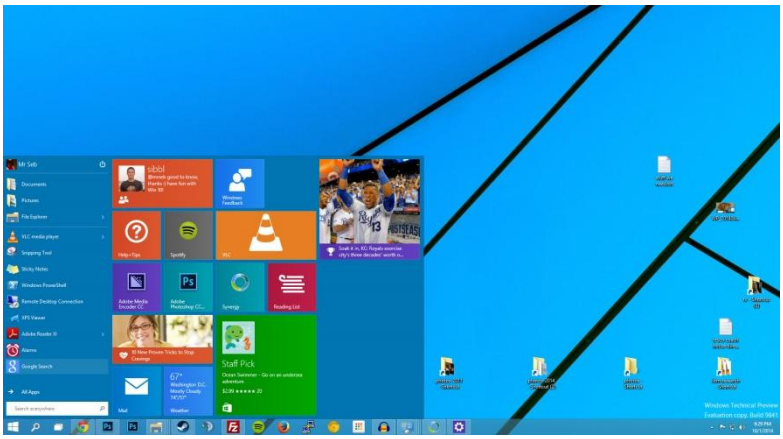
Figure 23: Most popular computer operating systems in 2024 (Kulakov et al., 2025).

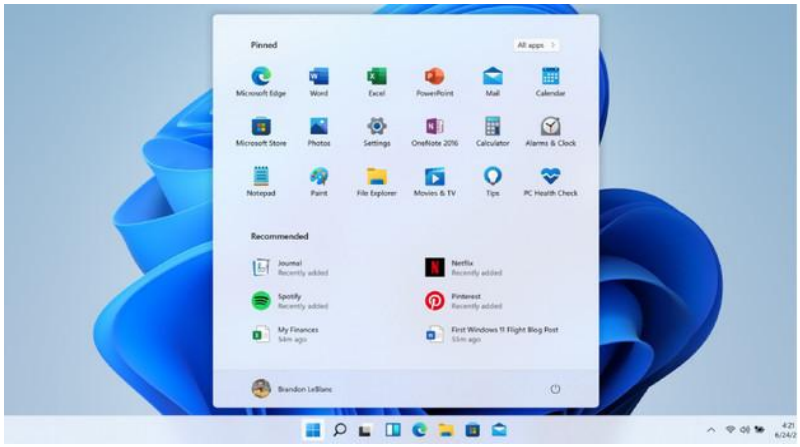
❖ **History of Windows Versions:**

Year	Windows version	The interface
1985	**Windows 1.0**	

1987	Windows 2.0	
1990	Windows 3.0	
1995	Windows 95	

1998	Windows 98	
2000	Windows Me (Millennium Edition)	
2006	Windows Vista	

2009	**Windows 7**	
2012	**Windows 8**	
2015	**Windows 10**	

2021	**Windows 11**	

❖ **Interface and functionalities**

Windows stands out for its intuitive user interface, which has evolved over the versions to become more ergonomic and customizable. Key features include:

- **The Start menu,** for quick access to applications and settings.
- **The taskbar,** for easy management of current applications.
- **The file system**, organized around Windows Explorer.

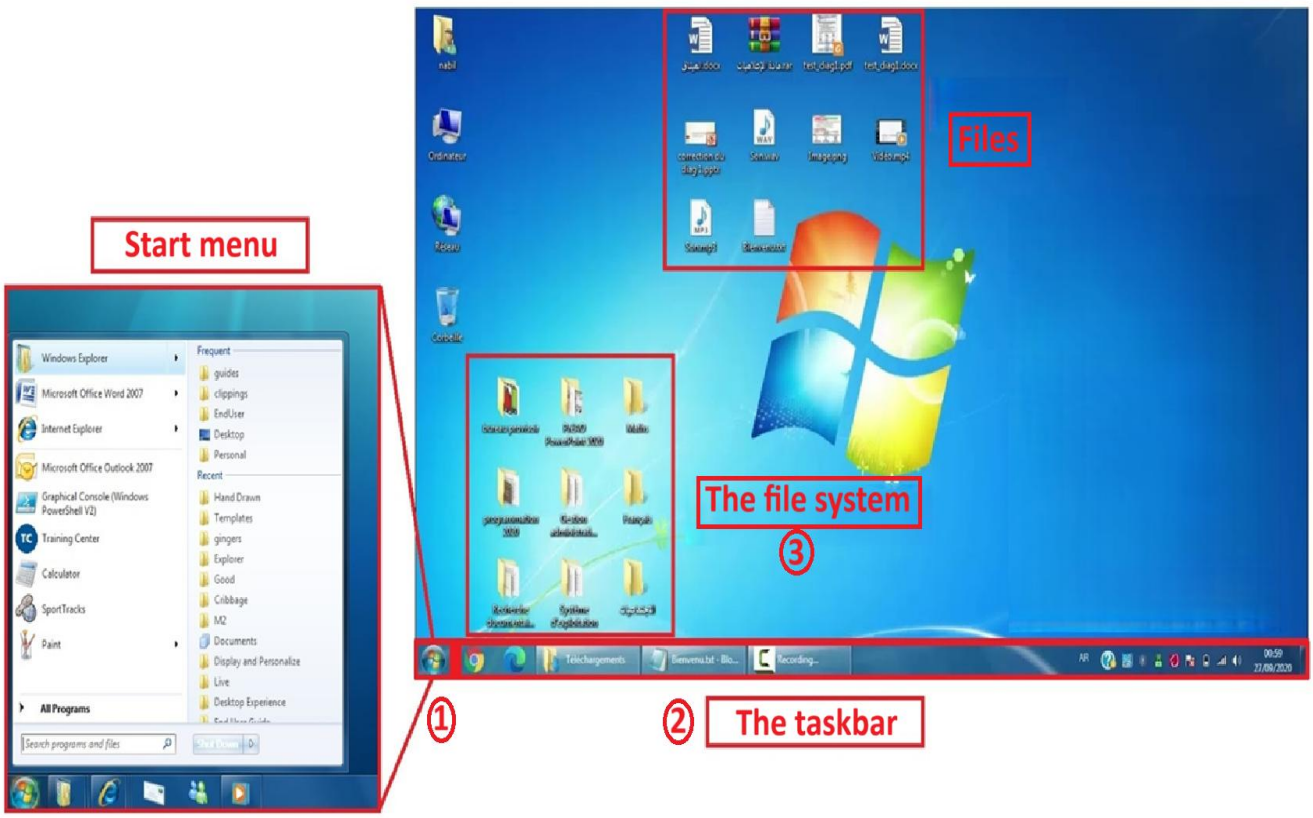


Figure 24: Windows 7 Interface.

7.2 Mac OS

Mac OS (Macintosh Operating System) is Apple's operating system for its Macintosh computers. It is best known as the first consumer system with a graphical interface based on Windows, icons, menus, and a mouse.

Figure 25: Mac OS (Macintosh Operating System).

7.3 Linux

Linux, or GNU/Linux, is an operating system or a **set of operating systems.** Its particularity is that it is open source and developed collaboratively. **Linux has many distributions**, including the best-known are Ubuntu, Linux Mint, Debian, etc**.**

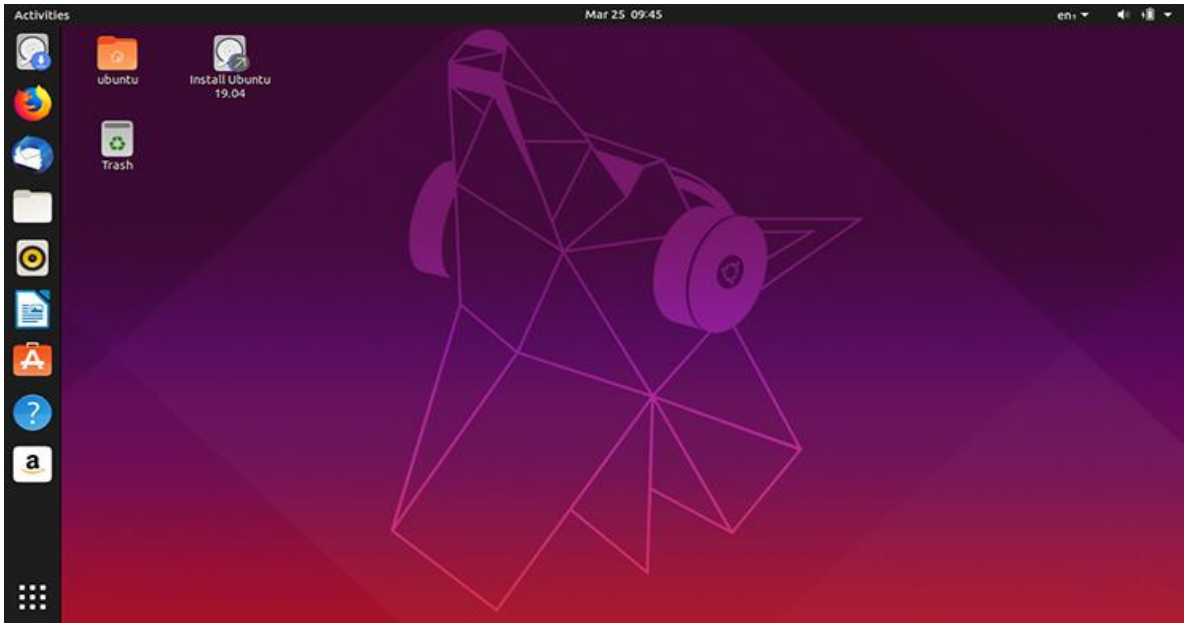


Figure 26: Linux distribution interface.

Conclusion

The operating system (OS) serves as the backbone of any computer system, **acting as a crucial intermediary between hardware and software**. It provides essential functionalities such as **resource management, user interaction, and system security,** while offering a user-friendly interface through abstractions like virtual machines. Operating systems can be categorized by user type (single-user or multi-user), tasking (single-tasking or multitasking), and display mode **(text-based or graphical)**. Key components of an operating system, such as the kernel, shell, and file system, work together to ensure efficient, seamless operation.

The three most popular operating systems—**Windows, macOS, and Linux**—each cater to different user needs and preferences**. Windows** is renowned for its user-friendly interface and widespread compatibility, making it a favorite among general users and professionals alike. **macOS** stands out for its sleek design and seamless integration with Apple's ecosystem, while **Linux** offers unparalleled flexibility and customization as an open-source platform. The distinction between **open-source** and **closed-source operating systems** further highlights the diversity in the OS landscape, with **open-source systems like Linux appealing to developers and tech enthusiasts**, and **closed-source systems like Windows and macOS providing ease of use and official support for mainstream users**.

Chapter III: Exploring Microsoft Office Suite

Introduction

An office suite comprises a collection of computer programs designed to facilitate basic office tasks, such as document creation, appointment scheduling, and invoice management. Typically, an office suite includes a word processor, a spreadsheet application, presentation software, and a drawing tool (Mercurio & Merrill, 2021). Additional components may include a data management program, an email client, a calendar, and an address book. These applications are distributed collectively as a unified product.

An office suite aims to provide tools that simplify, improve, and automate the organization of a company or group's activities: e.g., managing administrative data, synchronizing appointments, etc (De Amorim Amorim, 2021).

1. Overview and Historical Development of Office Suites

Office work has been computer-assisted since 1985 (Watanabe, 1987). Fifteen years later, the use of computers for office work has become widespread (Chafi et al., 2021). Office workers use word-processing software to write letters and reports, and spreadsheet software to create summary reports.

The main office suites are:

1.1 Microsoft Office

Microsoft Office first appeared in 1990, and was initially a package comprising applications that had previously been sold separately (Rassia, 2017). The advantage of the suite over separate software was lower cost. The first version of the office suite included Word, Excel, PowerPoint, and Outlook (formerly known as Mail). There was also a commercial "Pro" offering that included Microsoft Access and Microsoft Schedule Plus. Over the years, office applications have expanded, sharing components such as spell-checkers (Dam-Krogh et al., 2024). Microsoft Office is currently the world's most widely recognized office suite. Since the 2003 version, Microsoft has added the word "Office" to the front of each program's name in the suite, which now includes Microsoft Outlook, Microsoft Publisher, and Microsoft OneNote.

1.2 IBM Lotus Symphony

IBM Lotus Symphony is the name of a set of applications for creating, editing (modifying), and sharing office documents, especially word processing and spreadsheets (Tidrow, 2008). It appeared in 1985 as an integrated software application for DOS (Holcombe & Guiochon, 1986). IBM has revived the Symphony name for a new office suite, available since 2007 in its Lotus software range, which is now free (Bäuerle et al., 2022).

1.3 OpenOffice

OpenOffice.org is a project launched on 13 October 2000 by Sun Microsystems to produce a free office software package based on StarOffice (Hauge et al., 2010). The resulting product is distributed under the same name and several licenses (the LGPL and, up to version 2.0beta2, not

included, the SISSL), and runs on several platforms, including Windows and many Unix systems, such as Linux, Solaris, and Apple OS X (Huysmans et al., 2008).

1.4 Libre Office

LibreOffice is a free and open-source office suite that originated from the OpenOffice.org project and is managed by The Document Foundation (Berényi & Sasvári, 2022). The Free Software Foundation supports it and consolidates much of the former OpenOffice.org community (Markushevich, 2023).

2. Microsoft Office

Microsoft Office is a proprietary office suite developed by Microsoft that operates on both desktop and mobile platforms. It includes applications such as Word, Excel, PowerPoint, OneNote, Outlook, Access, and Publisher, depending on the selected package (Hild & Wach, 2010). Microsoft Office also provides a web-based version accessible in browsers, as well as mobile versions for Windows Phone, iPhone, iPad, and Android devices, each named after the specific platform (Mercurio & Merrill, 2021).

2.1 Microsoft Office versions

Since its initial release, Microsoft Office has experienced significant development to meet the evolving needs of users in business, education, and personal productivity. Later versions introduced enhancements in functionality, interface design, and integration with emerging technologies such as cloud computing and collaborative platforms (Wilson, 2014).

Microsoft Office has seen many versions over the years. Here is a list of the most popular versions:

- Microsoft Office 1.0 was released in 1990.
- Microsoft Office 2.0 was released in 1992.
- Microsoft Office 3.0 was released in 1992.
- Microsoft Office 4.0 was released in 1993.
- Microsoft Office 95 was released in 1995.
- Microsoft Office 97 was released in 1996.
- Microsoft Office 2000 was released in 1999.
- Microsoft Office XP was released in 2001.
- Microsoft Office 2003 was released in 2003.
- Microsoft Office 2007 was released in 2007.
- Microsoft Office 2010 was released in 2010.
- Microsoft Office 2013 was released in 2013.
- Microsoft Office 2016 was released in 2015 for Mac and in 2016 for Windows.
- Microsoft Office 2019 was released in 2018 for both Mac and Windows.

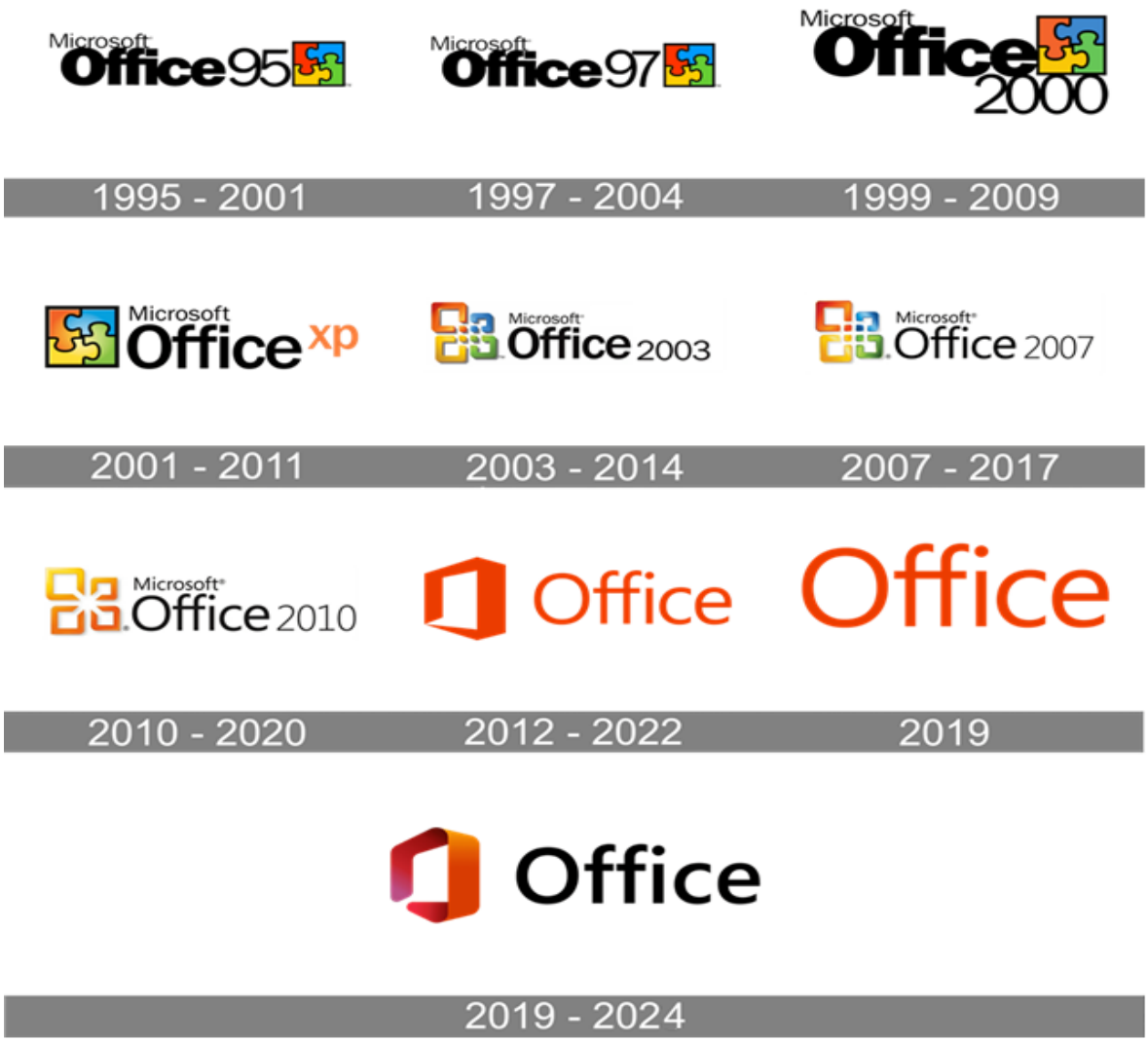


Figure 27: Evolution of Microsoft Office logos and software versions.

2.2 The main Microsoft Office applications

The main Microsoft Office programs are productivity tools widely used in professional, educational, and personal environments. Here's a list of the main Microsoft Office suite programs:

- **Microsoft Word:** A widely used word processing program for creating and editing text documents, such as reports, letters, CVs, and articles (Lambert et al., 2010).
- **Microsoft Excel:** A powerful spreadsheet program used to create, organize, and analyze data in spreadsheet format. Excel is widely used for managing finances, creating charts, and performing complex calculations (Mercurio & Merrill, 2021).
- **Microsoft PowerPoint:** Presentation software for creating visually appealing slideshows for professional, educational, or personal presentations (Joshi, 2017).
- **Microsoft Outlook:** A personal information manager that includes e-mail, calendar, contacts, and tasks. It is often used to manage business and personal communications (Wilson, 2014).

- **Microsoft Access:** A relational database management system for storing, managing, and analyzing large quantities of data. Access is often used to create customized database applications for companies (Viescas, 1999).
- **Microsoft OneNote:** Digital note-taking software that lets users capture ideas, to-do lists, sketches, and other information in an organized format (Crum, 2014).
- **Microsoft Publisher:** Desktop publishing software for creating a wide variety of visual documents such as brochures, flyers, business cards, and newsletters (McCarter & Mabin, 2007).
- **Microsoft Teams:** A team communication and collaboration platform that enables team members to communicate, share files, hold virtual meetings, and work together on projects in real time (Rojabi, 2020).

3. Microsoft Word

Microsoft Office, developed by Microsoft Corporation and launched in 1989, is a widely used suite of applications for professional and personal tasks. Its core programs include Word, Excel, PowerPoint, OneNote, Outlook, Access, and Publisher, each designed for specific functions. The main versions of Microsoft Word:

- **Word 1.0 (1983):** The initial release of Word for the MS-DOS operating system was basic in functionality, yet it established the foundational concepts of modern word processing software (Llc, 2010).
- **Word for Mac (1985):** Microsoft introduced a version of Word specifically designed for Macintosh computers in 1985, thereby expanding its user base (O'Shea, 1983).
- **Word for Windows (1989):** The release of the first Word version for Microsoft Windows in 1989 significantly increased the software's popularity (Haigh, 2006).
- **Microsoft Office integration (1990):** With the launch of Microsoft Office 1.0 in 1990, Word became a central component of the Office suite (Beckman, 1995).
- **Ongoing improvements:** Over time, Word has undergone continuous updates and enhancements, introducing features including spell and grammar checking, formatting styles, and track changes (Lowe & Williams, 2010).

Figure 28: Microsoft Word Versions from 1983 to Present

3.1 Basic Functions of Microsoft Word:

As one of the most widely used word processors, Microsoft Word offers comprehensive tools for creating, editing, formatting, and sharing documents. The key features are summarized below (Foulkes, 2020):

- **Document creation:** Microsoft Word facilitates the creation of various types of text documents, including letters, reports, and articles.
- **Text entry and editing:** Users can enter and modify text efficiently. Microsoft Word also provides advanced features, including copy and paste and text dragging.
- **Text formatting:** Microsoft Word provides a range of formatting options, including font selection, font size, font styles, text color, alignment, and indentation.
- **Element insertion:** Microsoft Word allows the insertion of various elements, including images, tables, shapes, graphics, text boxes, hyperlinks, comments, and fields.
- **Spelling and grammar checking:** Microsoft Word includes integrated tools that identify errors and provide suggestions for correction.
- **Saving and sharing:** Documents can be saved locally or shared electronically, for example, via email.
- **Printing:** Microsoft Word supports direct printing with adjustable print settings to accommodate specific requirements.
- **Styles and templates:** Predefined or custom styles can be applied to ensure consistent formatting. Microsoft Word also provides templates for different document types.

3.2 The Microsoft Word user interface:

Microsoft Word is a word processing application that forms a core component of the Microsoft Office suite. It is used to create and print documents in both professional and personal contexts. Microsoft Word 2007 introduced a redesigned menu system, featuring sub-menus displayed as icon bars with dynamic content. The 2010 version closely resembles the 2007 release but incorporates several enhancements.

- Word 2003 documents use the **.doc** file extension.
- The **.docx** file extension is used for documents created in Word 2007, 2010, 2013, and the current 2024 version.

The image below illustrates the main components of the Microsoft Word interface. Key elements are labeled to illustrate the program's layout and functionality, including the Title Bar, Quick Access Toolbar, Ribbon, Document Title, Control Buttons, Document Area, Text Area, and Status Bar. This interface helps users find tools, enter and edit text, and navigate their documents efficiently.

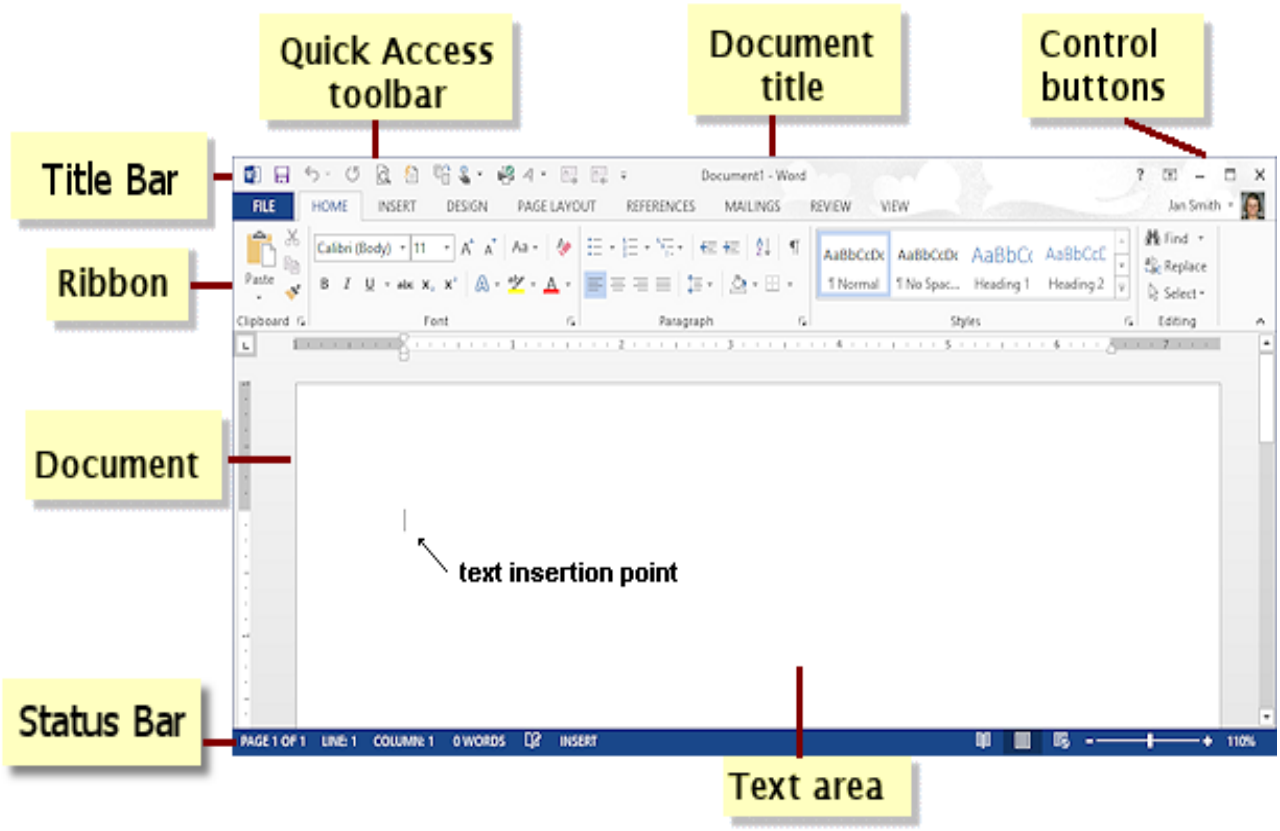


Figure 29: Microsoft Word interface.

3.3 Creating, opening, and saving documents

When you open Microsoft Word, it displays a blank document for you to begin working on. To create a new document, click the File button and then select New. To open an existing document, select "Open" from the File menu. To save your work in various formats, select "Save As" and choose the desired format.

- **Creating a document:** To open a new document, click on the File button, then on New, then on the Blank Document command.
- **Opening a Document:** To open an existing document, click the File button, then select the Open command. A dialog box will appear. You can browse your file tree to find your file and open it by double-clicking on the file or by selecting the file and then clicking on "Open."
- **Saving a document:** Once you have created a document, don't forget to save it, or you risk losing all your work. To do this, click on the File button, then on the Save As button. You can then choose the format and location for saving the file, and specify the file name.

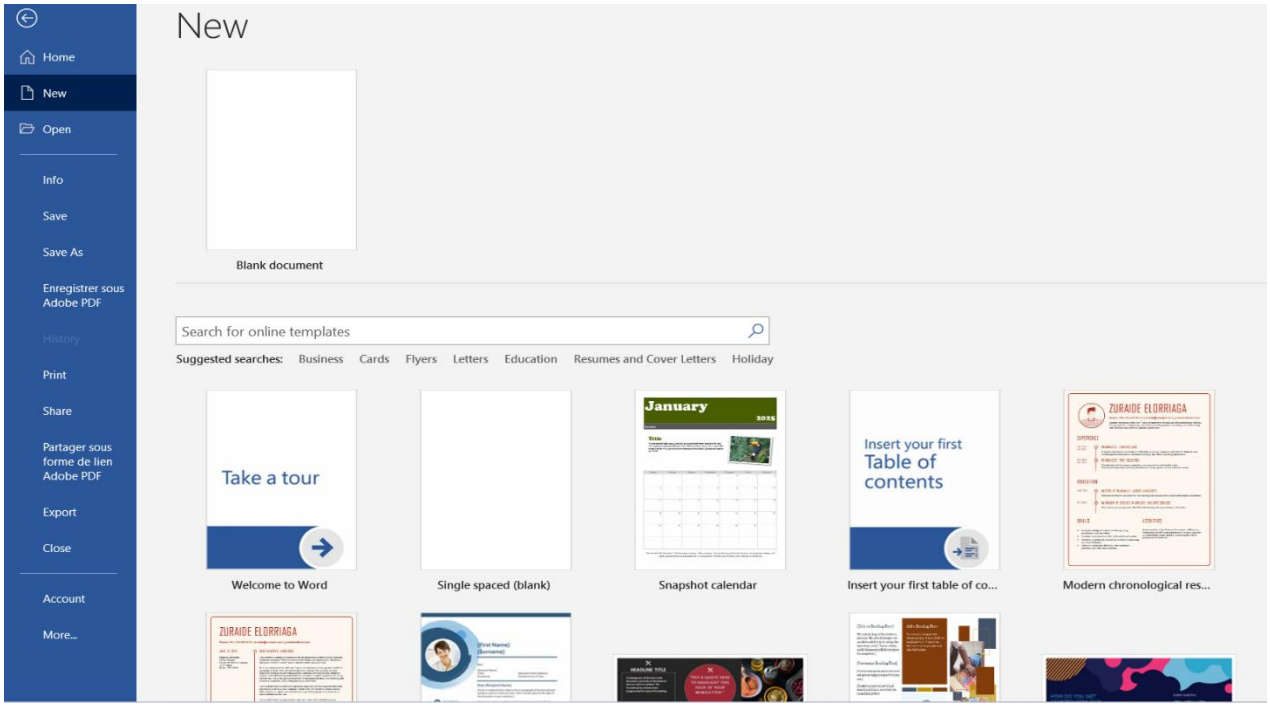


Figure 30: Open a Word document.

3.4 Basic Formatting

3.4.1 Entering Text and Using Paragraphs

This guide covers basic methods for entering and managing text and paragraphs in Microsoft Word.

- **Entering Text**

  You can begin by opening Microsoft Word to enter your text. Click the location where you want to type, and type your text at the selected location.

- **Editing Text**

  - Editing text in Microsoft Word enables users to easily modify, delete, or rearrange content. You can use cut, copy, and paste commands to manage text efficiently.
  - The Find and Replace feature helps locate and update specific words quickly and efficiently.
  - Word also offers tools for spell check, grammar correction, and text formatting.

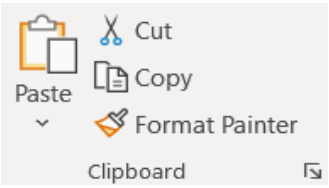


Figure 31: clipboard shortcuts in MS Word

- **Managing Paragraphs**

  - Paragraph management in Microsoft Word involves adjusting the text layout and spacing to enhance readability.

- Text alignment options include left, center, right, and justified, each contributing to a more organized document appearance.
- Indentation and line spacing tools facilitate content organization and enhance document structure.
- Bulleted and numbered lists offer a systematic approach to presenting information.
- Borders, shading, and paragraph marks increase visual clarity and offer greater control over formatting.

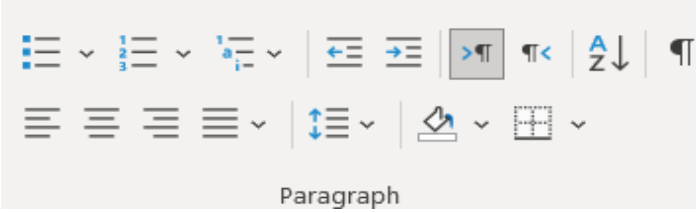


Figure 32: Paragraph group in MS Word

3.4.2 Clear Page Layout

- To begin, use the Justify function to align text evenly on both sides of the paragraph.

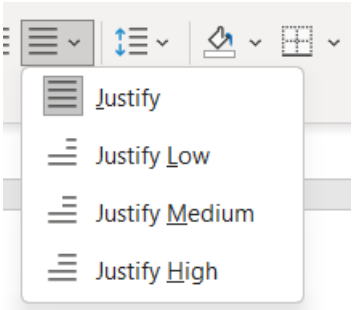


Figure 33: The "Justify" function.

- Next, adjust line and paragraph spacing according to your preferences for better readability.
- Additionally, customize the font type and size to enhance text clarity.

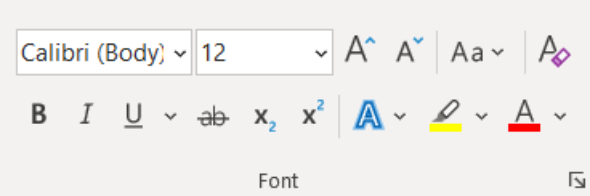


Figure 34: The Font option.

- By following these simple steps in Microsoft Word, you can enter, edit, and organize text while ensuring a precise and professional page layout.

3.4.3 Formatting Characters and Paragraphs

Formatting in Microsoft Word enhances the clarity, visual appeal, and readability of documents. Character formatting refers to adjustments made to the appearance of individual letters or words. Font type, size, and color can be adjusted to emphasize key information in a document.

a) Font Type

The font type in Microsoft Word determines the visual style of text. Choosing an appropriate font enhances both the readability and the overall presentation of the document.

1. Select the text to be modified.
2. Click the Home tab in the Ribbon interface.
3. Open the Font drop-down menu within the Font group.
4. Select the preferred font from the list of available options.
5. The selected text will display in the new font style immediately.

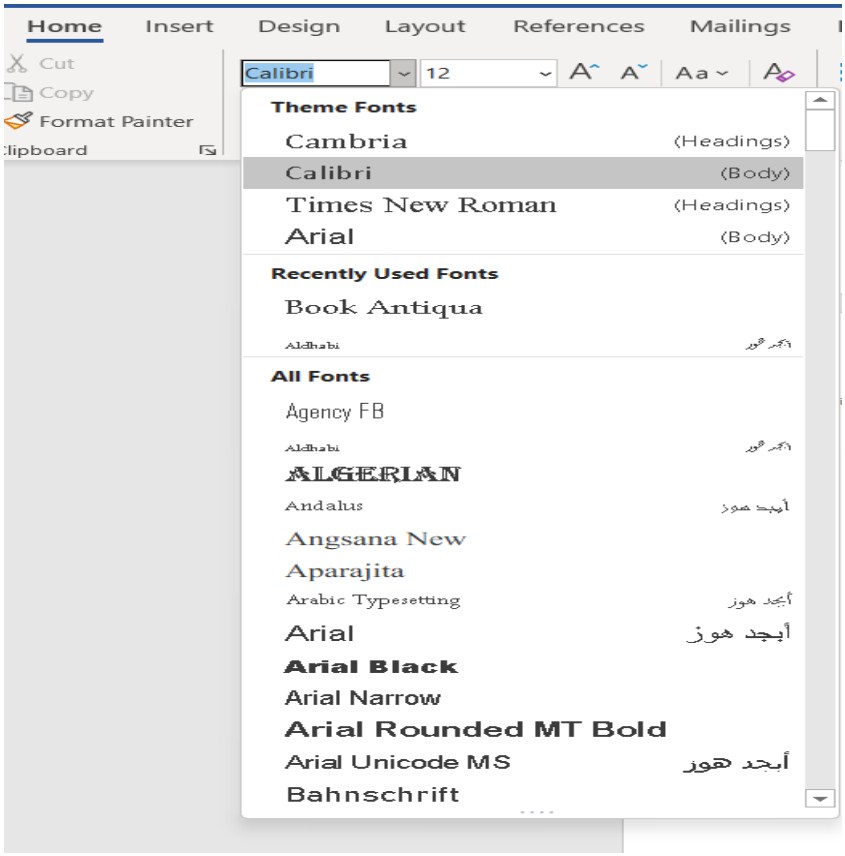


Figure 35: The font type in MS Word

b) Font size

Font size in Microsoft Word determines the visual dimensions of the displayed text.

To modify the font size, select the desired text, navigate to the Home tab, and select a value from the Font Size menu.

Alternatively, the Increase Font Size and Decrease Font Size icons provide rapid adjustments to text size.

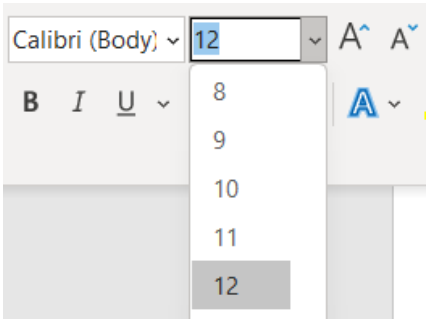


Figure 36: The font text in MS Word

c) Font color

Adjust the font color in Microsoft Word to enhance text visibility or ensure consistency with the document's formatting.

To change the font color, select the desired text, then click the Font Color icon on the **Home tab**.

Select a color from the palette or choose More Colors to access additional customization options.

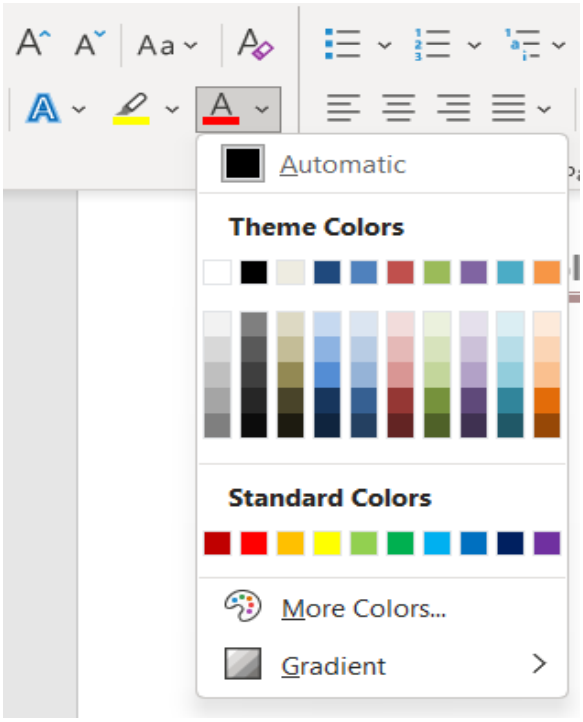


Figure 37: The font color in MS Word

d) Text alignment

Set text alignment in Microsoft Word to control how text is positioned between the page margins.

Choose to align text to the left, center, right, or justify it for even spacing on both sides.

Click the Alignment icons in the Home tab to apply your preferred alignment style.

Figure 38: Text alignment in Microsoft Word

e) Line spacing

Line spacing in Microsoft Word determines the amount of vertical space between lines of text.

Adjusting line spacing enhances readability and contributes to a visually balanced document.

To modify line spacing, select the Home tab, choose Line and Paragraph Spacing, and then select the desired spacing option.

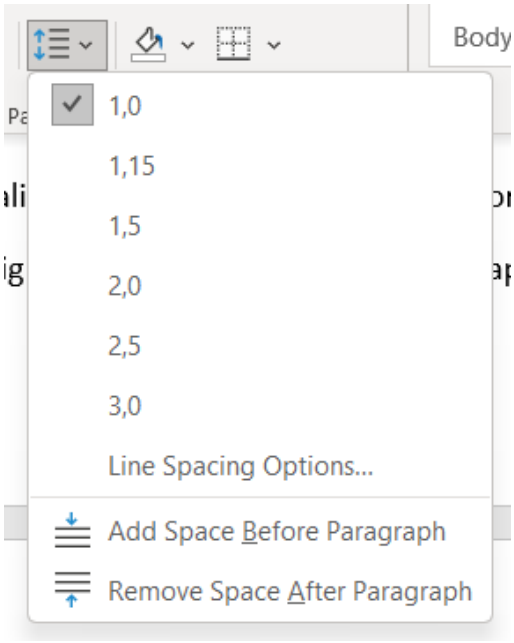


Figure 39: Line spacing in MS Word.

f) Using Lists and Bullets

Lists and bullets organize information clearly and accessibly.

To create a bulleted list, select the Bullets icon located in the Home tab.

For numbered steps, use the Numbering icon.

The Multilevel List option enables the creation of subpoints and hierarchical structures.

Utilizing these tools results in a more structured and professional document.

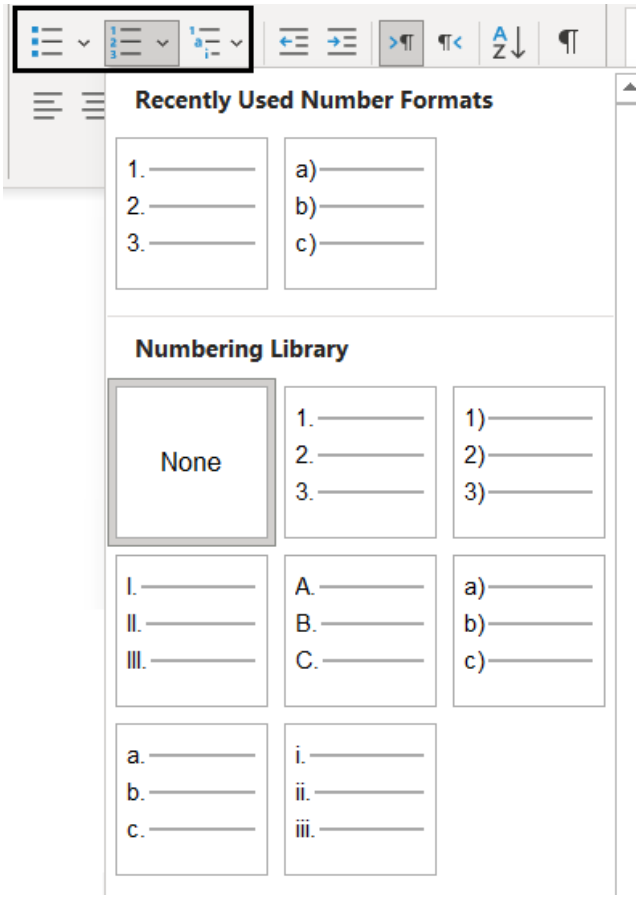


Figure 40: Lists and Bullets in Microsoft Word

3.5 Document Organization and Structure

3.5.1 Using Headers and Footers

A header is a section located at the top of a document, whereas a footer is positioned at the bottom. Headers and footers commonly include supplementary information such as page numbers, dates, author names, and footnotes (Jia-Ji, 2006). These elements contribute to the organization and readability of lengthy documents. Content placed in the header or footer is displayed on every page of the document.

To insert a header or footer:

1- Select the Insert tab, then click the Header or Footer command. In our example, we'll click the Header command.

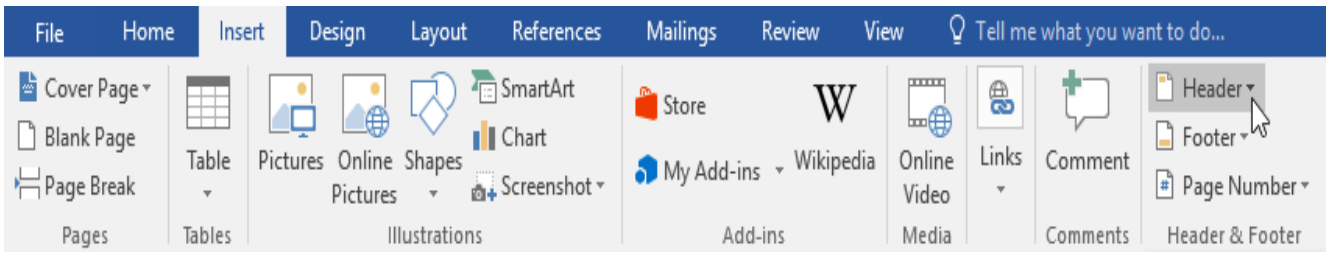


Figure 41: Header or Footer command

2- In the menu that appears, select the desired header or footer.

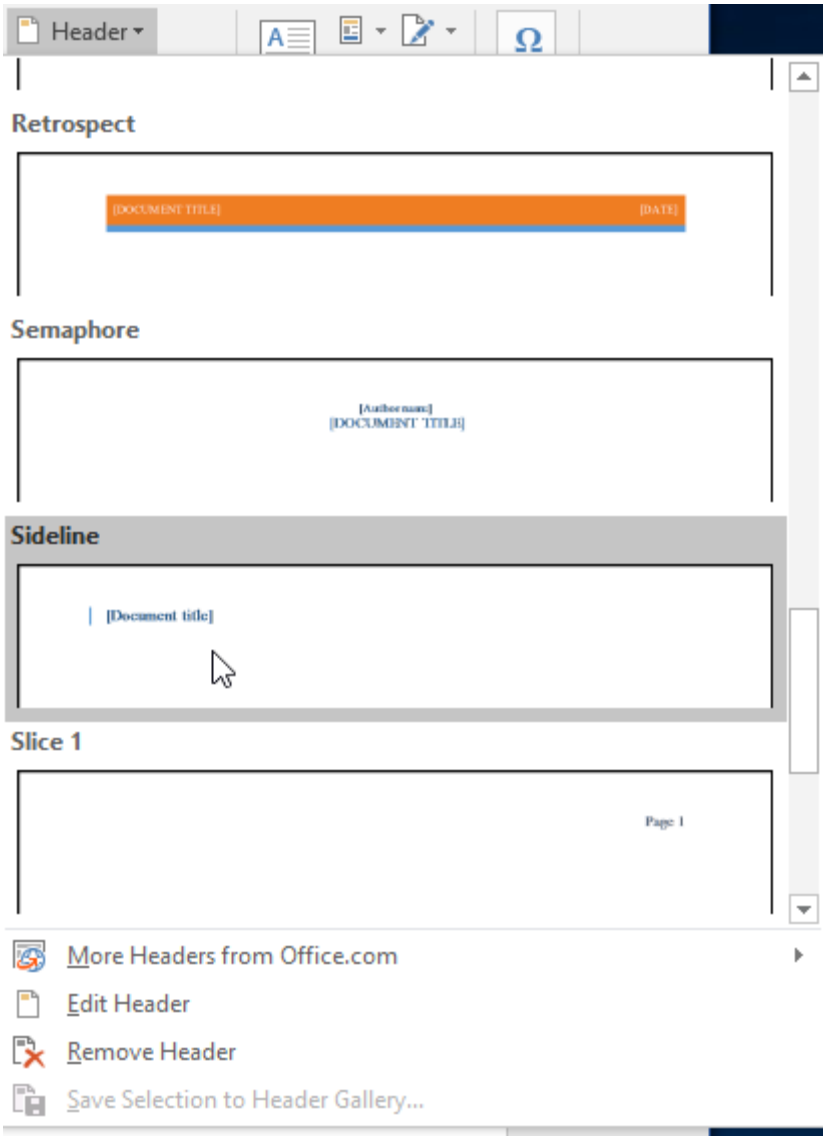


Figure 42: Inserting a header menu.

- Page numbers

Page numbers automatically number each page in your document and offer various formats to fit your preferences. They are typically placed in the header, footer, or side margin. To restart numbering in a new section, use Word's "Restart at" option. Adding page numbers improves organization and clarity.

To add page numbers:

1- On the Insert tab, click the Page Number command.

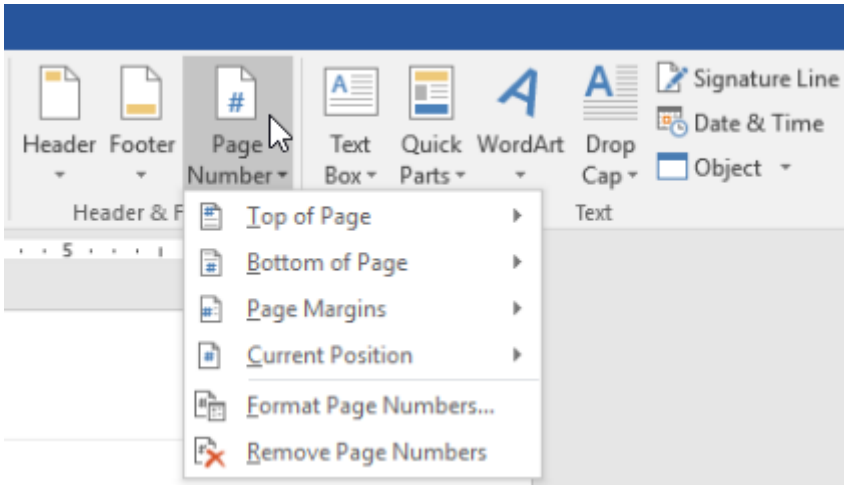


Figure 43: Page number command.

2- Open the "Top of Page", "Bottom of Page", or "Page Margins" menu, depending on where you want the page number to be positioned, and then select the desired style of header.

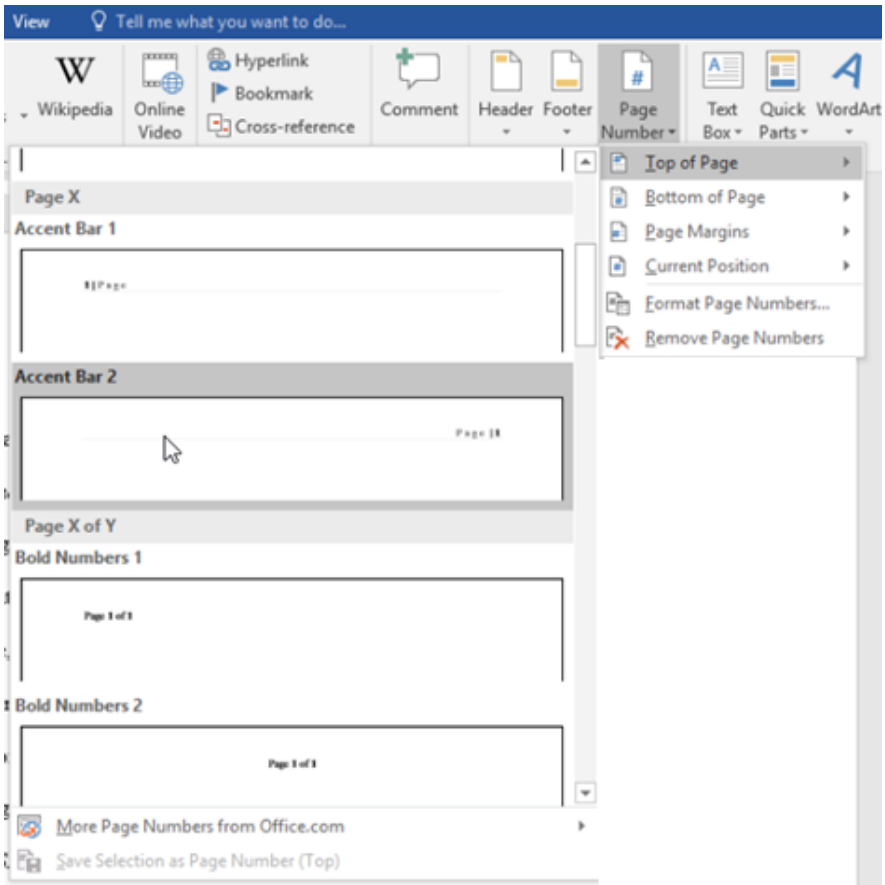


Figure 44: Inserting a page number.

- Inserting section breaks

Use section breaks to organize and structure your document. Go to the Layout or Insert tab, select Breaks, and choose continuous, next page, or odd/even page breaks. Adjust headers and footers for each section as needed. Make changes to specific sections. Remove a section break to merge the sections.

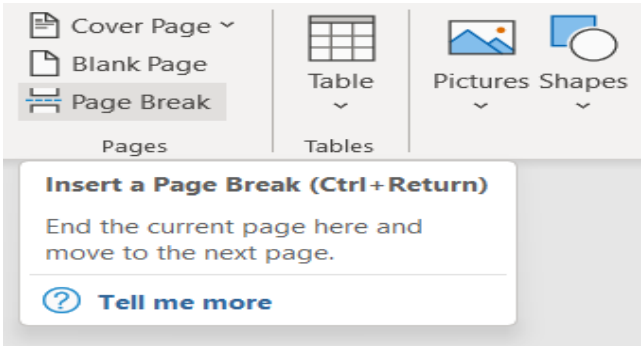


Figure 45: Inserting section breaks

Section breaks let you divide your document into distinct parts with unique formatting. They give you flexibility to adjust the layout and settings for each section.

- Create the Table of Contents

A table of contents lists each section of a document, along with the page number where it begins. A basic example is shown below:

Figure 46: Example of Table of Contents.

To create a table of contents in Word

- **Step 1: Applying Heading Styles:** To apply a heading style, select the relevant text and choose the appropriate heading from the Styles group in the Home tab.

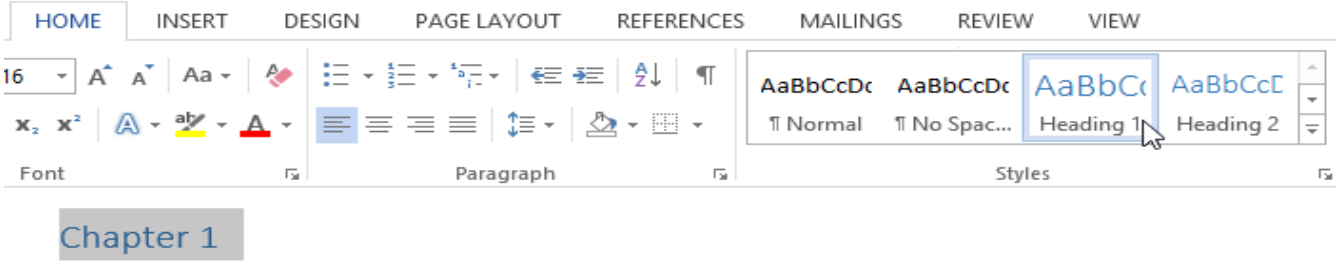


Figure 47: Heading Styles

- **Step 2: Inserting the Table of Contents:** After applying heading styles, insert the table of contents by navigating to the References tab on the Ribbon and selecting the Table of Contents command. Choose a built-in table from the menu to display the table of contents in your document.

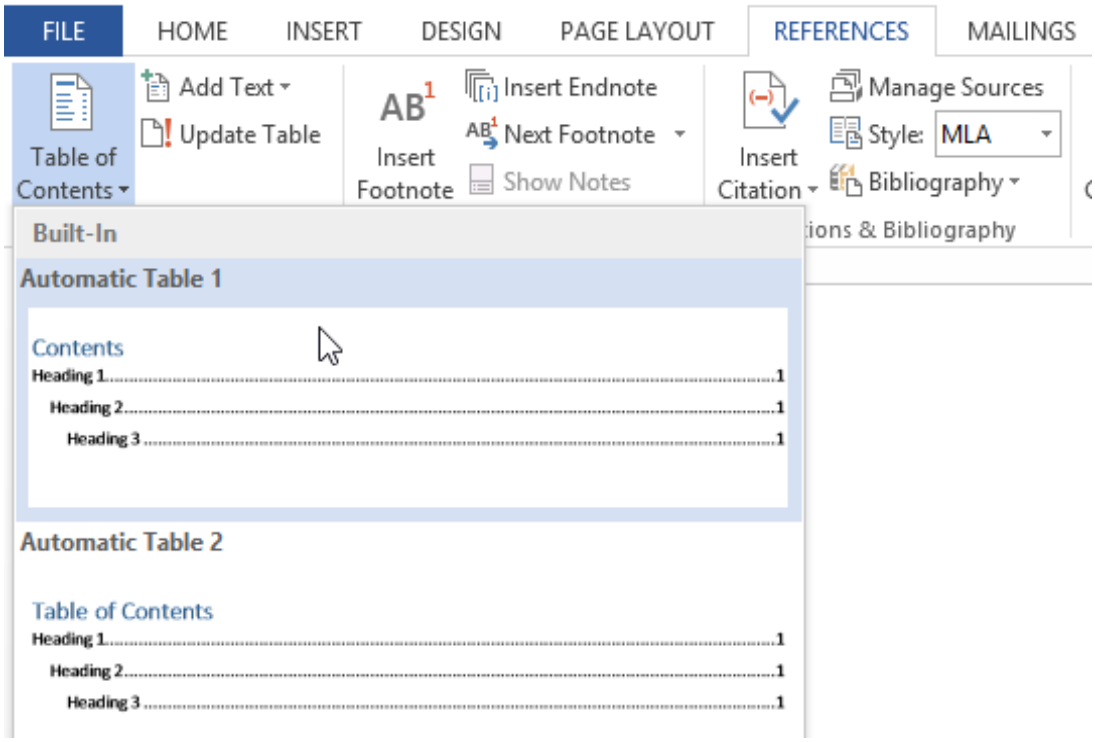


Figure 48: The table of contents command.

3.5.2 Working with Graphics and Pictures

Adding images and graphics enhances the visual appeal of your documents. You can insert graphs from Microsoft Excel into Word, as Microsoft products integrate seamlessly. After copying and pasting visuals, you may need to adjust formatting to ensure they align with your text.

To insert a picture from a file:

1. Go to the **Insert** tab on the ribbon.
2. Click **Pictures**.
3. Choose **This Device** to select an image from your computer.
4. Browse and select the desired picture.
5. Click **Insert** to add it to your document.

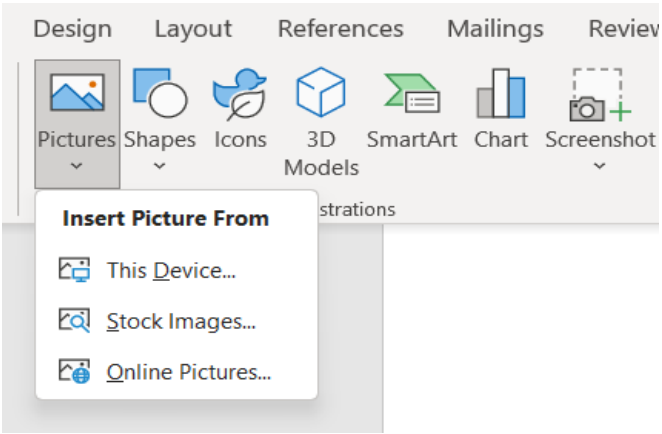


Figure 49: Inserting Images in Word.

3.5.3 Working with Tables

Tables in MS Word organize data in rows and columns for a clear and professional presentation. They can be created and customized with features such as layout changes and style options.

To insert a blank table:

- **Using the Grid:**

1- Place the insertion point where you want **the table** to appear.
2- Navigate to **the Insert tab**, then click the **Table** command.

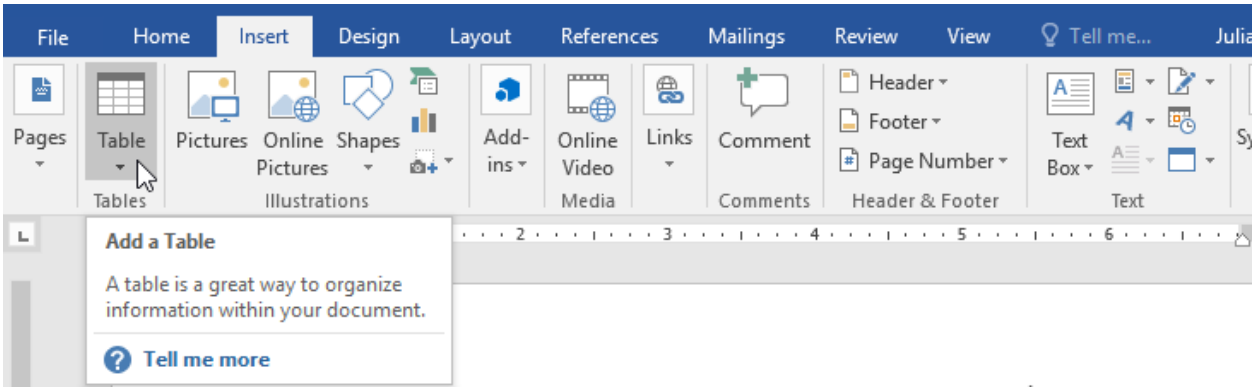


Figure 50: Inserting tables in Word.

3- A drop-down menu with a grid will appear. Hover over the grid to choose the desired number of **columns** and **rows**.

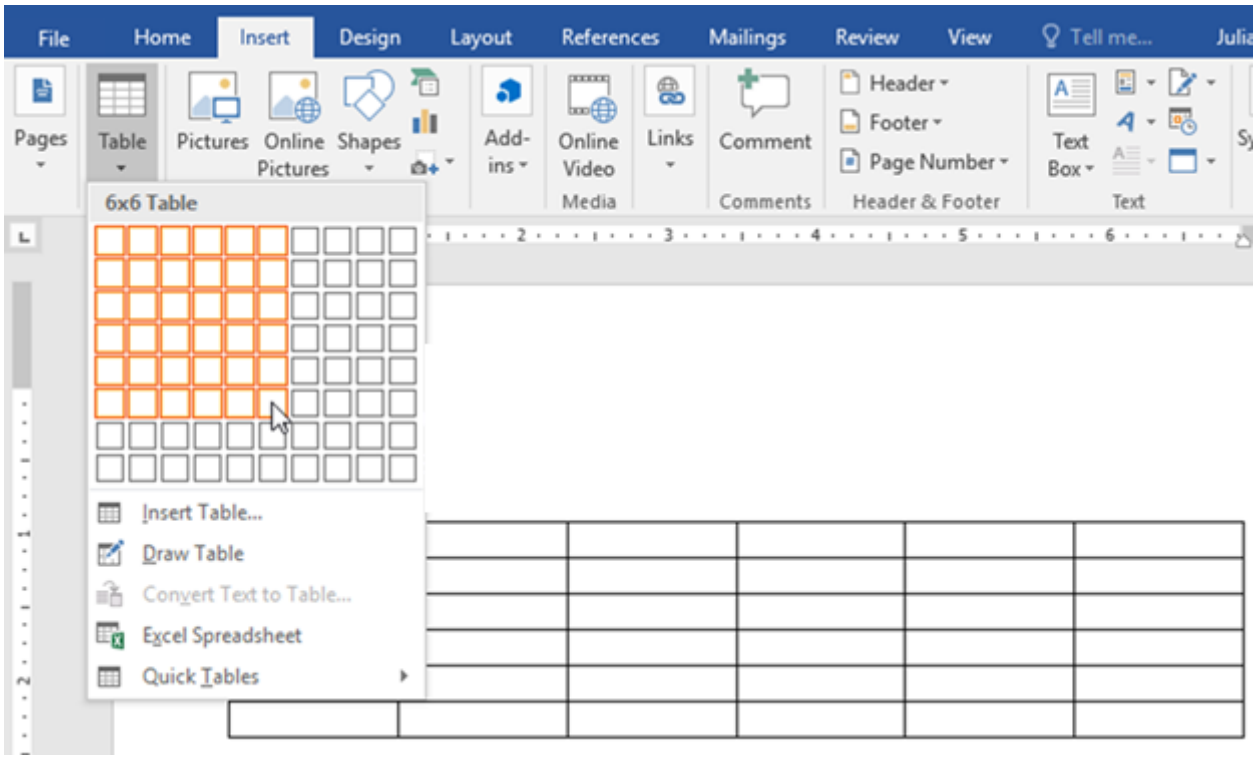


Figure 51: Inserting columns and rows.

4. Click the grid to **display the table**, and **click** a cell and type to **enter text**.

Monday	Tuesday	Wed			

Figure 52: Inserting tables using a grid.

- **Using Table Dialogue Box:**

The following are the steps of creating a table using the Table Dialogue Box in MS Word:

1. Go to the **Insert tab** and click on the **Table button**.
2. Under the grid, you will see an **Insert Table button**. Click on it.

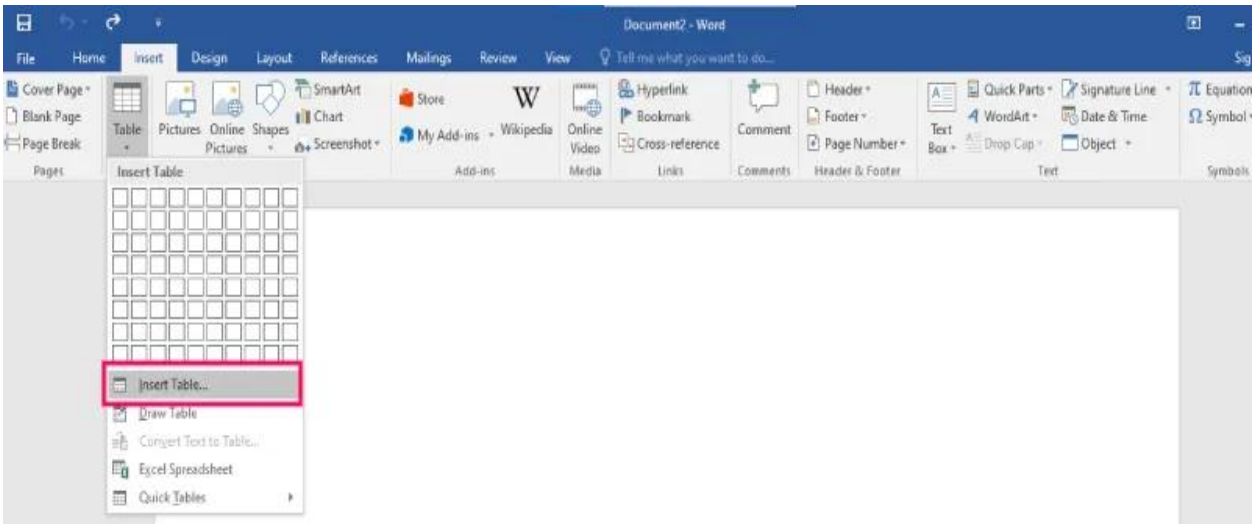


Figure 53: Inserting tables command.

3. In the Insert **Table Dialogue box**, specify **the number of rows and columns** as required, and then click the **OK button**.

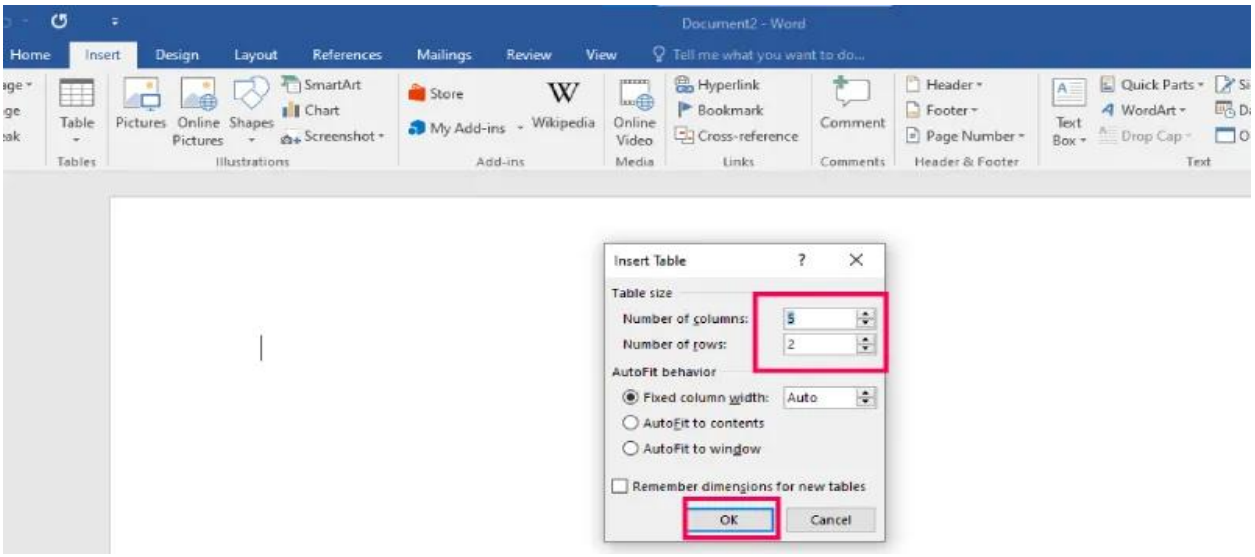


Figure 54: Inserting tables using the Dialogue box

3.5.4 Working with Diagrams and Charts

A chart visually presents information, making numerical data such as comparisons and trends easier for readers to understand.

To insert a new chart:

1. Place the cursor where you want the chart in the Word document.
2. Go to Insert > Chart in the Illustrations group.

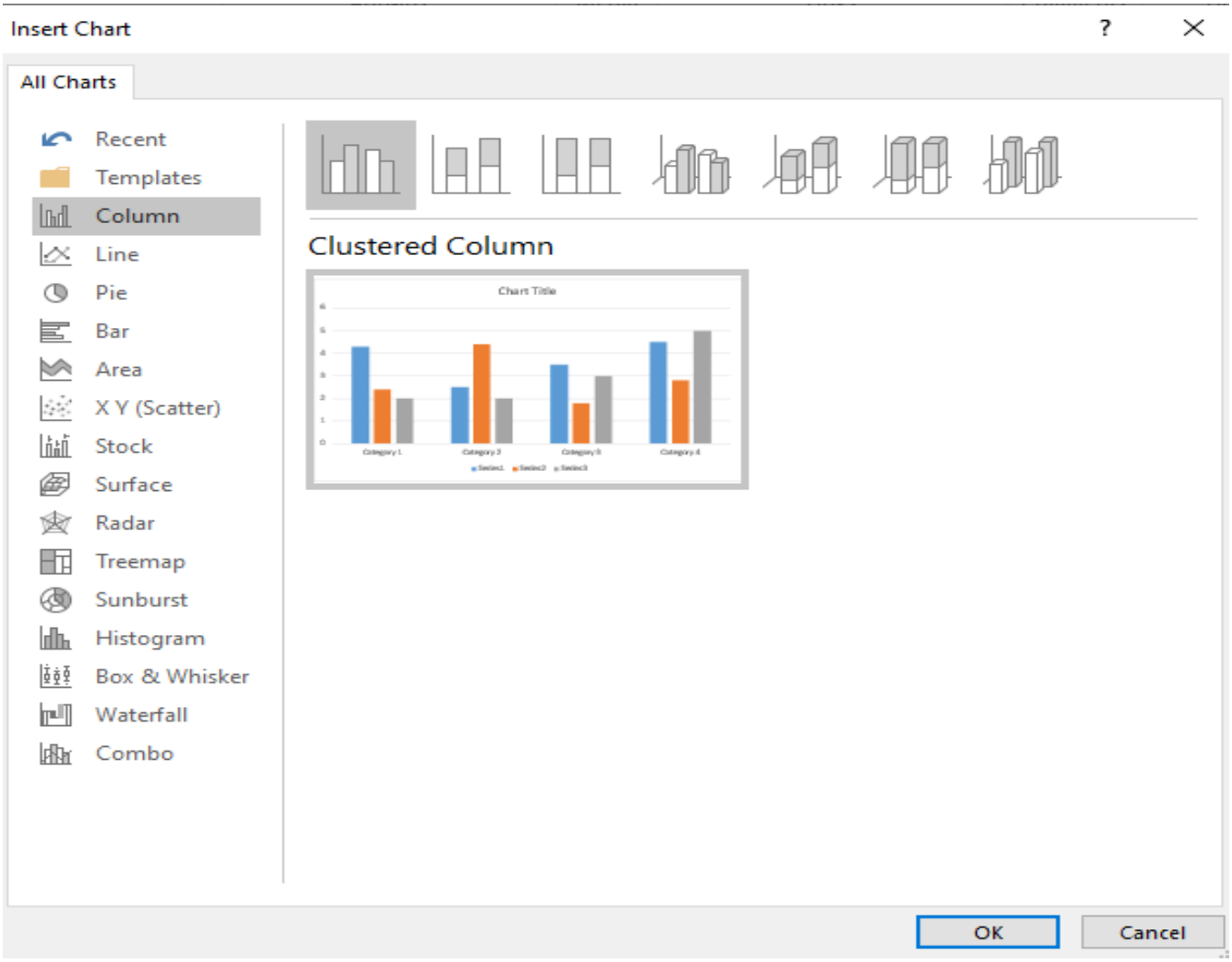


Figure 55: Insert a new chart in MS Word.

3. A chart and spreadsheet window appear. The spreadsheet contains placeholder text that needs to be replaced with actual source data. Word utilizes this source data to generate the chart.

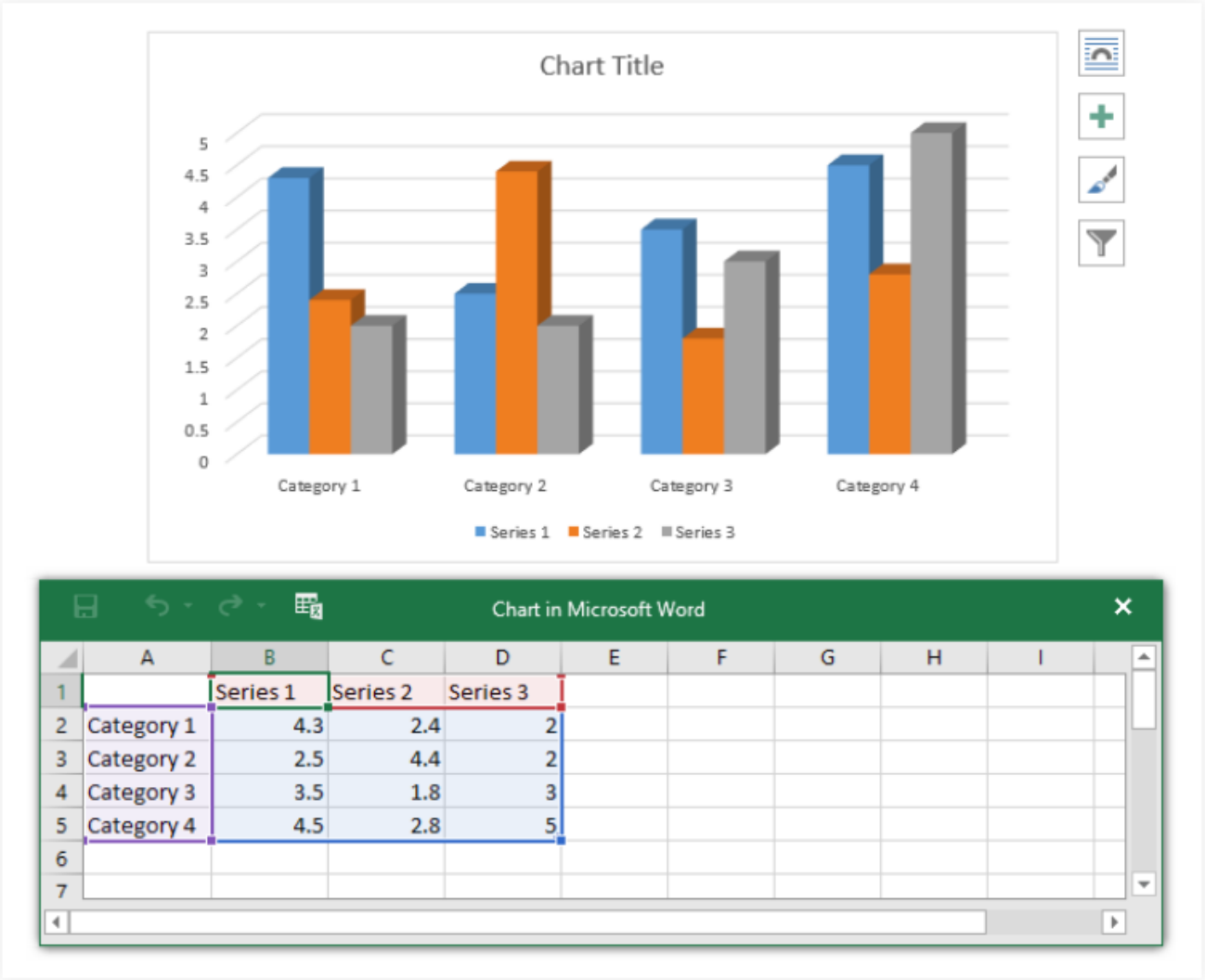


Figure 56: Example of a chart in Microsoft Word.

4. Microsoft Excel

Microsoft Excel is a spreadsheet software program in the Microsoft Office suite developed and distributed by Microsoft (Fylstra et al., 1998). The most recent version is Excel 2024.

It is designed to run on Microsoft Windows, macOS, and Android. Excel software includes functions for numerical calculation, graphing, data analysis, and programming. It is particularly used in accounting, finance, logistics, and database management (Lyons, 2023).

4.1 Applications of Microsoft Excel

- Manage numerical data in tables, as well as related textual information, schedules, and dates.
- Link data to enable automatic calculation of results.
- Provide a range of mathematical, statistical, and data search functions.
- Display numerical data in graphical formats.

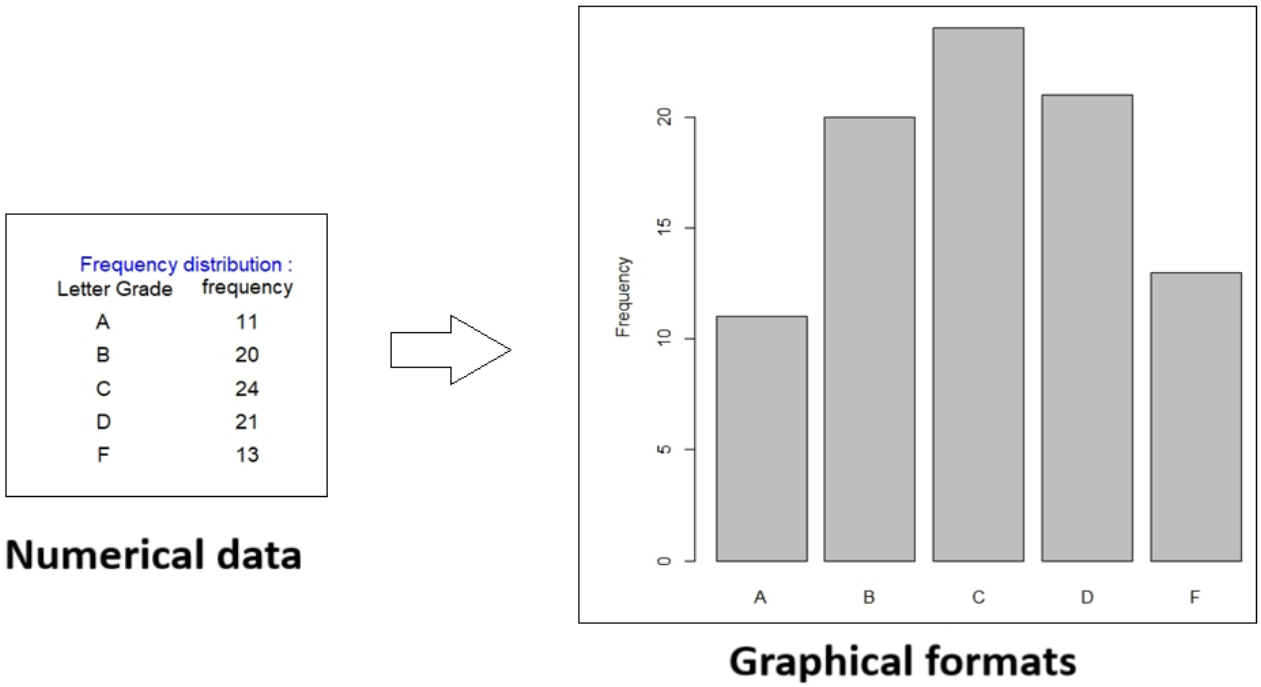


Figure 57: Display numerical data in graphical formats.

4.2 MS Excel Interface

When you open Excel, the user interface appears as shown below. We will review its basic features and how to navigate them.

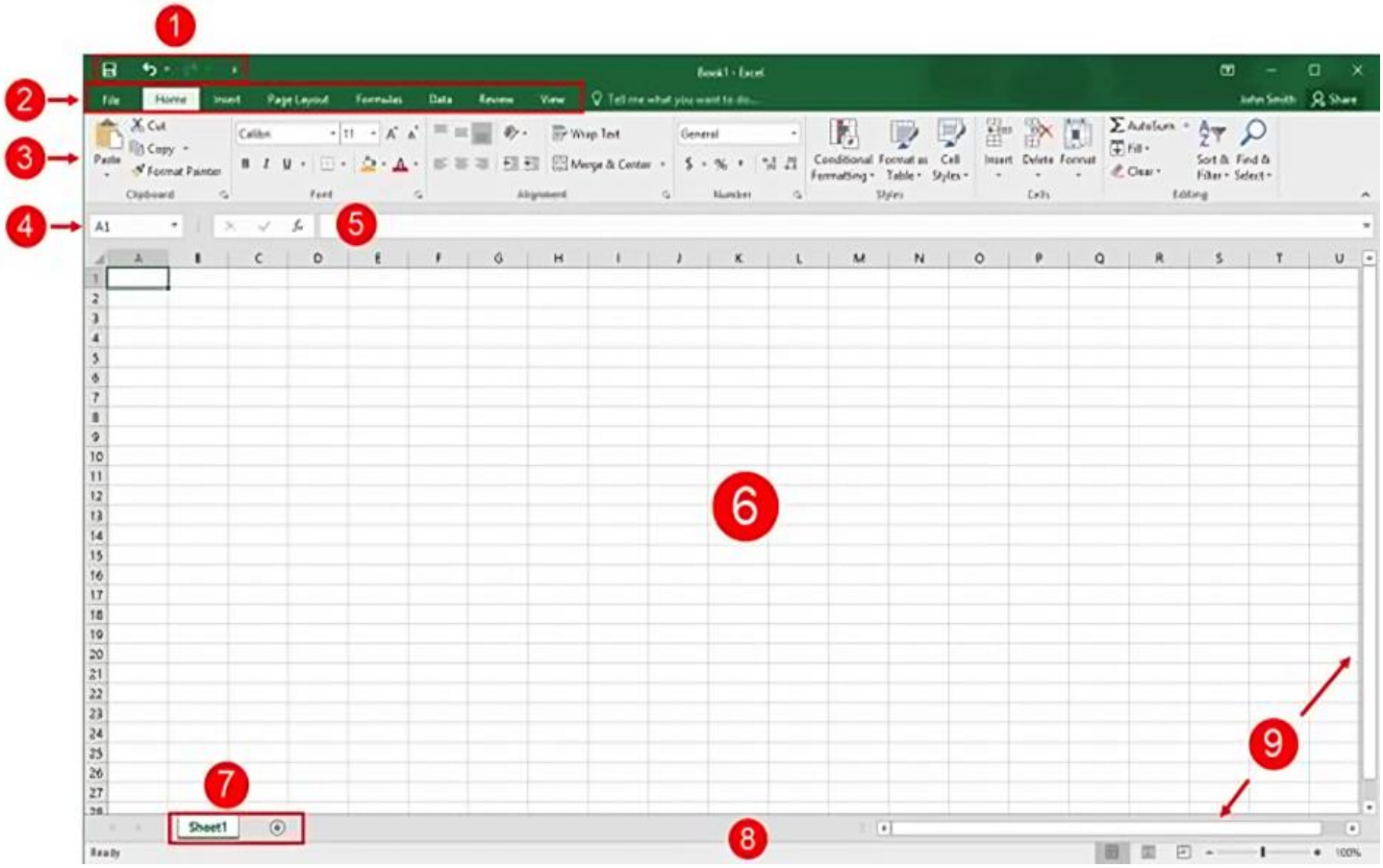


Figure 58: MS Excel Interface

1. **Quick Access Toolbar**

The Quick Access Toolbar offers fast access to frequently used commands. It is fully customizable and can be placed above or below the ribbon.

2. **Tabs**

Commands are grouped under tabs. Select a tab to view its commands in the ribbon.

3. **Ribbon Interface**

The ribbon displays commands organized into groups under each tab. Some commands may appear greyed out, indicating they are only available in specific situations. The File tab, which opens the Backstage view, is also included.

4. **Name Box**

Each cell is named using the format <Column>_<Row>. The Name Box displays the name of the currently selected, or active, cell. For example, the active cell in the sample image is A1.

5. **Formula Bar**

Located next to the Name Box, the Formula Bar allows you to enter data into a cell. This data can include text, numbers, symbols, images, or formulas.

6. **Working Area**

The working area displays the data contained in the file.

7. **Worksheet Tabs**

Each Excel file is called a workbook, which can contain one or more worksheets. Use these tabs to switch between worksheets.

8. **Status Bar**

The status bar displays information about the workbook, including ongoing calculations and options for zoom and view.

9. **Scroll Bars**

Use the scroll bars to navigate horizontally or vertically through data that does not fit on the screen.

4.3 Creating and Opening Workbooks:

a) To initiate the creation of a new blank workbook:

1. Select **the File tab** to display the Backstage view.

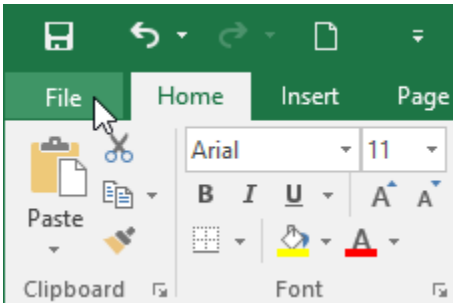


Figure 59: The File tab.

2. Select "**New**" and then choose "**Blank workbook**."
3. A new blank workbook will appear.

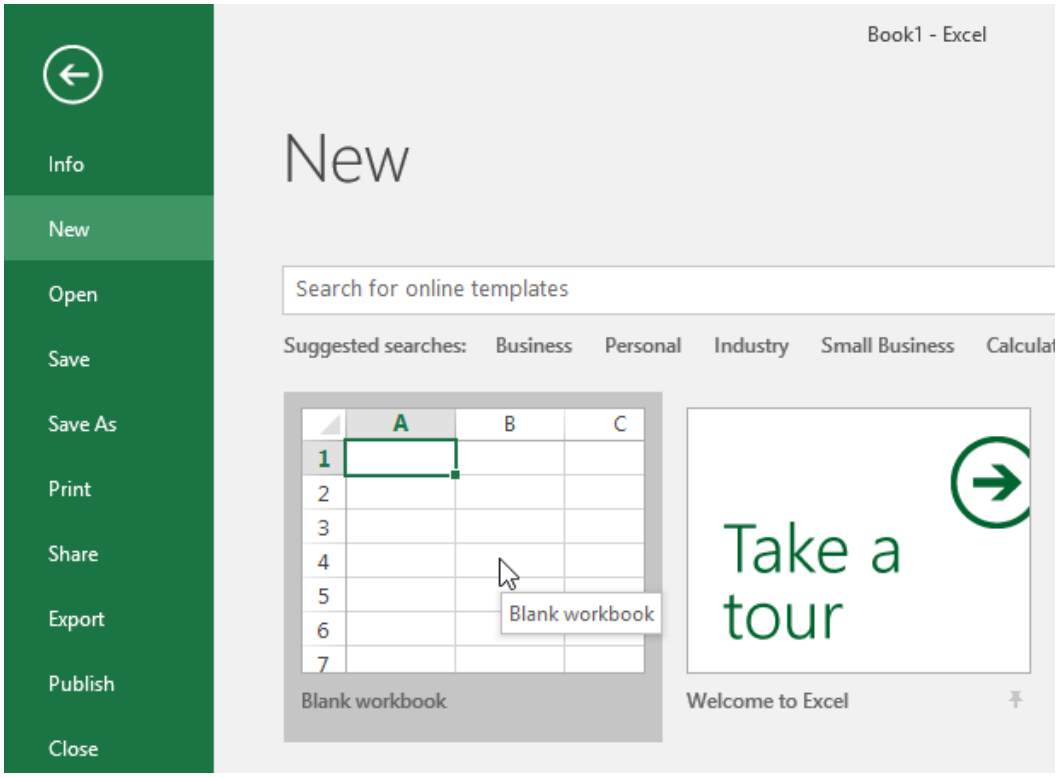


Figure 60: New blank workbook.

b) To open an existing workbook:

1. From the **File tab**, select **Open**.

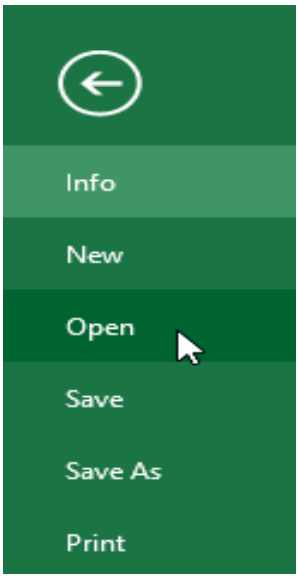


Figure 61: File tab.

2. Browse your **computer**, **cloud storage (such as OneDrive)**, or select a file from **the recent list**.

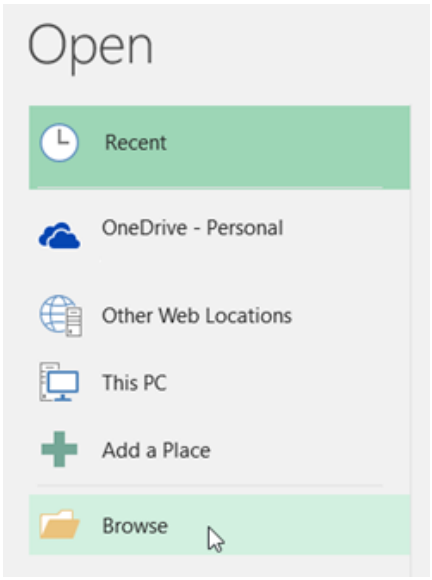


Figure 62: Open an existing workbook.

3. To open the file dialogue box directly, press **Ctrl+O** or **Ctrl+F12**.

c) Using templates:

A template is a predesigned spreadsheet utilized to generate new workbooks efficiently. Templates typically incorporate custom formatting and predefined formulas, thereby streamlining project initiation and reducing manual effort (Quintela-Del-Río & Francisco-Fernández, 2016).

To create a new workbook from a template:

1. Click the File tab to access Backstage view.

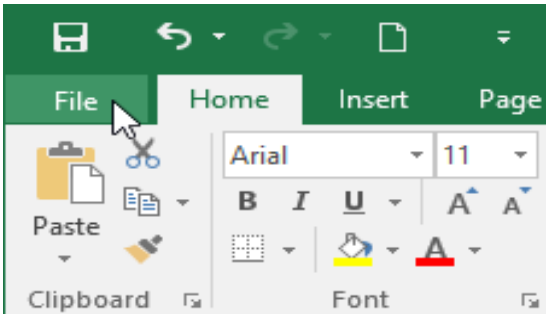
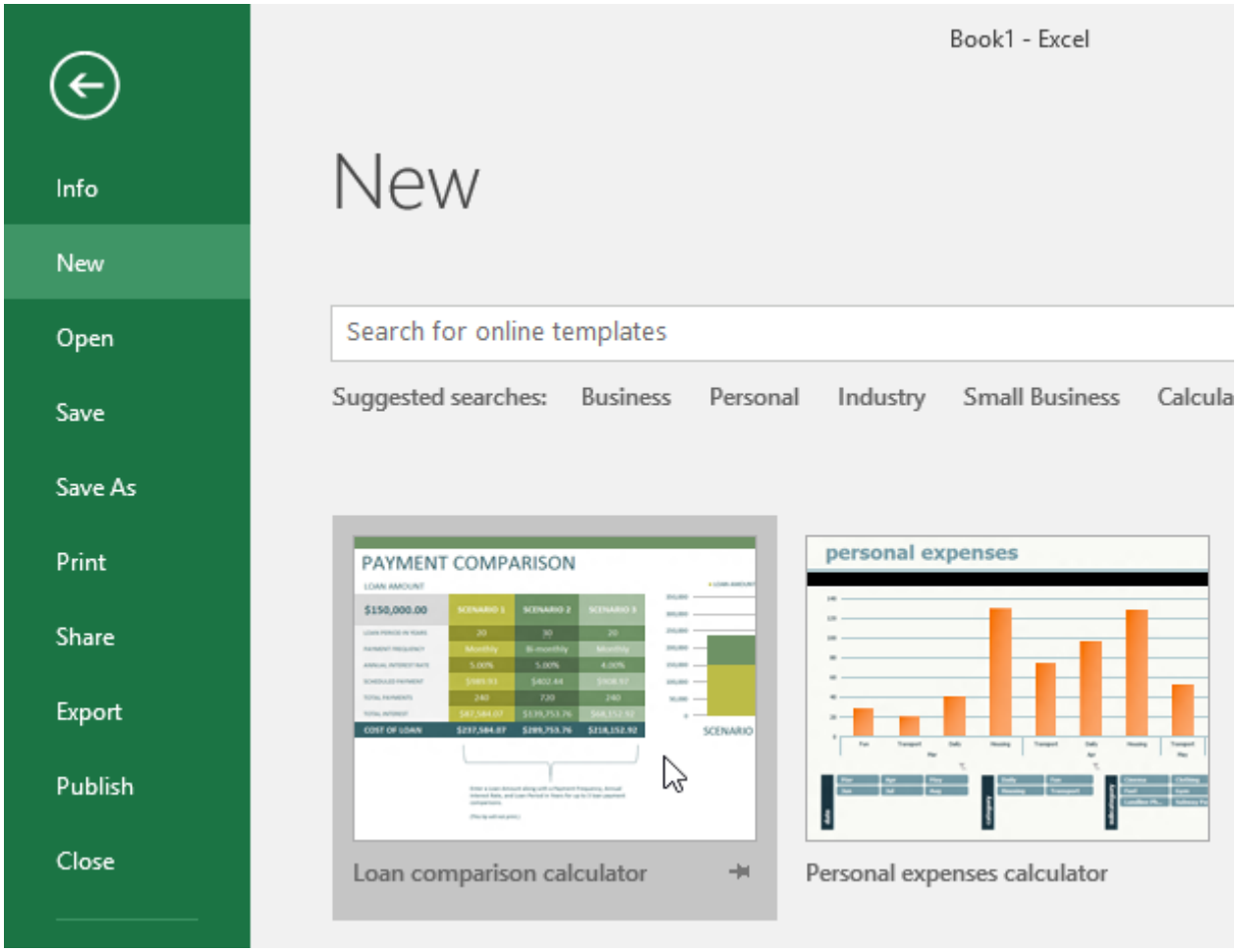


Figure 63: File tab.

2. Select **New**. Several templates will appear below the **Blank workbook** option.
3. Select a **template** to review it.



Figures 64: List of templates.

4.4 Basic tasks in Excel

a) Enter data

1. Click an empty cell to enter data.
2. For example, cell A1 is found at the intersection of column A and row 1 on a new sheet. Cells are referenced using their column letter and row number, so A1 means column A, row 1.
3. Type text or a number in the cell.
4. Press Enter or Tab to move to the next cell.

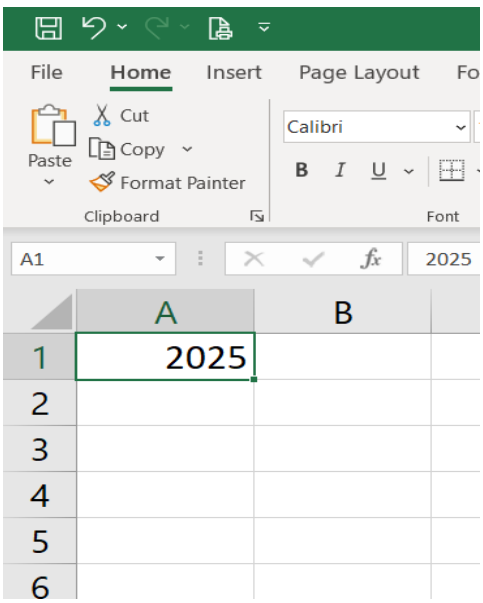


Figure 65: Enter Data.

b) Create charts:

To create a chart in Excel:

1. Select your data and open the Insert tab.

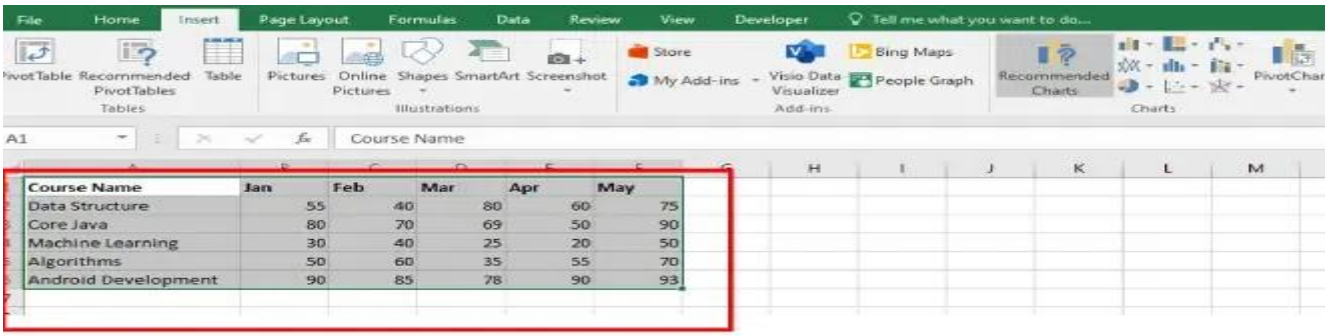


Figure 66: Insert data.

2. Choose a chart type from the Charts group or use Recommended Charts for suggestions.

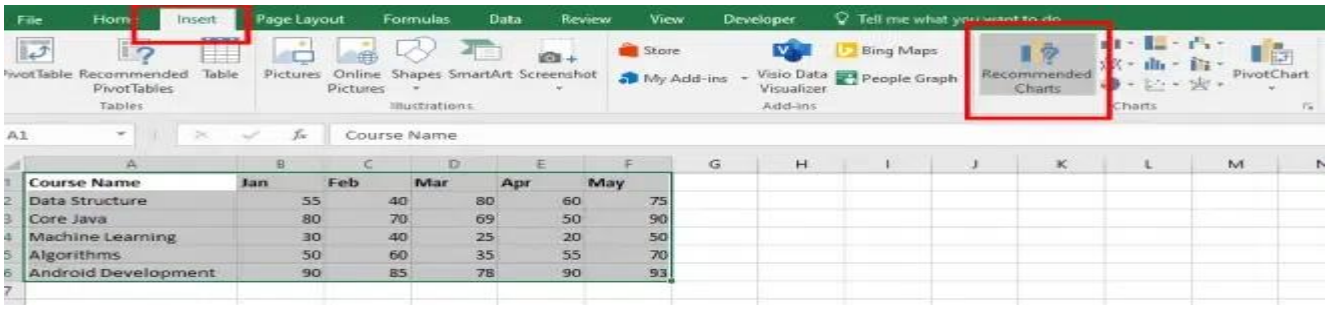


Figure 67: Recommended Charts

3. Excel will generate the chart, which you can customize using the Chart Design and Format tabs.

Figure 68: The Chart Design and Format tabs.

c) Use AutoSum to calculate the total of your data quickly.

1. After entering numbers in your sheet, you can quickly sum them using AutoSum.

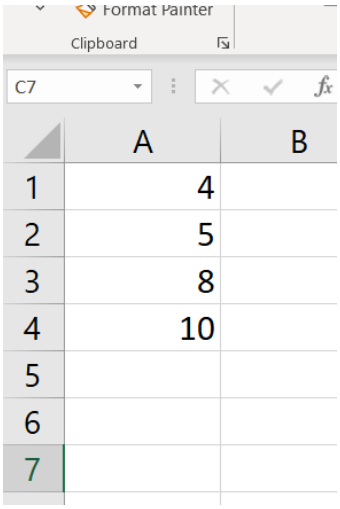


Figure 69: Entering Data in an Excel Worksheet.

2. Select the cell to the right or below the numbers you want to add.
3. Click the Home tab, and then click AutoSum in the Editing group.

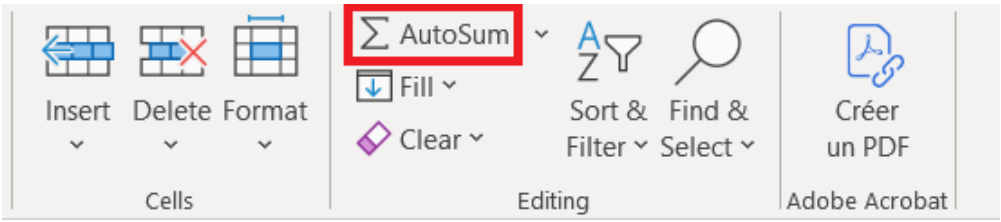


Figure 70: AutoSum option.

4. AutoSum on the Home tab.

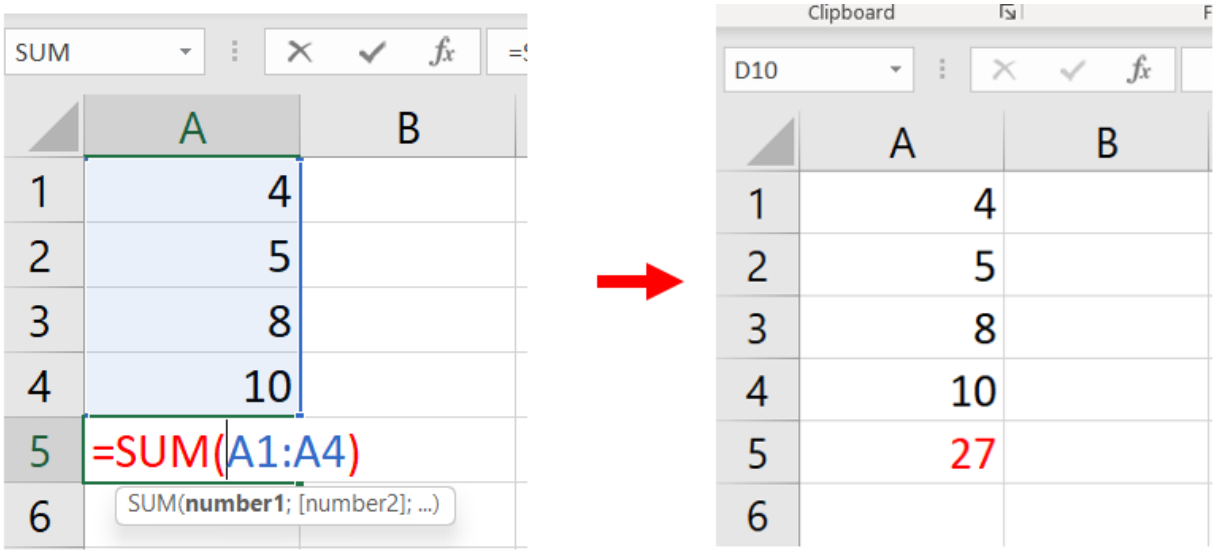


Figure 71: Example of the AutoSum option.

4.5 Page Layout view

Before modifying a workbook's page layout, consider viewing the workbook in Page Layout view to better visualize potential changes.

1. To access **Page Layout view**, select **the Page Layout view command** located in the bottom-right corner of the workbook window.

Figure 72: The Page Layout view command.

2. **Page orientation:** Excel offers two-page orientations: **landscape**, which arranges the page horizontally, and **portrait**, which arranges it vertically. Use portrait orientation for worksheets with many rows and landscape orientation for those with many columns. In this example, portrait orientation is optimal because the worksheet has more rows than columns.

Figure 73: Page orientation.

3. **To change page orientation:**
   - Select **the Page Layout tab** located on the Ribbon.
   - Choose **the Orientation command** and select either **Portrait** or **Landscape** from the drop-down menu.

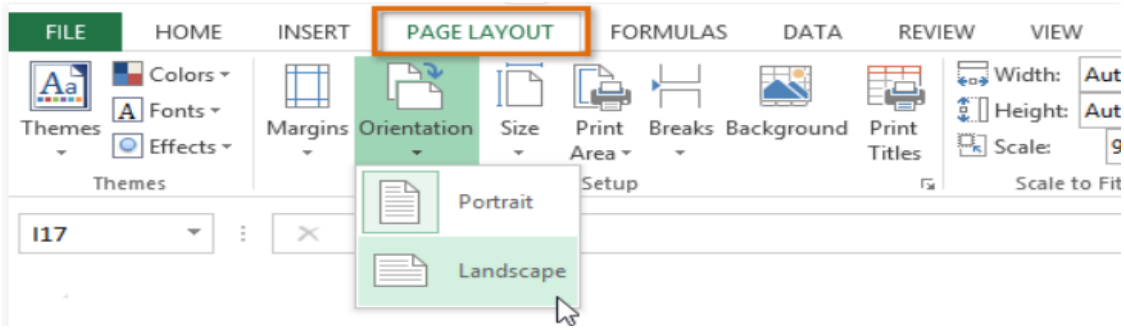


Figure 74: The Orientation command

4. **To format page margins:** Margins are the spaces between your content and the page edges. By default, Excel sets margins to Normal, providing a one-inch space on all sides. You can adjust margins as needed to fit your data better. Excel offers several predefined margin options.
   - Click the **Page Layout tab** on the Ribbon, then select **the Margins command**.
   - Choose the margin size you need from the drop-down menu. For example, selecting Narrow allows more content to fit on the page. The margins will be set to the chosen size.

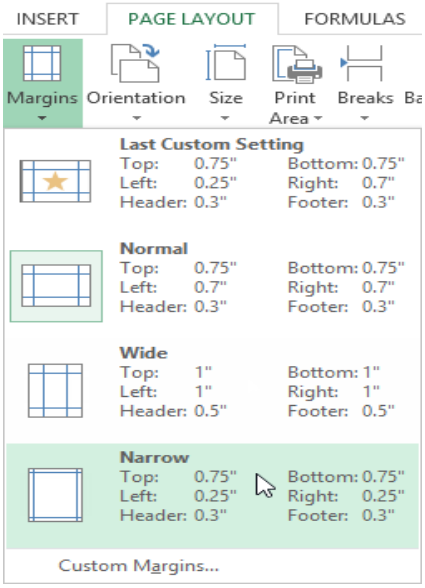


Figure 75: The Margins command

5- To set custom margins, follow these steps: You can customize margin sizes in Excel using the Page Setup dialog box.

1. On the Page Layout tab, click Margins and select **Custom Margins** from the drop-down menu. The Page Setup dialog box will open.

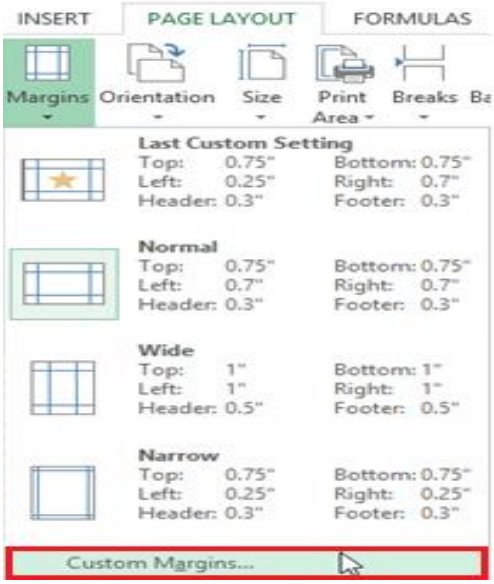


Figure 76: Custom Margins

2. Adjust the margin values as needed, then click OK.
3. The workbook margins will update according to your settings.

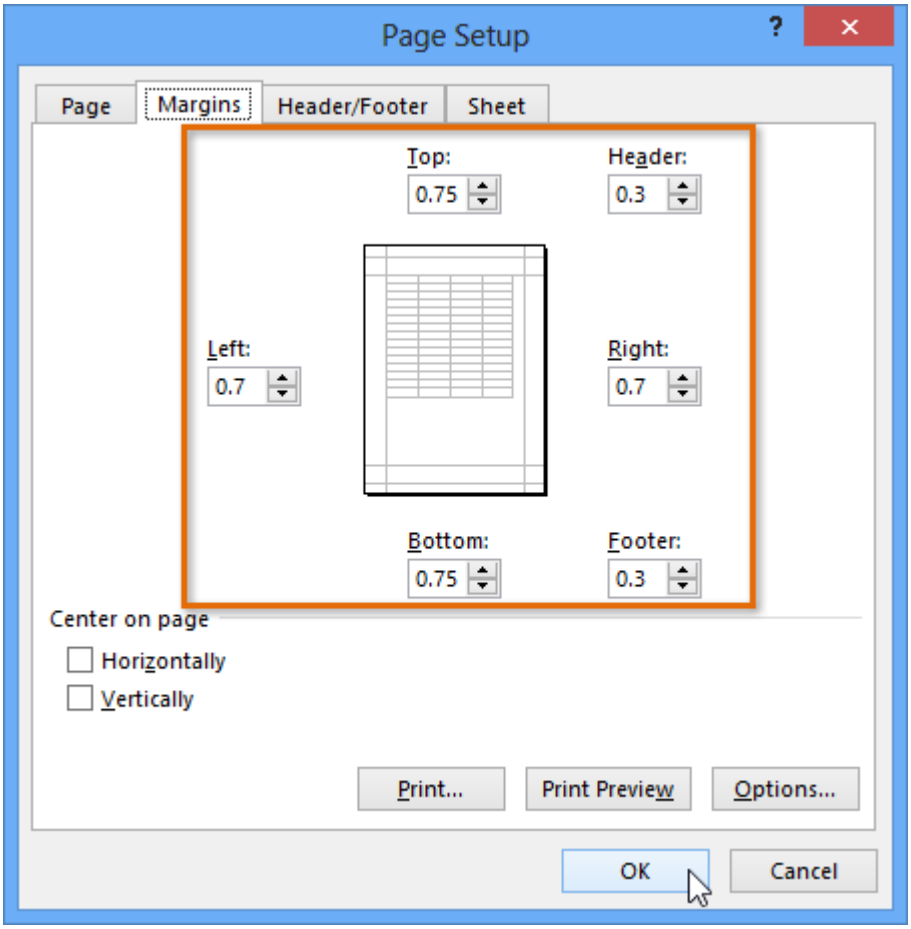


Figure 77: The workbook margins

4.6 Save your work:

1. Click the Save button on the Quick Access Toolbar, or press Ctrl+S.
2. Save button on the Quick Access Toolbar

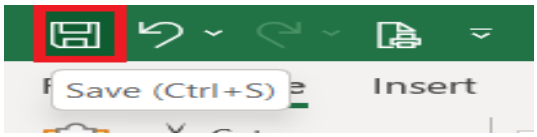


Figure 78: Save button on the Quick Access Toolbar

3. If you've saved your work before, you're done. If this is the first time you've saved this file:
4. Under Save As, pick where to save your workbook, and then browse to a folder.

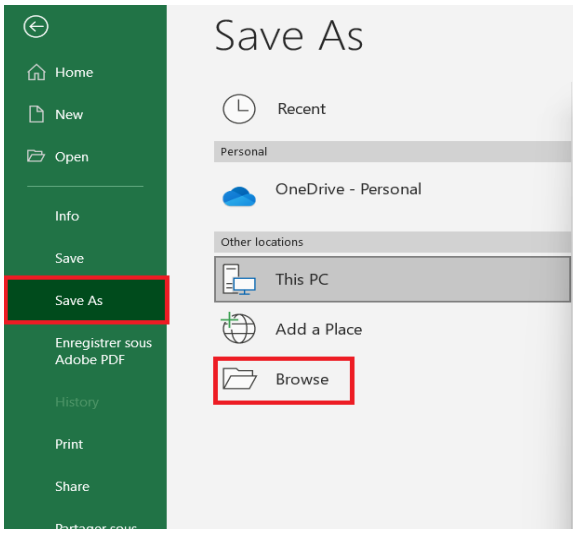


Figure 79: Save ss command.

5. In the File name box, enter a name for your workbook and click Save.

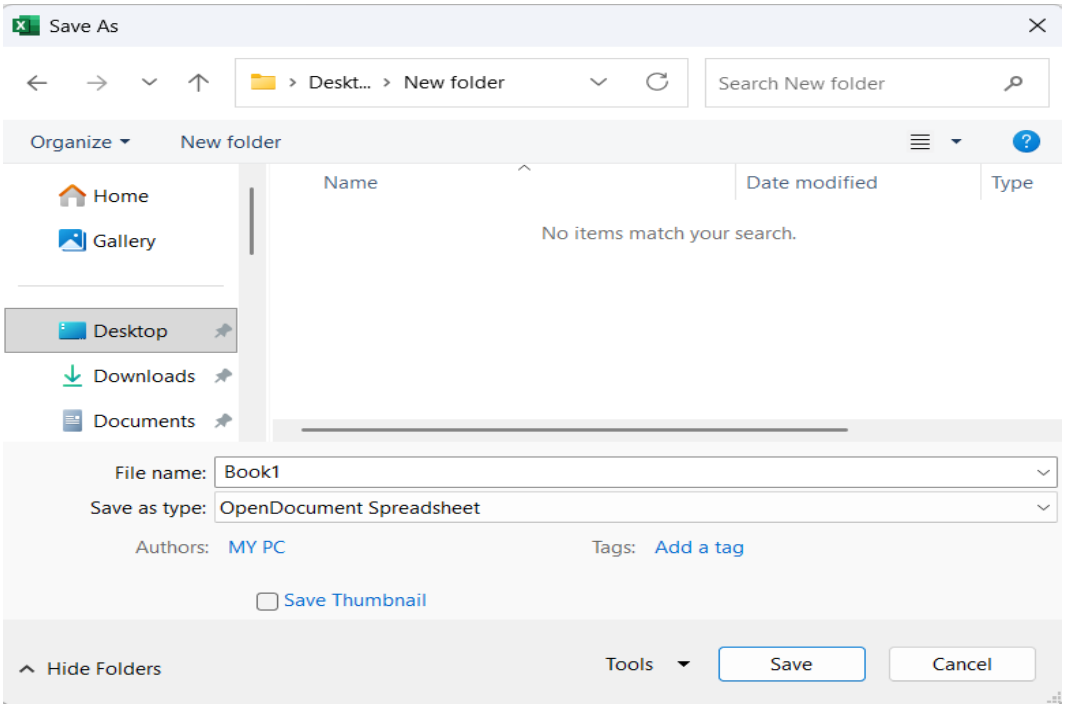


Figure 80: The File name box.

4.7 Print a worksheet or workbook

- **Print one or more worksheets**

    1. Select the worksheets to be printed.
    2. Click File and then Print, or press CTRL+P.
    3. Adjust print settings as needed, then click the Print button.

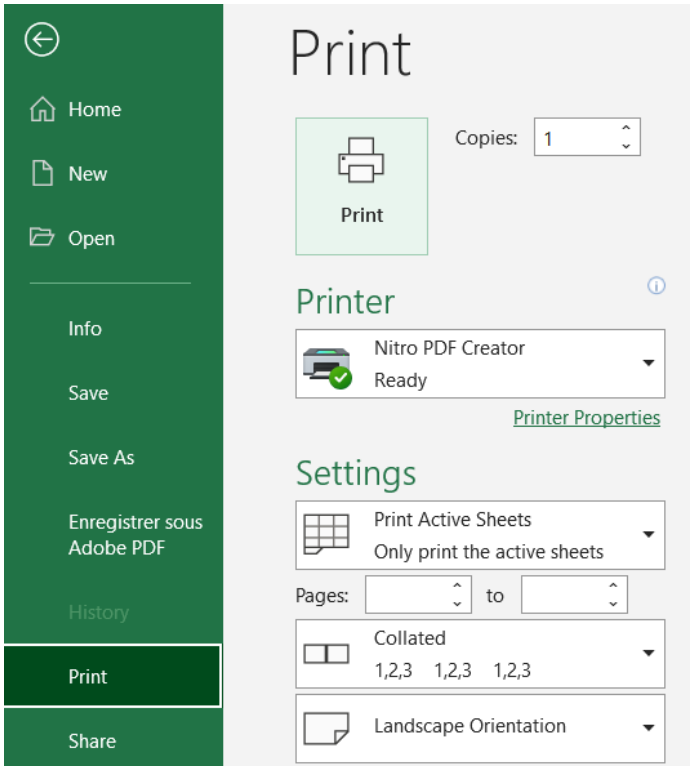


Figure 81: Print worksheets

- **Print one or several workbooks**
  1. All workbook files that you want to print must be in the same folder.
  2. Click File > Open.
  3. Hold down CTRL, click the name of each workbook to print, and then click Print.

- **Print all or part of a worksheet:** To print all or part of a worksheet, follow these steps.
  1. Select the worksheet, then highlight the data range you wish to print.
  2. Go to File and choose Print.
  3. In Settings, select the arrow next to Print Active Sheets and choose the desired option, and click Print.

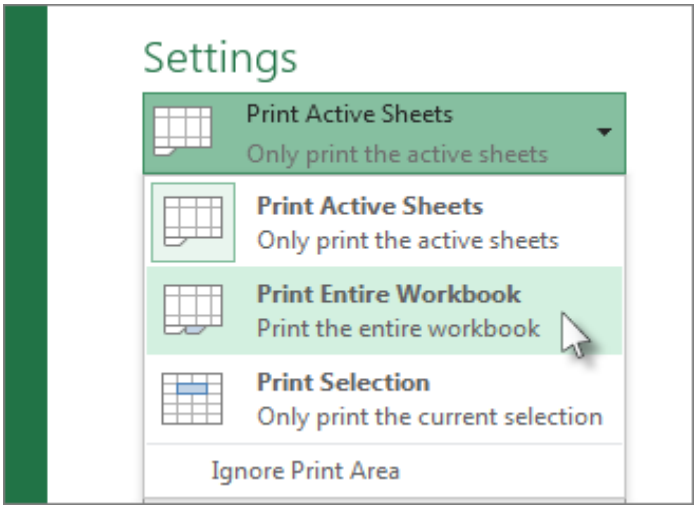


Figure 82: Print all or part of a worksheet

- **Printing an Excel Table**
  1. Select any cell within the table to activate it.
  2. Navigate to the File menu and select Print.
  3. In the Settings section, select the dropdown next to Print Active Sheets and choose Print Selected Table.

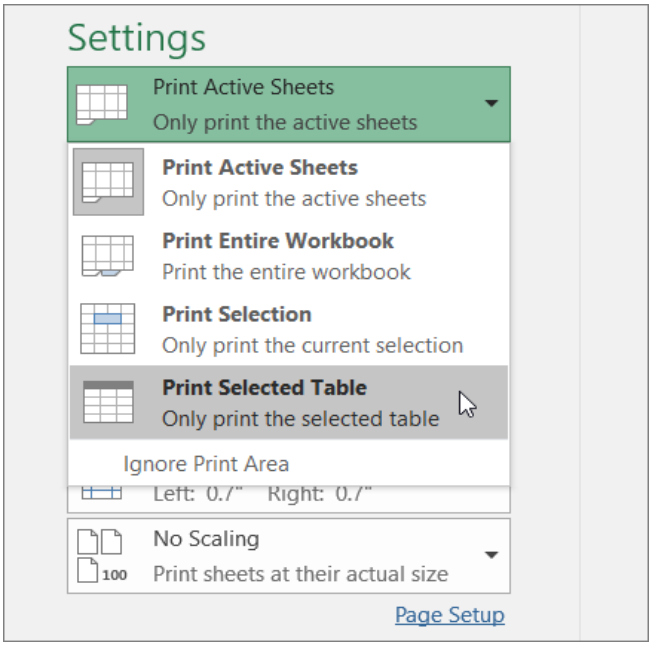


Figure 83: Printing an Excel Table

5. Microsoft PowerPoint

Microsoft PowerPoint is a presentation software included in the Microsoft Office suite and available for both Windows and macOS (Sulastri et al., 2025). The latest version, PowerPoint 2024, is included in the Office 2024 suite. Since April 2014, PowerPoint has also been available on iPad, iPhone, Windows Phone, and Android devices.

PowerPoint is a presentation software used to develop dynamic slide presentations. These presentations may incorporate animation, narration, images, videos, and additional multimedia elements.

5.1 The PowerPoint interface

Knowing the parts of the PowerPoint window helps you use the software effectively. Look at the labeled parts below as we define each one (Frandsen, 2011):

1. **Title Bar:** Displays the presentation name and program.
2. **Quick Access Toolbar:** Provides shortcuts for common commands such as Save, Undo, and Redo.
3. **Ribbon:** Contains tabs like Home, Insert, Design, and Transitions.
4. **Slides Pane:** Displays thumbnail previews of each slide in the presentation.
5. **Slide Area:** Serves as the main workspace to create and edit slides.
6. **Notes Pane:** Provides space to add speaker notes for individual slides.

7. **Status Bar:** Shows slide number, language, and view options.
8. **View Buttons & Zoom Slider:** Switch views and adjust zoom.

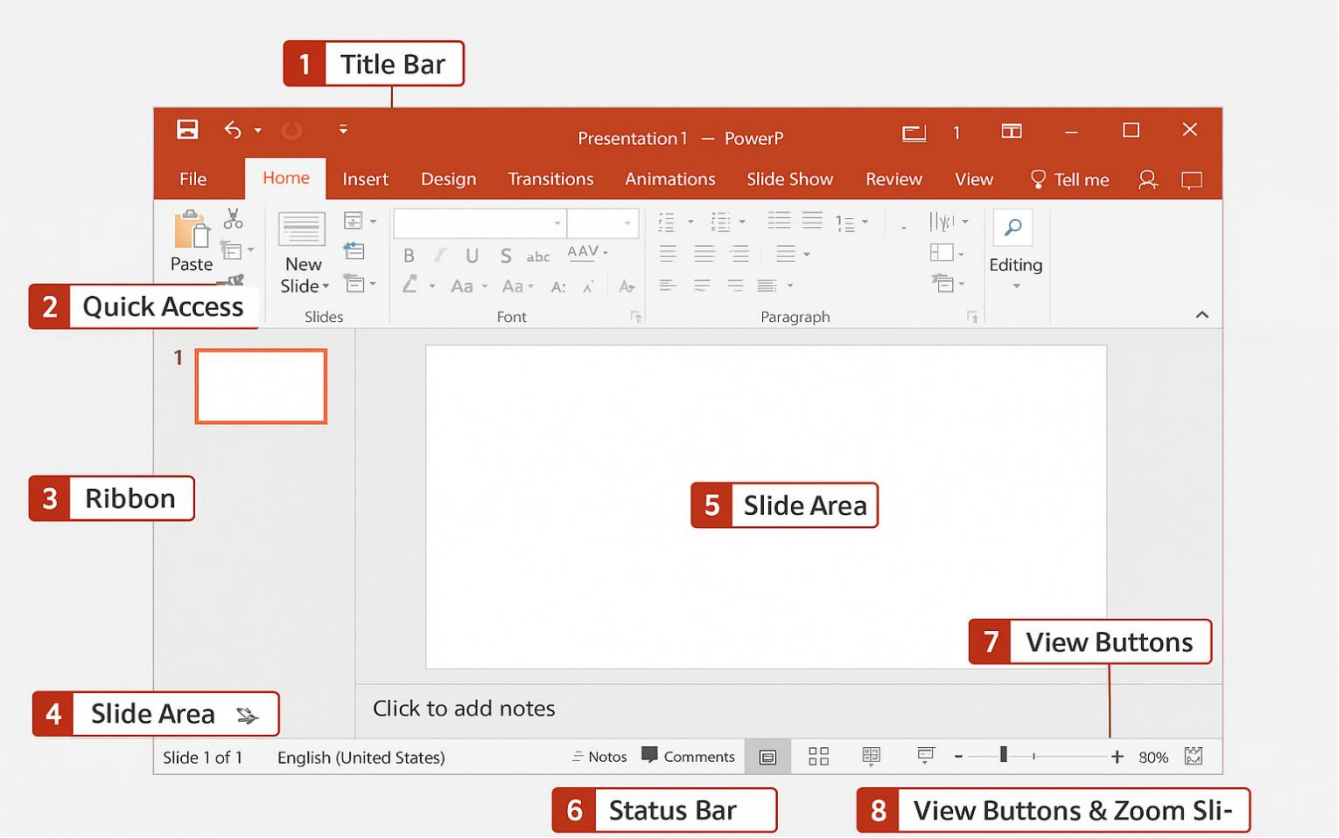


Figure 84: Main Interface Elements of PowerPoint.

5.2 Creating and Opening Presentations:

- **To create a new presentation in PowerPoint,** follow these steps:
  1. Start by selecting **the File tab** to access Backstage view.

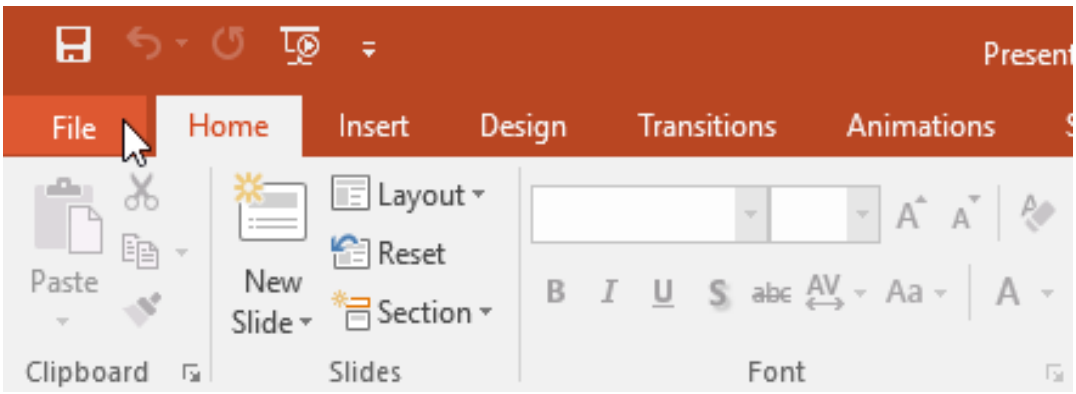


Figure 85: The File tab.

2. On the left side of the window, click on **New.**

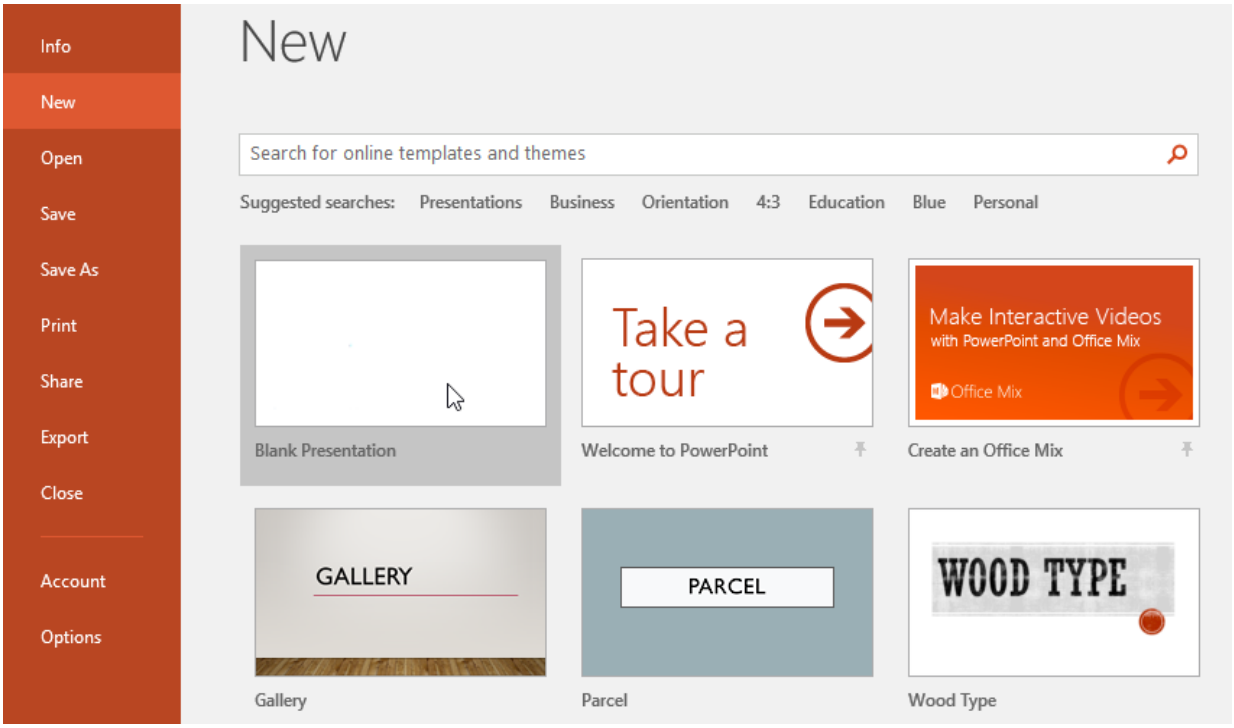


Figure 86: Create a new presentation.

3. Then, choose **Blank Presentation**. A new blank presentation will now be created for you.

- **To create a new presentation from a template:** A template is a ready-made presentation design that helps create new slide shows quickly by providing predefined layouts and styles.

1. Select the File tab to open Backstage view, and then choose New.
2. Choose a suggested search to browse **available templates**, or utilize the search bar to locate specific templates.

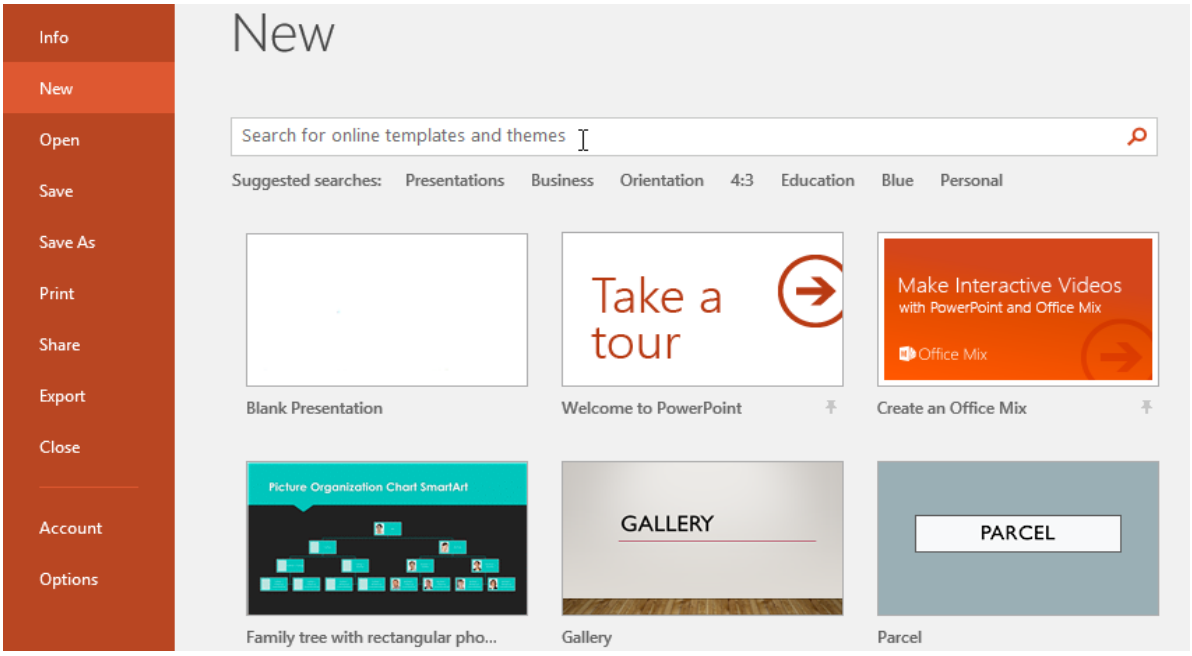


Figure 87: The available ppt templates

3. Select a template to view its details.

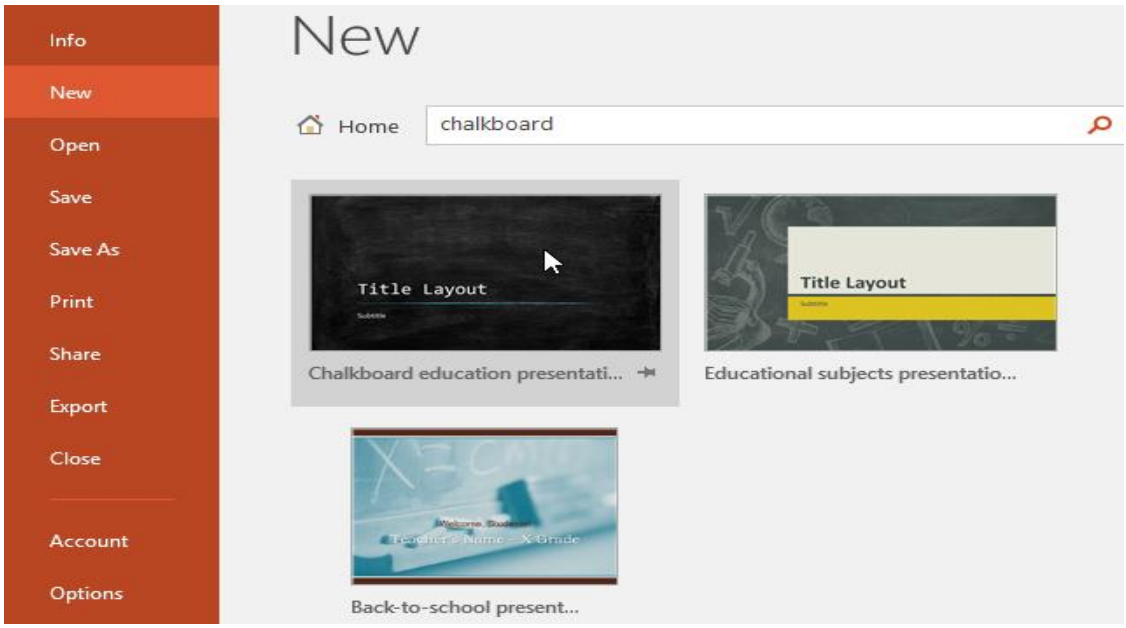


Figure 88: A PPT template.

4. A preview of the template will be displayed, along with further information on its use.
5. Select Create to apply **the chosen template**. A new presentation will be generated using the selected template.

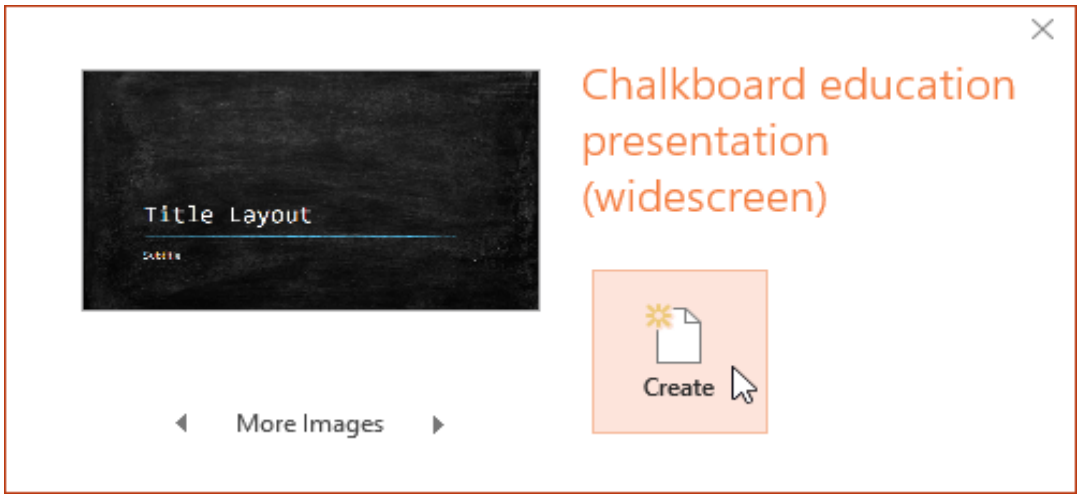


Figure 89: Create a new presentation from a template.

- **To open an existing presentation:**

1. Select **the File tab** to access Backstage view, and then click Open.
2. Select **Open**

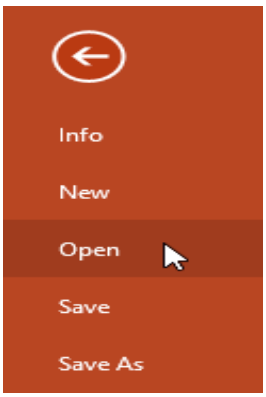


Figure 90: The File tab.

3. Select **Browse**

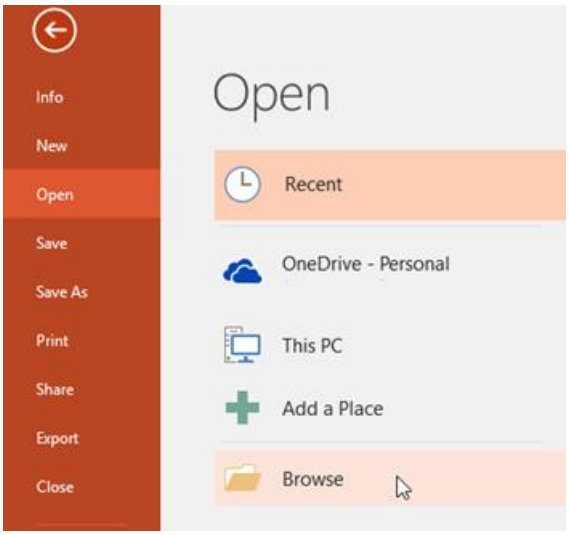


Figure 91: Open command list.

4. The Open dialog box appears. Locate and select your presentation, and then click Open.

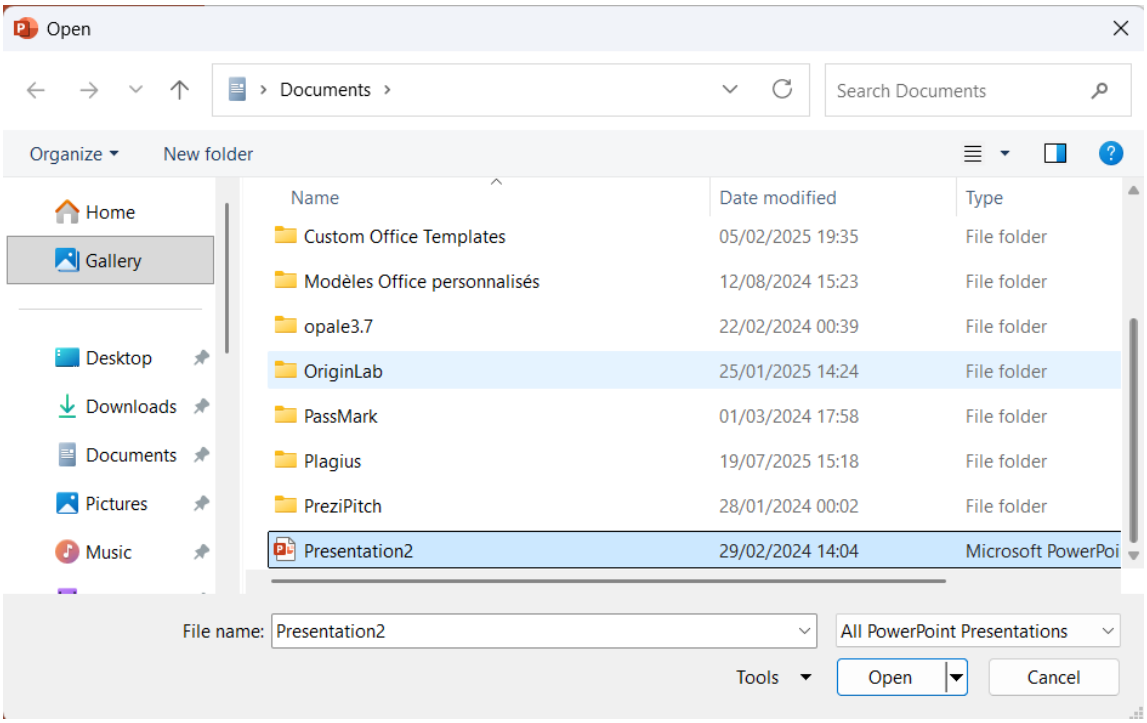


Figure 92: open an existing presentation.

- **To save a presentation:** Save your presentation at the start of a project or when making updates to prevent data loss. Select a location that is easy to access later.
    1. Locate and select **the save command** on **the Quick Access Toolbar**.

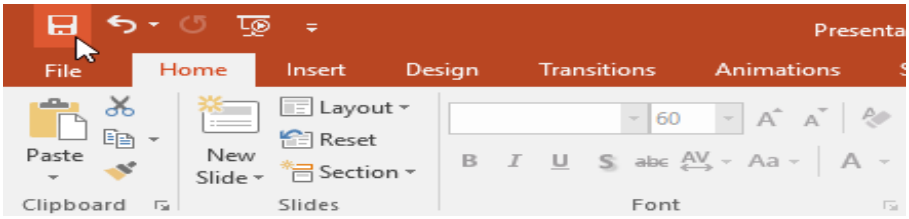


Figure 93: The Save command on the Quick Access Toolbar.

2. If you're saving the file for the first time, **the Save As** pane will appear in Backstage view.
3. Next, choose a **save location** and enter a file name. Click Browse to **save on your computer**, or select OneDrive **to save to your cloud account**.

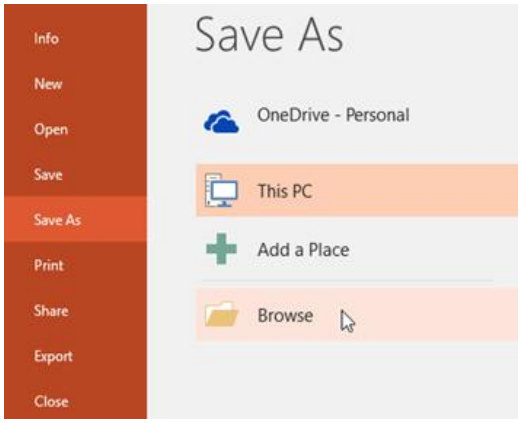


Figure 94: The Save As command.

4. The Save As dialog box will appear. Select the location where you want to save the presentation.
5. Enter a file name for the presentation, then click Save. Your presentation is now saved.

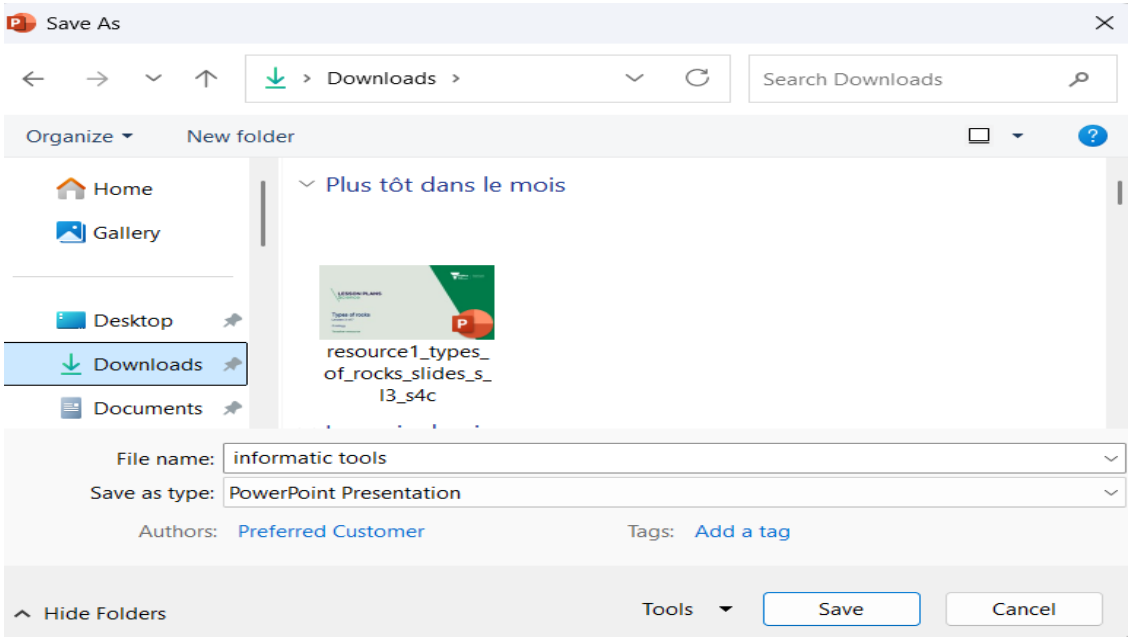


Figure 95: Save a presentation

5.3 Slide Basics

PowerPoint presentations consist of **slides**. To create a slide show, you should understand the basics of working with slides.

- **Inserting a new slide:** A new presentation initially contains a single slide with the Title Slide layout. Additional slides can be inserted as needed, selecting from various available layouts.

  To insert a new slide:

  On the Home tab, select the lower portion of the New Slide command.

  1. Select the preferred slide layout from the displayed menu.

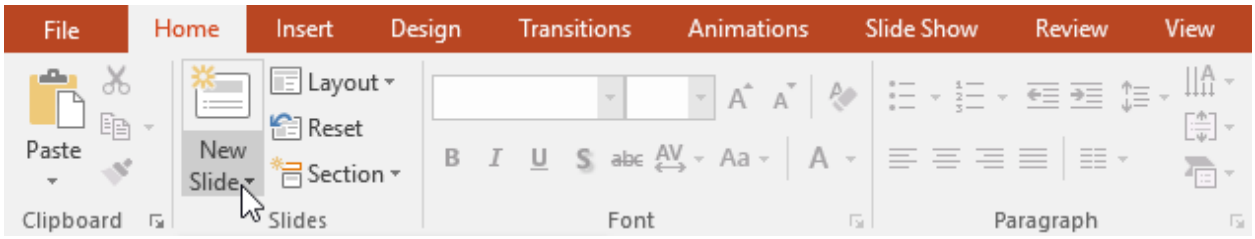


Figure 96: The New Slide command.

2. The new slide will be displayed. Click a placeholder to enter text or select an icon to insert content such as images or charts.

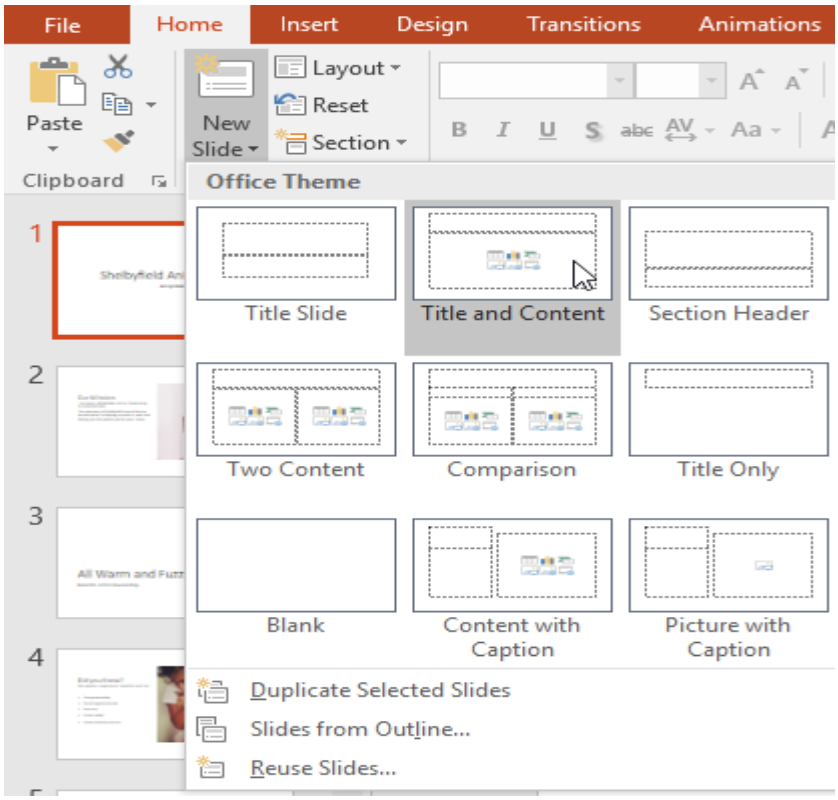


Figure 97: The various types of new slides.

3. To modify the layout of an existing slide, select the Layout command and then choose the preferred design.

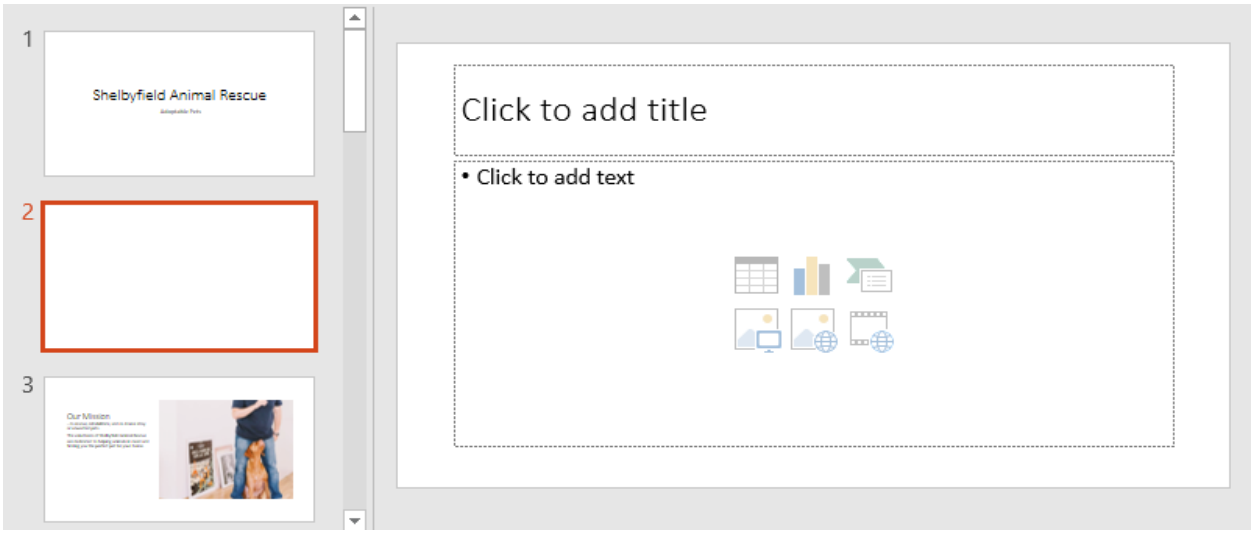


Figure 98: Modifying the layout of an existing slide.

4. To add a slide with the same layout as the currently selected slide, select the upper portion of the New Slide command.

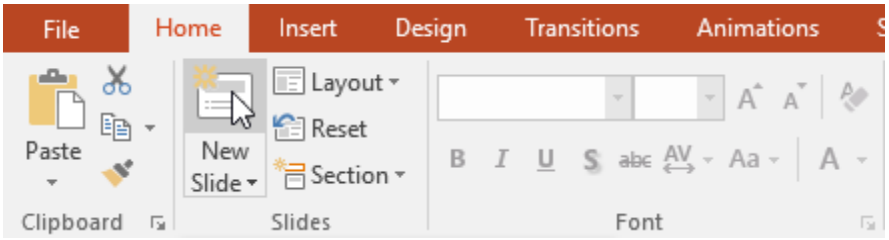


Figure 99: Add a slide with the same layout.

- **Working with slides**

1. **Duplicate slides:** To quickly copy a slide, select it, right-click, and choose Duplicate Slide. To duplicate multiple slides, select them before duplicating.

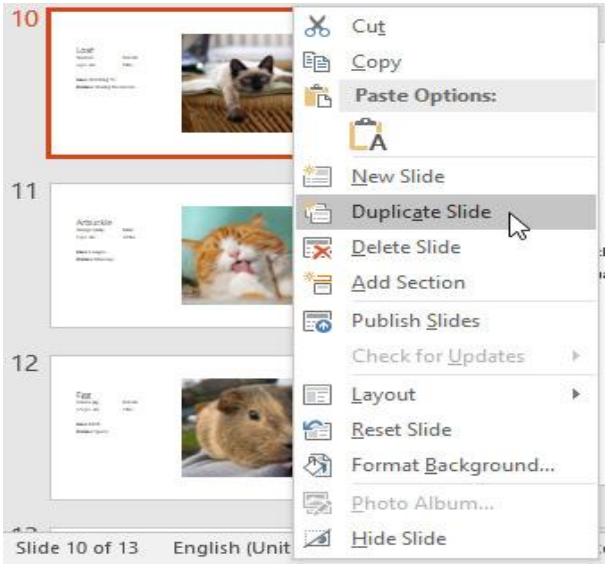


Figure 100: Duplicate slides.

2. **Move slides:** To rearrange slides, click and drag the slide in the Slide Navigation pane to your preferred position.

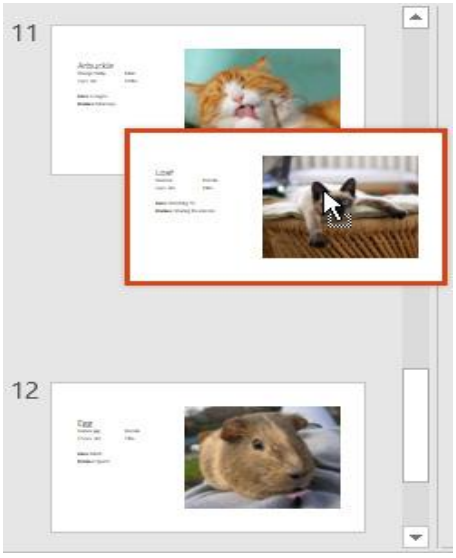


Figure 101: Move slides.

3. **Delete slides:** To remove a slide, select it and press the Delete or Backspace key.

- **To add a text box**

When you insert a text box, you can add extra content to your slide. Text boxes stay in the same spot, even if you switch to a different theme, unlike placeholders.

1. On the Insert tab, select the Text Box command.

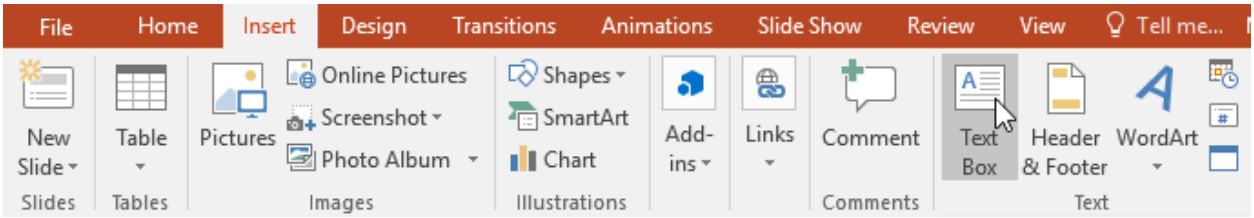


Figure 102: The Text Box command

2. Click and drag the cursor to draw the text box on the slide.

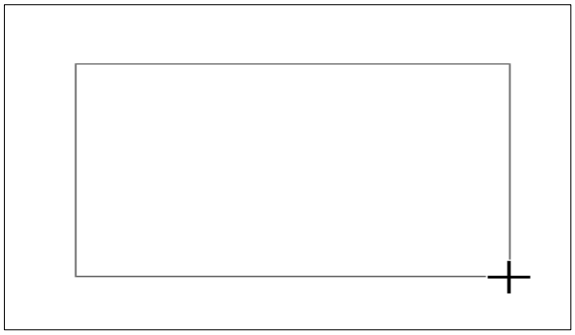


Figure 103: Draw the text box on the slide.

3. The text box appears on the slide. To add text, click inside the text box and begin typing.

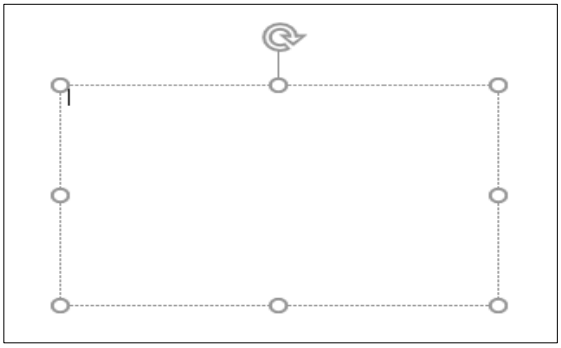


Figure 104: the text box.

- **To change the slide size**

To adjust the slide size, go to the Design tab and select Slide Size. Choose a preset option or select Custom Slide Size for additional settings.

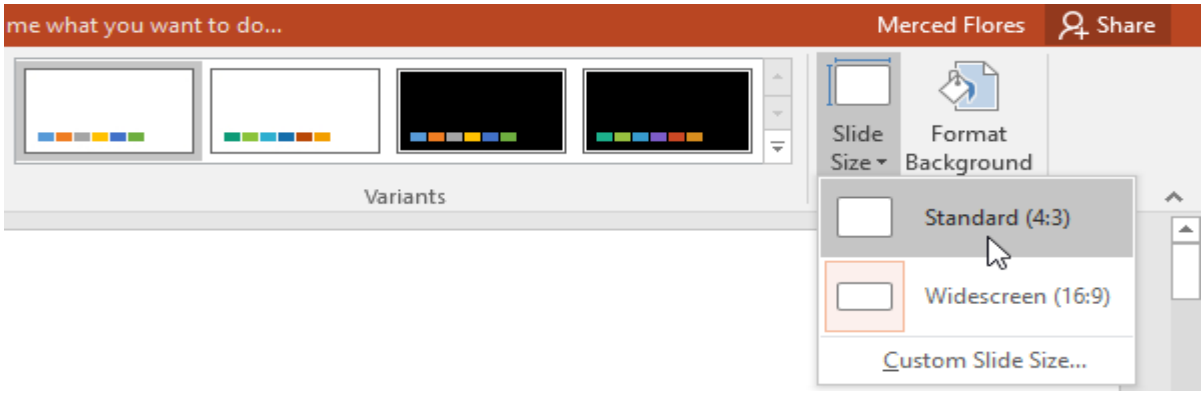


Figure 105: Change the slide size.

- **To apply a theme**

Go to the Design tab on the Ribbon and click the More drop-down arrow to view all available themes.

1. Select the desired theme.

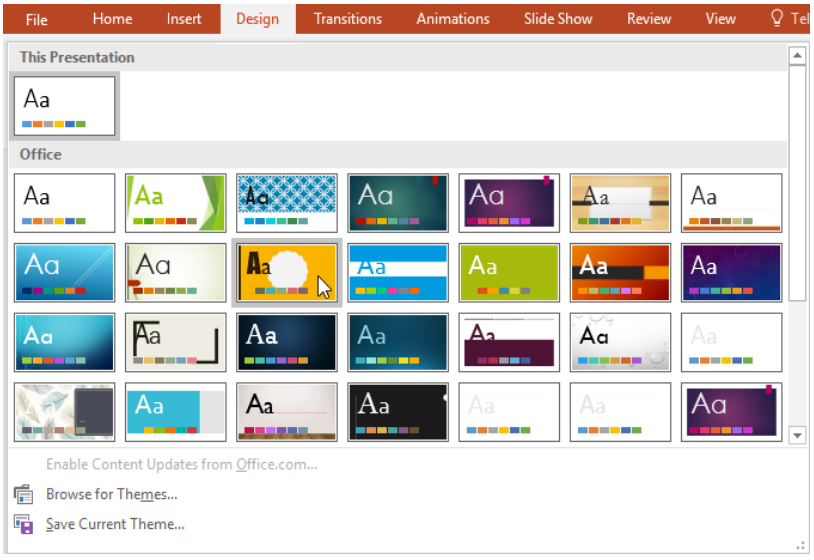


Figure 106: The desired theme.

2. The selected theme will apply to your entire presentation.

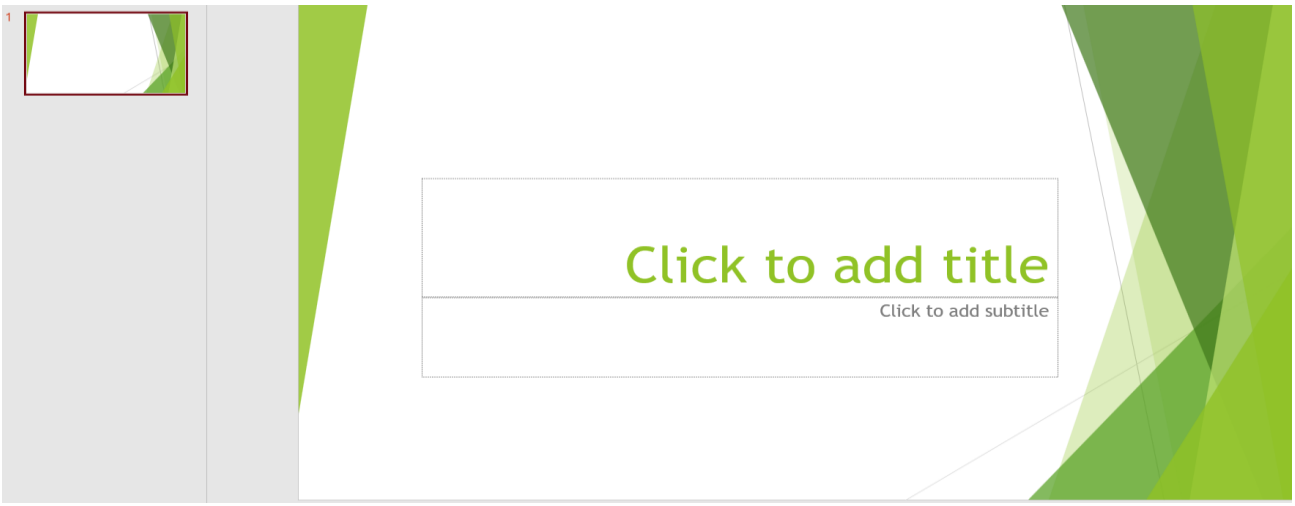


Figure 107: Presentation theme.

5.4 Applying Transitions

- **To apply a transition:** In the Slide Navigation pane, select the slide that will follow the transition.

1. Click the Transitions tab. By default, none is selected under Transition to This Slide.

Figure 108: Transitions tab.

2. Click More to see all transitions.

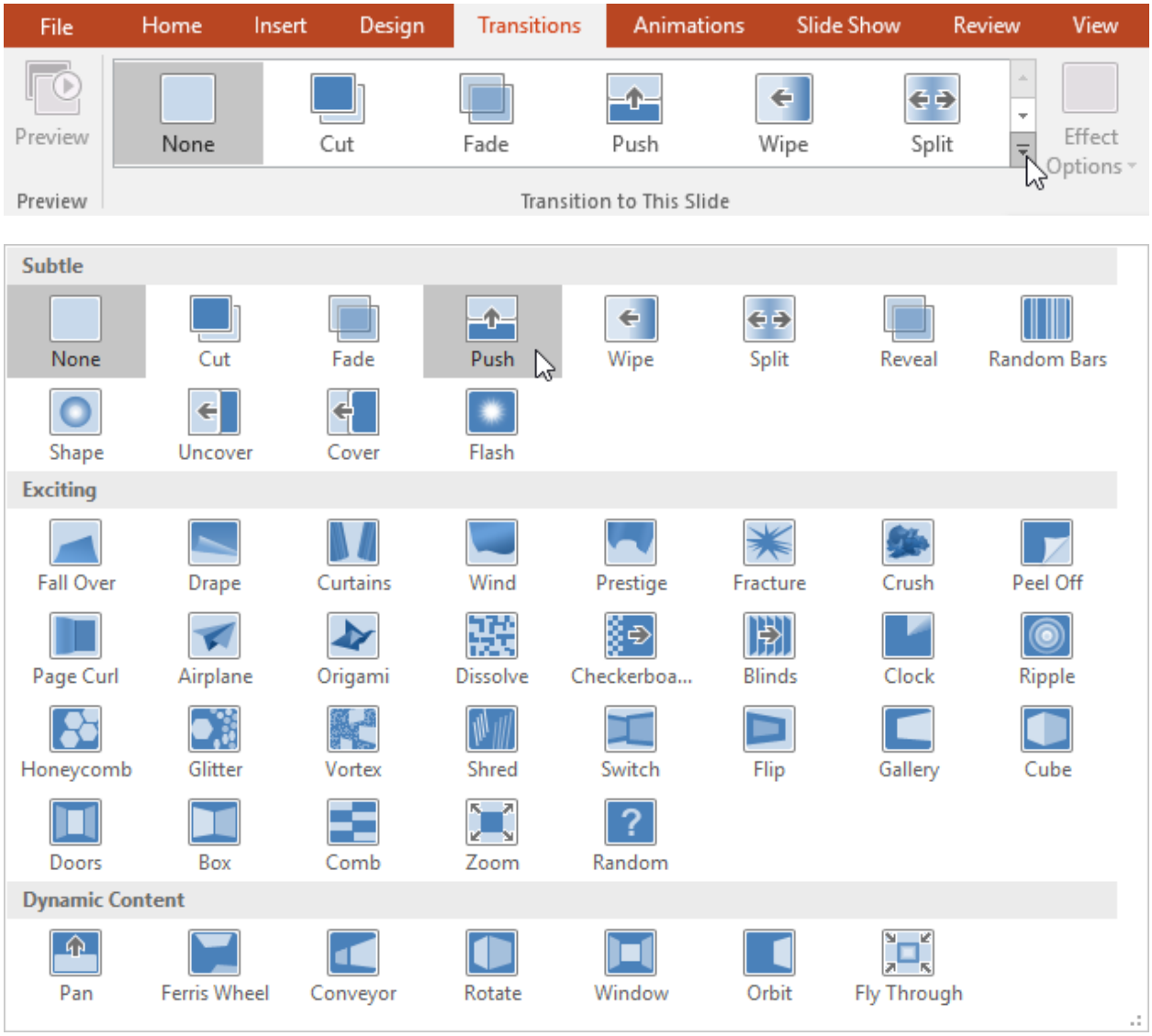


Figure 109: All transitions

3. Click a transition to apply and preview it on the slide.
4. To apply the same transition to all slides, click Apply to All in the Timing group.

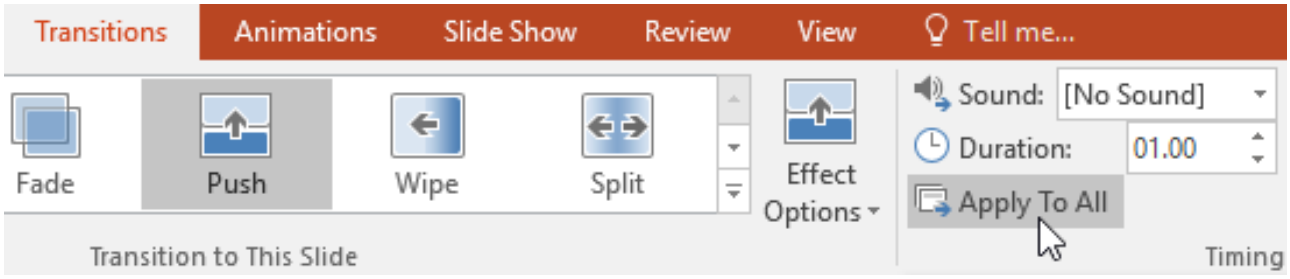


Figure 110: Apply the same transition to all slides.

- **To modify the transition effect:** Efficiently customize the appearance of a transition by adjusting its direction.
    1. Select the slide containing the transition to be modified.

2. Click the Effect Options command and select the appropriate option. Available options depend on the chosen transition.

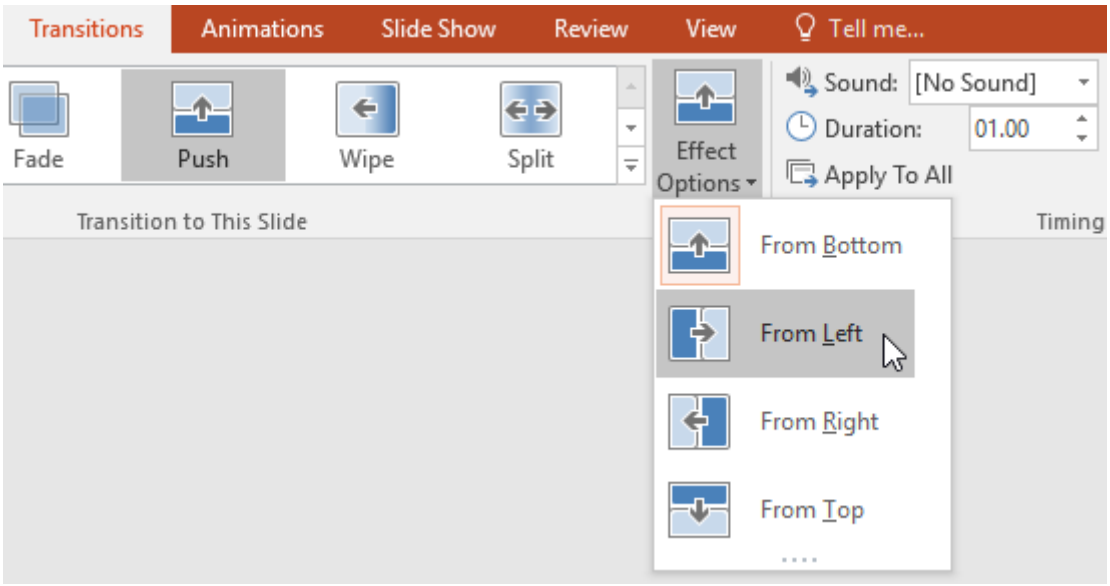


Figure 111: The Effect Options command.

3. The transition is modified, and a preview is displayed.

- **To modify the transition duration:**

1. Select the slide with the transition you want to modify.
2. In the **Duration field of the Timing group**, enter your preferred transition time.

   For example, set it to 00.50 seconds to speed up the transition.

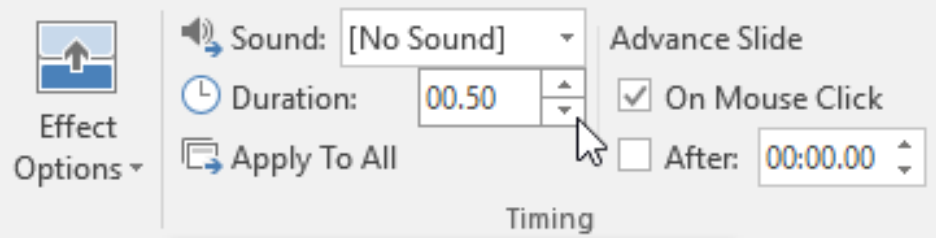


Figure 112: Duration field of the Timing group.

- **To remove a transition:**

1. Select the slide with the transition you want to remove.
2. Select None in the Transition to This Slide group to remove the transition.

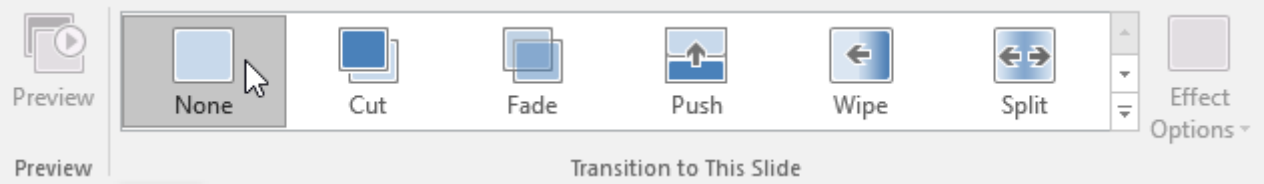


Figure 113: The Transition to This Slide group.

3. To remove transitions from all slides, select None for any slide and click Apply to All.

5.5 Inserting Videos and Audio

a) Inserting Videos: You can insert a video into a PowerPoint slide to enhance audience engagement during your presentation.

- **To insert a video from a file:**
  1. On the Insert tab, select Video, then choose Video on My PC.

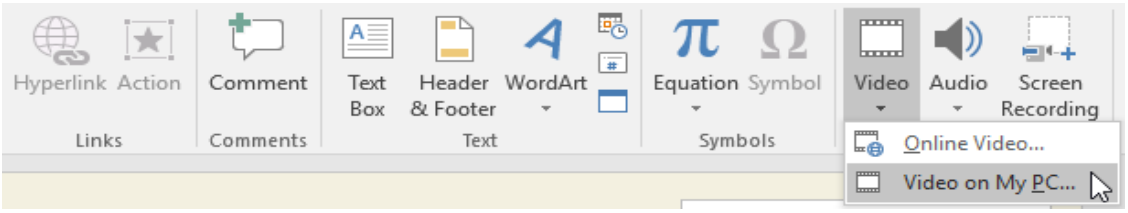


Figure 114: The Video Insertion Option.

2. Select the video file and click Insert.

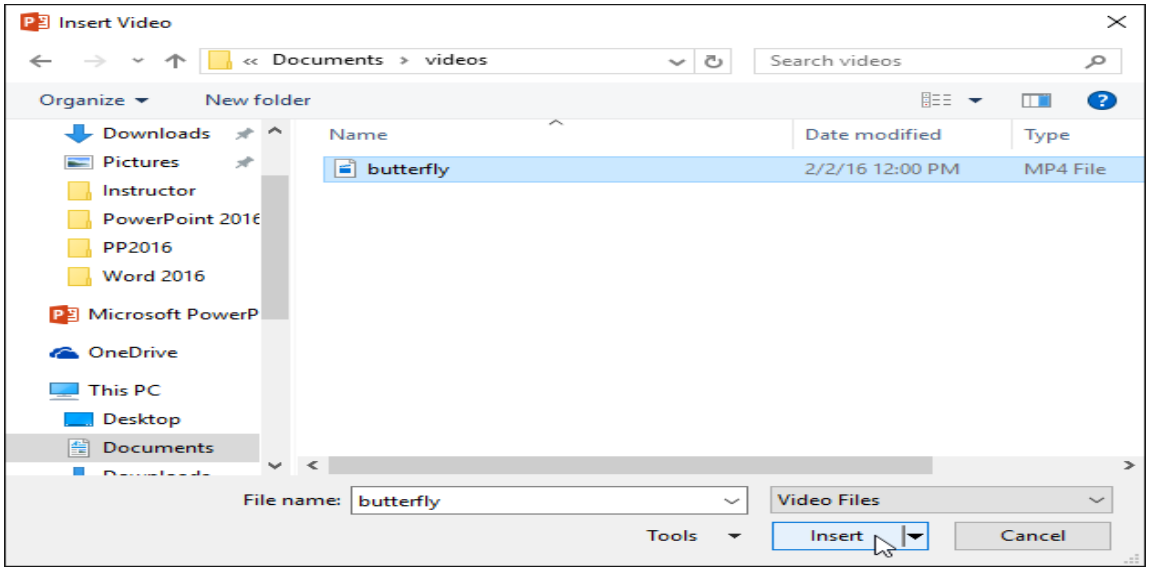


Figure 115: Selecting and Inserting a Video File.

3. The video will appear on the slide. The video will be added to the slide.

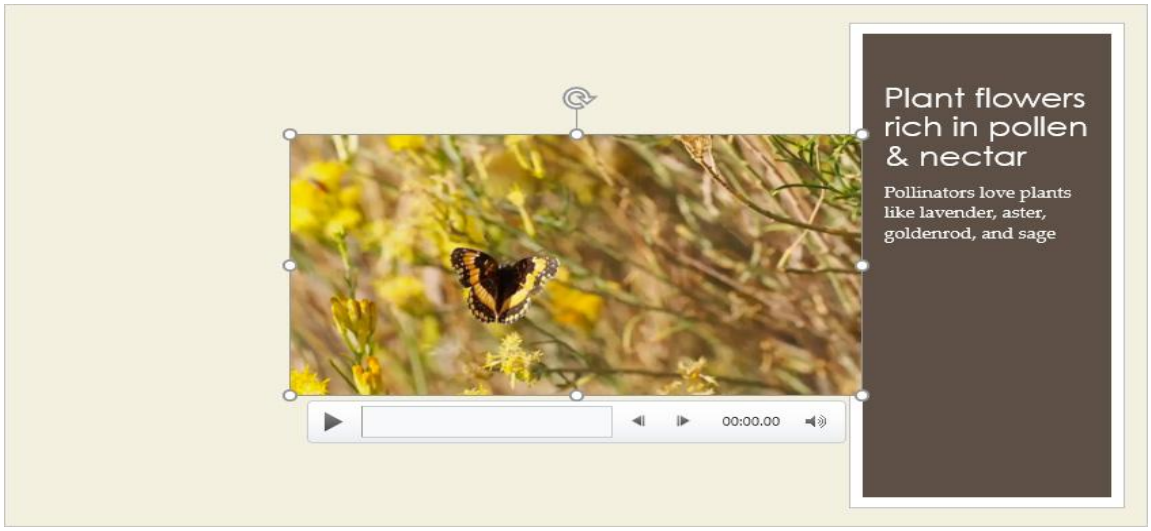


Figure 116: Inserting a Video into a Slide.

b) Inserting Audio:

- **To insert audio from a file:**

1. On the Insert tab, select the Audio drop-down and choose Audio on My PC.

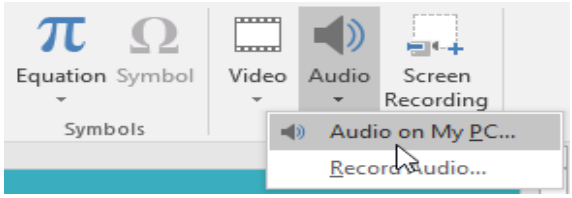


Figure 117: The Audio Insertion Option.

2. Select the audio file and click Insert.

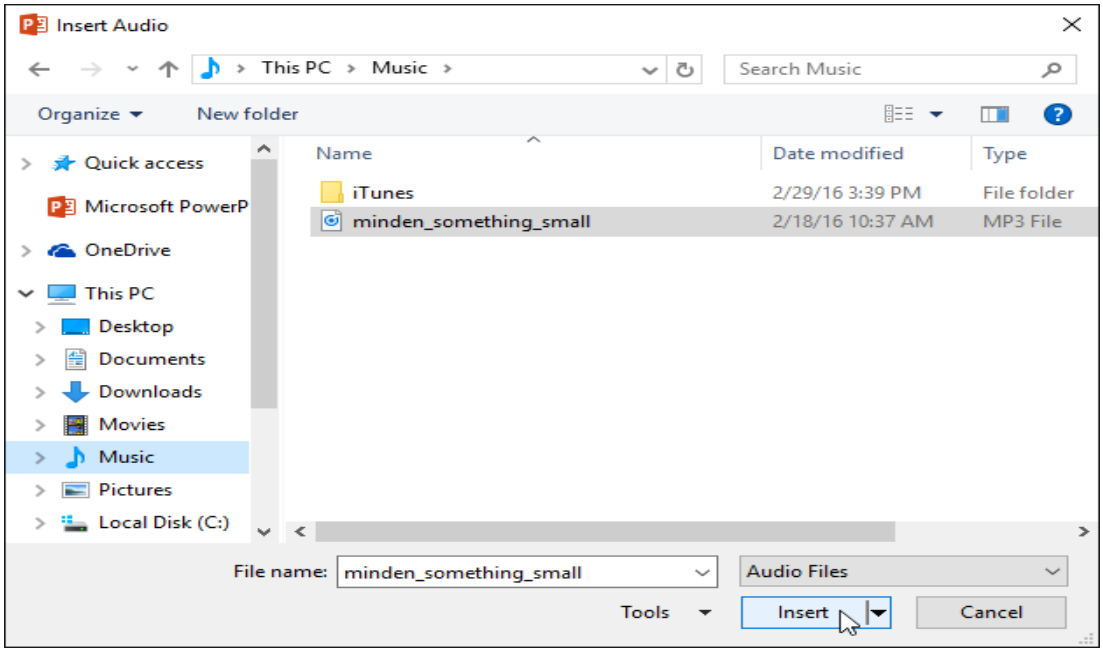


Figure 118: Selecting and Inserting an Audio File.

3. The audio file will be added to the slide.

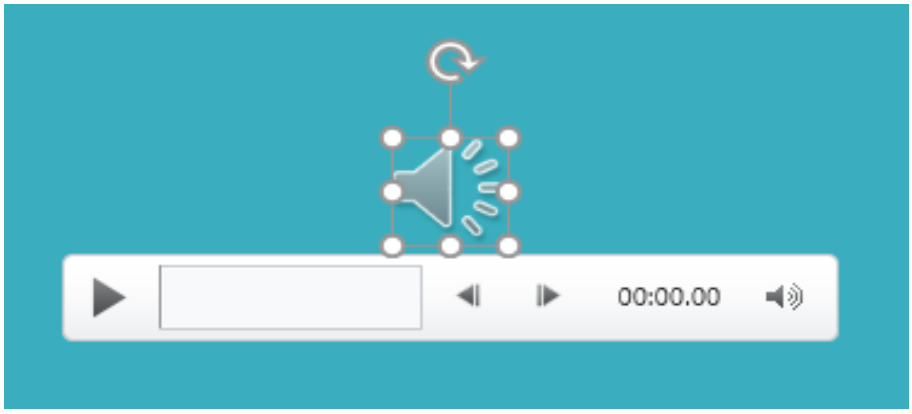


Figure 119: Inserting Audio into a Slide.

6. Introduction to LaTeX

6.1 Definition and Overview of LaTeX

LaTeX is a typesetting program that extends the original TeX system developed by Donald Knuth (Kemp et al., 1996). A typesetting program focuses on formatting input text into lines, paragraphs, and pages, whereas word processors integrate text entry, formatting, display, and printing within a single application (Goossens et al., 1993). In TeX, users enter both the document text and formatting commands in a text editor, then compile the file to produce formatted output. The resulting document can be viewed with a previewer or printed using a printer driver (Pérez et al., 2004). TeX also functions as a programming language, enabling users to develop additional features. LaTeX itself is a comprehensive collection of such enhancements, and ongoing community contributions continue to expand its capabilities through new packages (Grätzer, 2016).

6.2 Benefits of LaTeX

- LaTeX is an open-source document preparation system recognized for its professional formatting capabilities and user-friendly interface. It offers precise control over document layout, which ensures consistency and a polished appearance across multiple projects (Baramidze, 2014).
- LaTeX is particularly valued in scientific and academic contexts for its ability to typeset complex mathematical equations and automate reference management (Oetiker et al., 2009).
- The system is cross-platform compatible, flexible, and extensible, supporting output formats including PDF, HTML, and presentation slides.
- Additional advantages include automated features such as indexing and numbering, robust collaboration support, and enhanced security through file encryption.
- LaTeX is free, customizable, and scalable, and benefits from a large community that provides continuous updates, support, and new features (Frank et al., 2021).
- These attributes make LaTeX an optimal solution for producing professional, structured, and high-quality documents.

6.3 LaTeX Installation

To install LaTeX on Windows, follow these basic steps. Specific instructions may vary depending on the Windows version.

- Step 1: Visit **miktex.org**

- Step 2: Find the download section
- Step 3: Download MiKTeX

Figure 120: Download MiKTeX.

- Step 4: Open the MiKTeX installer

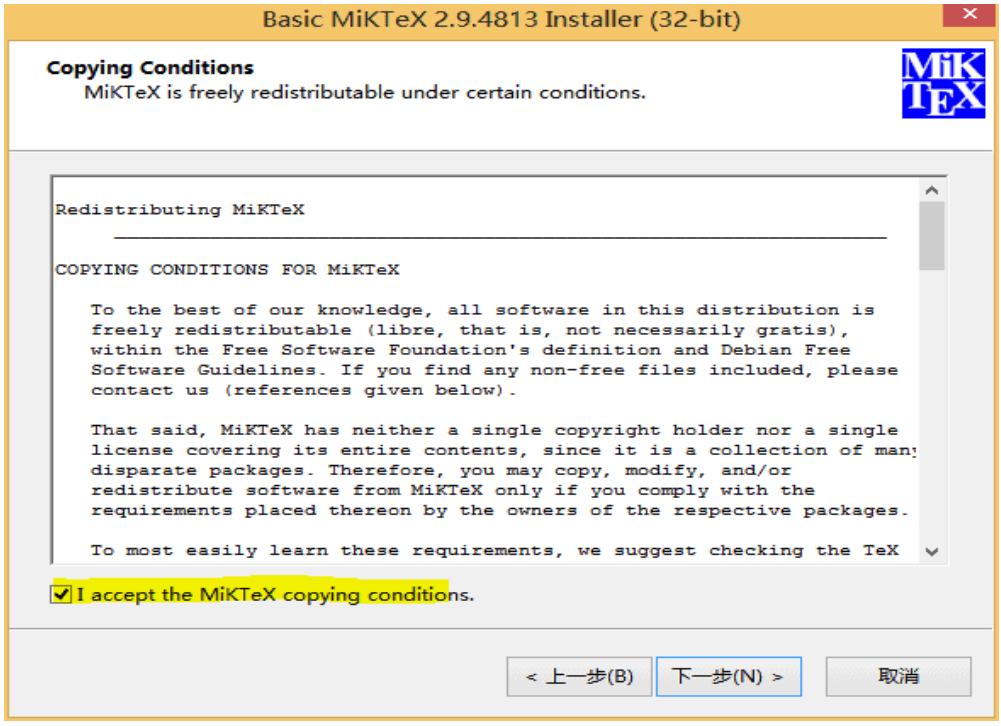


Figure 121: The MiKTeX installer.

- Step 5: Choose to automatically install missing packages.

Figure 122: Automatic Installation of Missing Packages.

- Step 6: Start TeXworks: After installation, use TeXworks as your LaTeX editor.

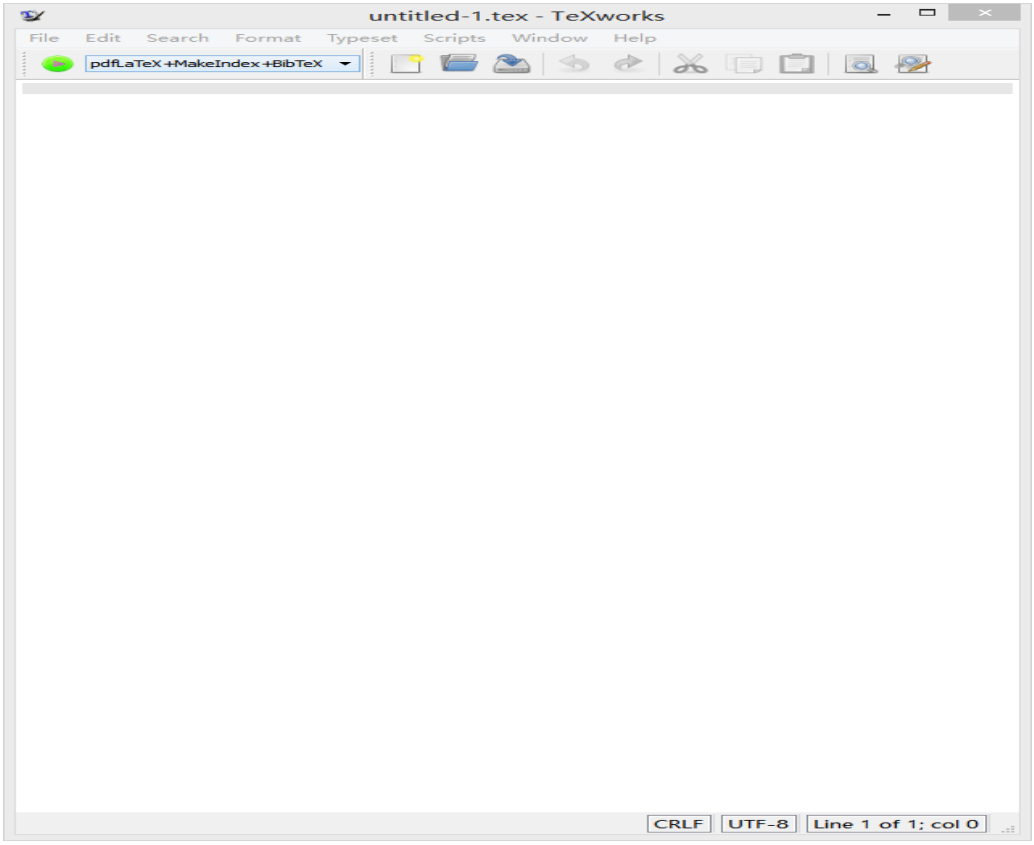


Figure 123: Start TeXworks.

- Step 7: Write your LaTeX code and select compile.

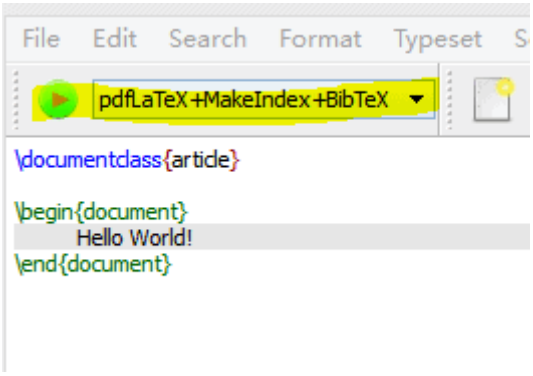


Figure 124: Writing and Compiling LaTeX Code

- Step 8: Create your first document: You can now compile code from this website or blog.

  Required packages will download automatically.

6.4 The basic structure of a LaTeX document:

The basic structure of a LaTeX document consists of two main parts: the **preamble** and the **document body** (Grätzer, 2016).

- **Preamble:** This section appears before \begin{document}. It defines the document class (e.g., article, report, book) and includes packages or custom settings. Example:

```
\documentclass{article}
\usepackage{graphicx}
```

- **Document Body:** This part starts with \begin{document} and ends with \end{document}. It contains the main content, including titles, sections, text, figures, and tables. Example:

```
\begin{document}
\title{My First LaTeX Document}
\author{ author }
\date{\today}
\maketitle
\section{Introduction}
This is my first LaTeX document.
\end{document}
```

6.5 LaTeX/Text Formatting

LaTeX provides a variety of commands and environments to format text efficiently. Key features include the following (Kottwitz, 2011):

a. Font Styles

- **Bold text:** \textbf{text}
- **Italics:** \textit{text} or \emph{text} for emphasis, typically displayed in italics.
- **Underline:** \underline{text}
- **Monospace font: \texttt{text}, useful for** code or literal text.
- **Small caps:** \textsc{text}

b. Paragraph and Line Formatting

- **New paragraph:** Insert a blank line in the source code to start a new paragraph.
- **Line break:** Use \\ to begin a new line without starting a new paragraph.
- **Horizontal spacing: Use** \quad for standard space, \qquad for double space, or \hspace{length} for custom spacing.
- **Vertical spacing: Use** \vspace{length}, \smallskip, \medskip, or \bigskip for vertical gaps.

c. Text Alignment

- **Left-aligned:** \begin{flushleft} ... \end{flushleft}
- **Right-aligned:** \begin{flushright} ... \end{flushright}
- **Centered:** \begin{center} ... \end{center}

d. Special Features and Environments

- **Footnotes:** \footnote{footnote text}
- **Block quotations:** \begin{quote} ... \end{quote} (indents the text on both sides)

- **Verbatim text:** \begin{verbatim} ... \end{verbatim} preserves exact spacing and line breaks, making it ideal for code.
- **Lists: Use** \begin{itemize} ... \end{itemize} for bullet points and \begin{enumerate} ... \end{enumerate} for numbered lists.

6.6 Compilation and Visualization

a) Compilation

Use a LaTeX editor like TeXworks or TeXstudio to compile your document. Choose the appropriate compiler —PDFLaTeX, XeLaTeX, or LuaLaTeX —based on your document's needs.

b) Visualization

After compiling, open the PDF in a viewer such as Adobe Acrobat, Sumatra PDF, or Atril to review the final output.

Conclusion:

Microsoft Office programs like Word, Excel, and PowerPoint, as well as LaTeX, each serve particular needs for creating documents and managing data. On the one hand, Microsoft Word offers a user-friendly interface for creating and editing text, making it a good option for letters, reports, and other formal documents. On the other hand, Excel helps organize, calculate, and visualize data, making data analysis more efficient. PowerPoint is a great program for creating visual presentations, with a focus on communication, rigor, and presentation. LaTeX is a professional typesetting system used predominantly in science and academia for the production of complex documents, sophisticated mathematical notation, and official references.

These tools facilitate the creation of organized, polished, and visually appealing documents that balance usability, data precision, and communication of ideas.

Chapter IV: Software and Algorithms

Introduction:

Software and algorithms are essential components of modern computing and technology (Schindelin et al., 2012; Outeiral et al., 2020). Software is a computer program that provides instructions to a computer to accomplish a specific task. They can range from calculators to operating systems and word processing applications (Zhang et al., 2022; Xie & Song, 2024).

On the other hand, algorithms are sequences of instructions or rules that describe how to solve a problem or execute a task (Marchetti et al., 2022). They are the foundation on which many software rely, dictating the steps to achieve a given result. Algorithms are everywhere in all areas of computing, from software development to data analysis to artificial intelligence and computer science networks (Wang et al., 2023). Software and algorithms play an essential role in many scientific fields, from solving mathematical problems to analyzing complex data (Chen et al., 2020; Ghosh et al., 2011).

Computer programming is the skill of designing sequences of instructions that enable a computer to perform specific tasks. It involves designing, coding, and debugging computer programs in various languages, such as Python, Java, C++, and others (Forbus & Forbus, 1985; Pinto & Terroso, 2022). Programming offers a powerful way to solve problems, automate processes, and develop a wide range of applications, from business software and mobile apps to dynamic websites and complex algorithms in data science (Fedorenko et al., 2019; Lin et al., 2022).

Software and algorithms enable computers to process information, solve problems, automate tasks, and create innovative solutions across virtually all areas of modern life, from finance to medicine, through industry and leisure (Olhede & Wolfe, 2018; Baidya et al., 2023). They are at the heart of the digital revolution and continue to shape our world exponentially (Abiteboul & Dowek, 2020). This chapter explores the definition of these fundamental concepts and highlights their significant use in biology.

1. Software in Biological Sciences: basic Concepts of Software

1.1 Definition of software

Software is a set of instructions, data, or programs that run on computers and execute specific tasks (Bowie, 1980). It is the opposite of hardware, which refers to a computer's physical components. Software is a generic term for applications, scripts, and programs that run on a device (Amla et al., 2024). It can be thought of as the variable part of a computer, while hardware is the invariable part.

The main categories of software are **application software** and **system software** (Bowie, 1980; Stegman et al., 2020). An **application software** is software that fulfills a specific need or performs tasks. **System software** is designed to run a computer's hardware and provides a platform for applications to run on.

Figure 125: Primary types of software.

1.2 Components of Software Systems

A software system consists of interrelated components that ensure functionality and efficiency. The main components are:

- **Programs:** Executable instructions in programming languages that perform specific tasks.
- **Data:** Information processed or generated by software, including experimental results and biological datasets.
- **Documentation:** User manuals and technical guides that describe software operation.
- **User Interface:** The methods users use to interact with the software, such as graphical or command-line interfaces.

In biological applications, these components facilitate data visualization, modeling of biological processes, and efficient management of research databases.

1.3 Classification of Software

Software is commonly classified by function into two primary categories (system software and application software), additional classifications include programming software, driver software, and licensing categories.

- **System Software:** Controls and manages computer hardware, providing the foundation for other software. Users generally do not interact with system software directly. Examples: Operating Systems (Windows, macOS), Device Drivers (for printers), Utilities (antivirus), and Firmware (BIOS).
- **Application Software:** Enables users to perform specific tasks or achieve particular goals, operating on top of system software. Examples: Word processors (Microsoft Word), spreadsheets (Microsoft Excel), web browsers (Chrome), media players (VLC), and games.
- **Programming Software:** Provides tools for developers to write, test, debug, and maintain software, supporting the development process. Examples: Compilers, debuggers, and code editors (e.g., Notepad++).

- **Driver Software:** Enables communication between the operating system and hardware peripherals (e.g., printers, scanners, keyboards), and is often considered a subset of system software.

1.4 Scientific and Specialized Software used in biology

Software plays a vital role in biology by enabling efficient data analysis, task automation, and predictive modeling. These capabilities have advanced genomics, drug discovery, and evolutionary biology, allowing scientists to interpret complex data more quickly and accurately (Wallace et al., 2016; Kass et al., 2017; Pavoine, 2020; Gao et al., 2025). The choice of software for biological and ecological research depends on the objectives of the study and the analyses required (Brousil et al., 2023; Pylvänäinen et al., 2025). Below are some of the most widely used tools in biological sciences:

1.4.1 Statistical and Data Analysis Software.

In biology, statistical software is used to analyze experimental and observational data. With these tools, researchers can conduct a wide range of statistical analyses, both descriptive and inferential, develop and test hypotheses, and present biological variability. Such software is often used for: Analyzing laboratory and field data. Regression analysis and hypothesis testing. Visualizing data in graphs and charts. Examples of statistical software commonly used in biology include R, SPSS, and MATLAB.

1.4.2 Bioinformatics Software

Bioinformatics tools are software that deal with biological information (including DNA, RNA, and proteins). They are indispensable for genetics, molecular biology, and genomics.
Key applications include:

- Sequence alignment and comparison
- Phylogenetic analysis
- Genome annotation and functional prediction

Some of these tools are BLAST, MEGA, Clustal Omega, and Geneious.

1.4.3 Image Processing and Visualization Software

Image analysis software is widely used in biology for both microscopic and macroscopic structures. These tools support image manipulation, enhancement, and quantitative analysis.
Common applications include:

- Microscopic image analysis
- Cell counting and morphology analysis
- Tissue and organ visualization

Commonly used software includes ImageJ, Fiji, and CellProfiler.

1.4.4 Modeling and Simulation Software

Modeling and simulation tools use mathematical and computational models to analyze biological processes. These resources enable researchers to better understand complex biological systems and test theoretical assumptions.

- Key applications include:
- Population dynamics modeling
- Ecosystem simulations
- Biochemical and physiological process modeling

Examples include MATLAB, Simulink, and NetLogo.

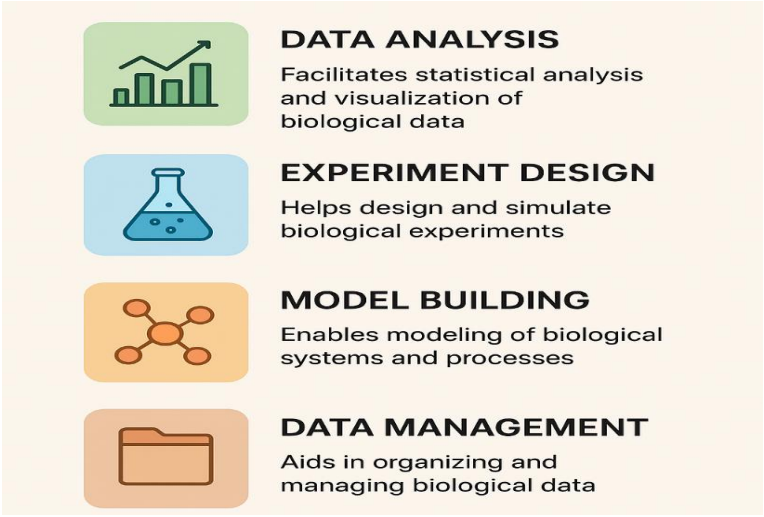


Figure 126: Applications of Software in Biological Studies.

2. Algorithms: Fundamental Concepts

2.1 Definition and Characteristics of Algorithms

An algorithm is a set of instructions designed to accomplish a specific task. It typically processes one or more inputs through defined steps to produce outputs (Rayward-Smith et al., 1991). While algorithms are fundamental to computer programming, they are also used for a wide range of computational tasks, including calculations and database searches (Yanofsky, 2010; Hill, 2015).

An algorithm must be clear, precise, and terminate after a defined number of steps. It should not continue indefinitely without producing a result.

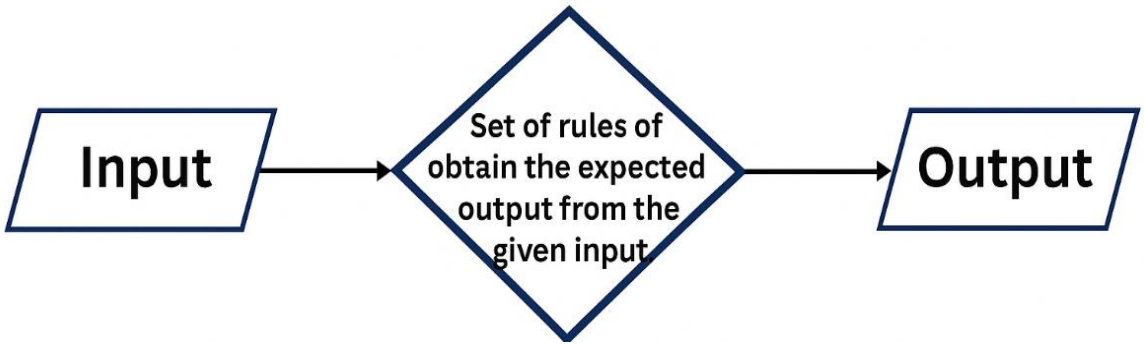


Figure 127: Algorithm Concept Diagram.

2.2 Essential Properties of Algorithms

A process qualifies as an algorithm if it meets the following essential properties.

- **Finiteness:** An algorithm must complete after a finite number of steps. This guarantees the process will terminate and produce an output promptly.
- **Correctness:** An algorithm is correct if it consistently produces the desired output for every valid input. In biology, ensuring correctness is essential for accurate data analysis and scientifically valid conclusions.
- **Efficiency:** Efficiency measures how well a process uses computational resources such as time and memory. In biology, efficient algorithms are crucial for processing large datasets, including genomics and proteomics, quickly and with minimal resources.

2.3 Structure and Functioning of Algorithms:

An algorithm is a well-organized sequence of instructions used to solve problems or complete tasks. It operates through several critical stages (Gentle, 2009):

1. **Input:** Data to be processed by the algorithm.
2. **Processing:** The algorithm performs logical and arithmetic operations on the data.
   - **Decision making:** Chooses different paths based on conditions.
   - **Looping:** Repeats steps until a condition is satisfied.
3. **Output:** Produces the final result after processing.
4. **Termination:** The algorithm stops once the task is complete.

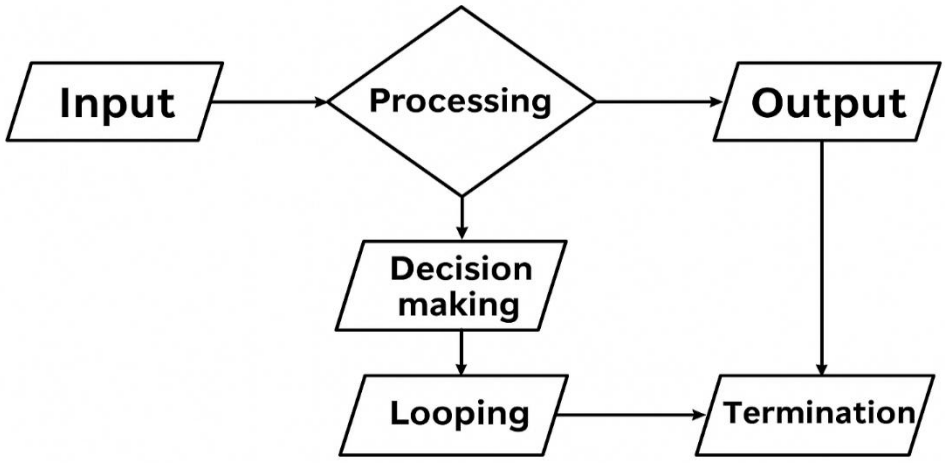


Figure 128: Algorithms Function Diagram (Muller, 2020).

2.4 Examples of Algorithms

2.4.1 Algorithm to Add Two Numbers

Start

Input two numbers (A and B)

Add the numbers (Sum = A + B)

Output the Sum

End

2.4.2 Algorithm to Find the Largest of Two Numbers

Start

Input two numbers (A and B)

If A > B, then A is the largest

Else, B is the largest

Output the largest number

End

2.4.3 Algorithm to Check if a Number is Even or Odd

Start

Input a number (N)

If N mod 2 = 0, then Output "Even"

Else, Output "Odd"

End

2.4.4 Algorithm to Find the Factorial of a Number

Start

Input a number (N)

Set Factorial = 1

For i = 1 to N: Multiply Factorial by i

Output Factorial

End

2.4.5 Algorithm to Search an Element in a List (Linear Search)

Start

Input a list of elements and the item to search

For each element in the list:

If the element matches the item, Output "Item Found" and End

If the end of the list is reached without a match, Output "Item Not Found"

End

2.5 Algorithms in Biological researches

Algorithms play an essential role in computational biology and bioinformatics, providing powerful tools for analyzing and interpreting complex biological data. They are applied across a wide range of biological disciplines:

- **Scientists use algorithms such as BLAST and FASTA for sequence alignment**, gene prediction, genome assembly, and detection of genetic variants (Paten et al., 2011; Song et al., 2021).
- **To predict protein structures and functions**, and to support drug discovery through molecular modeling and virtual screening (Schauperl & Denny, 2022; Lu et al., 2024; Zhou & DiMaio, 2025).
- **To model, construct, and analyze biological networks**, simulating various cellular and metabolic processes (Francis et al., 2024; Clark et al., 2025; Kratochvíl et al., 2025).
- **To construct phylogenetic trees and reconstruct ancestral sequences**, exploring evolutionary relationships among species (Yu et al., 2019; Wang et al., 2024).
- **Clinicians use algorithms to diagnose genetic diseases**, detect mutations, and predict individual treatment responses (Johnson et al., 2022; Roman-Naranjo et al., 2023).
- **Scientists apply advanced algorithms to enhance pattern recognition**, predictive modeling, and data mining in large-scale biological datasets (Angermueller et al., 2016; Yamada et al., 2018; Yang et al., 2020).

3. Difference between an Algorithm and a Program

Although often confused, an algorithm and a program are not the same. An algorithm is an abstract method that outlines the steps to solve a problem. It is independent of any specific technology or programming language (Tarsini & Anggraeni, 2024).

A program is the concrete implementation of an algorithm in a language a computer can process, such as Python, Java, or C++ (Burke, 2019). The same algorithm can be expressed as different programs depending on the context or requirements

For example, an algorithm to calculate the sum of two numbers can be implemented in various languages, but its logic remains unchanged. This demonstrates the universality of algorithms compared to the specificity of programs.

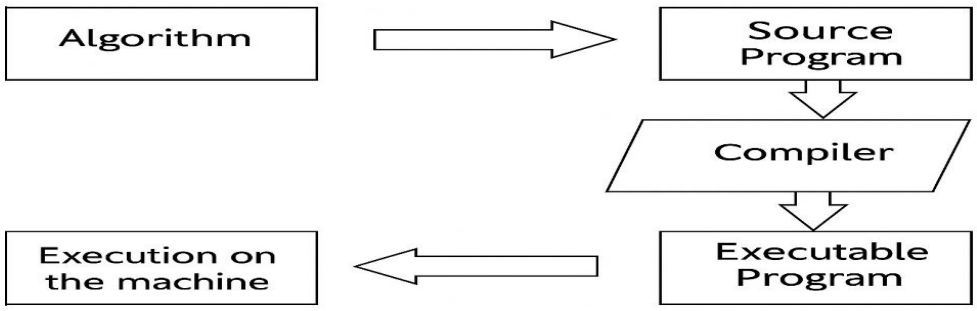


Figure 129: Process of creating and executing a program.

4. Examples of Algorithmic and Software Applications in Biological Sciences

The following examples illustrate software tools and algorithms employed in the biological sciences, emphasizing their distinct functions and contributions to biological research and analysis:

4.1 Genomic Analysis: Analyzing DNA and RNA in plants, animals, and microbes, and supports gene and mutation identification and clarifies disease genetics. Example Programs/Algorithms:

- BLAST: Searches for homologous sequences in genetic databases.
- Bowtie and BWA: Map genome sequences.

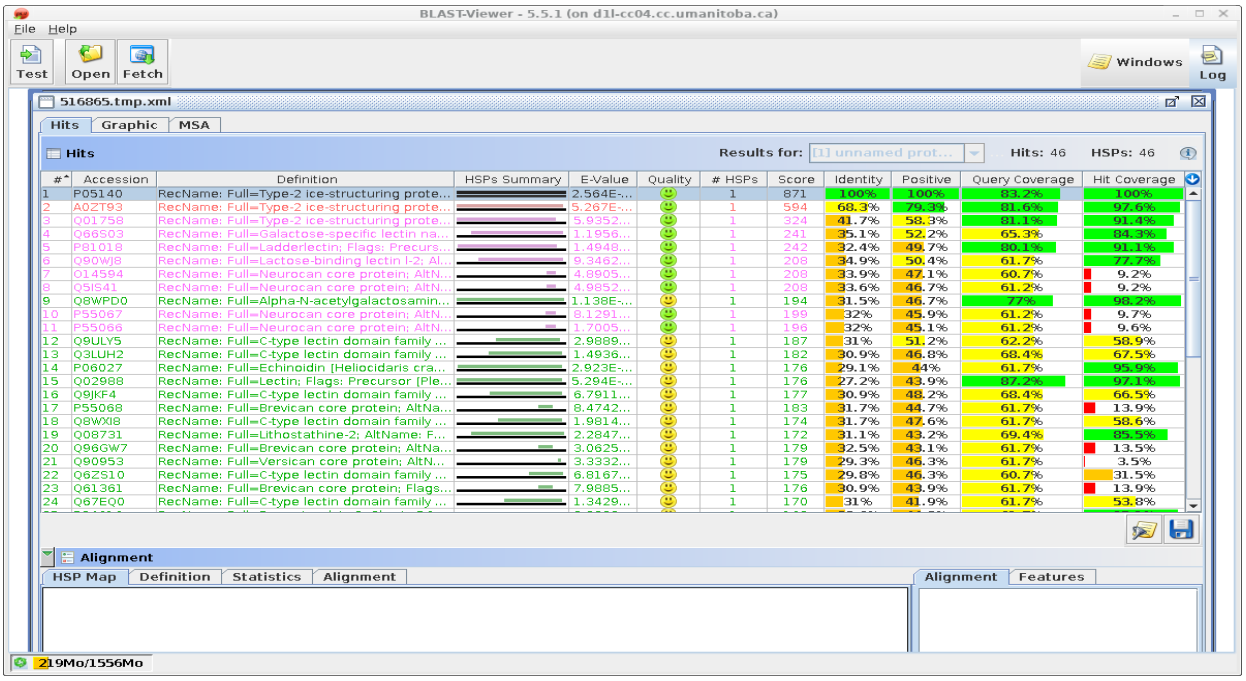


Figure 130: Searching local sequence databases using BLAST.

4.2 Disease Prediction: Predicts disease risk using biological data. Helps doctors quickly identify illnesses and make informed treatment decisions.

Example Programs/Algorithms:

- Machine learning models (Random Forest, SVM): Analyze patient data and predict risk.
- Polygenic Risk Score (PRS): Predicts genetic risk for disease.

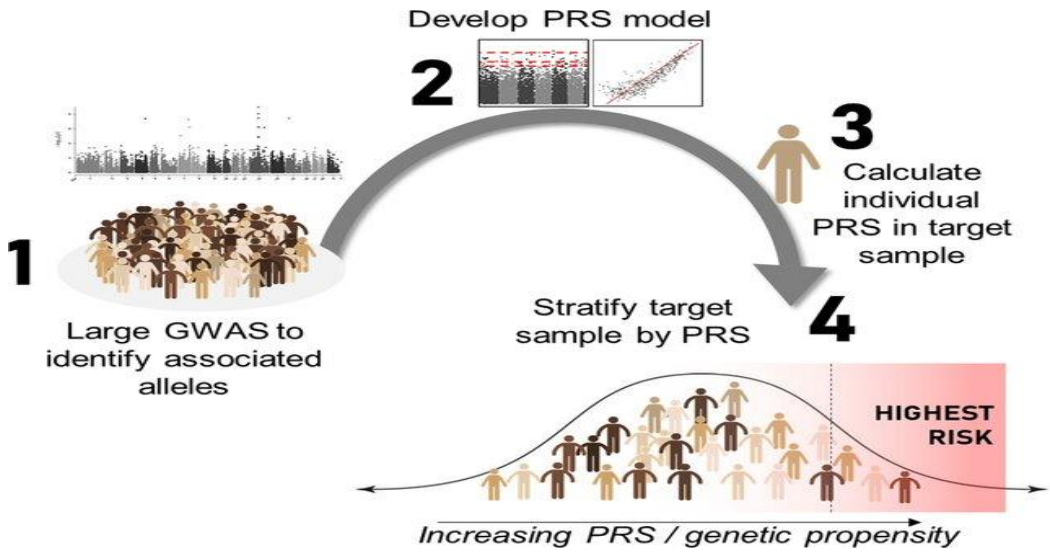


Figure 131: Polygenic risk score (PRS) calculation to identify high risk individuals. (kennedy et al. 2022)

4.3 Protein Structure Modeling: Predicting the three-dimensional structure of proteins based on their amino acid sequences.

Example Programs/Algorithms:

- AlphaFold: Accurately predicts the three-dimensional structure of proteins.
- Rosetta: Supports the development and design of novel proteins.
- Benefit: Enhances understanding of protein function and aids in the design of targeted therapeutics.

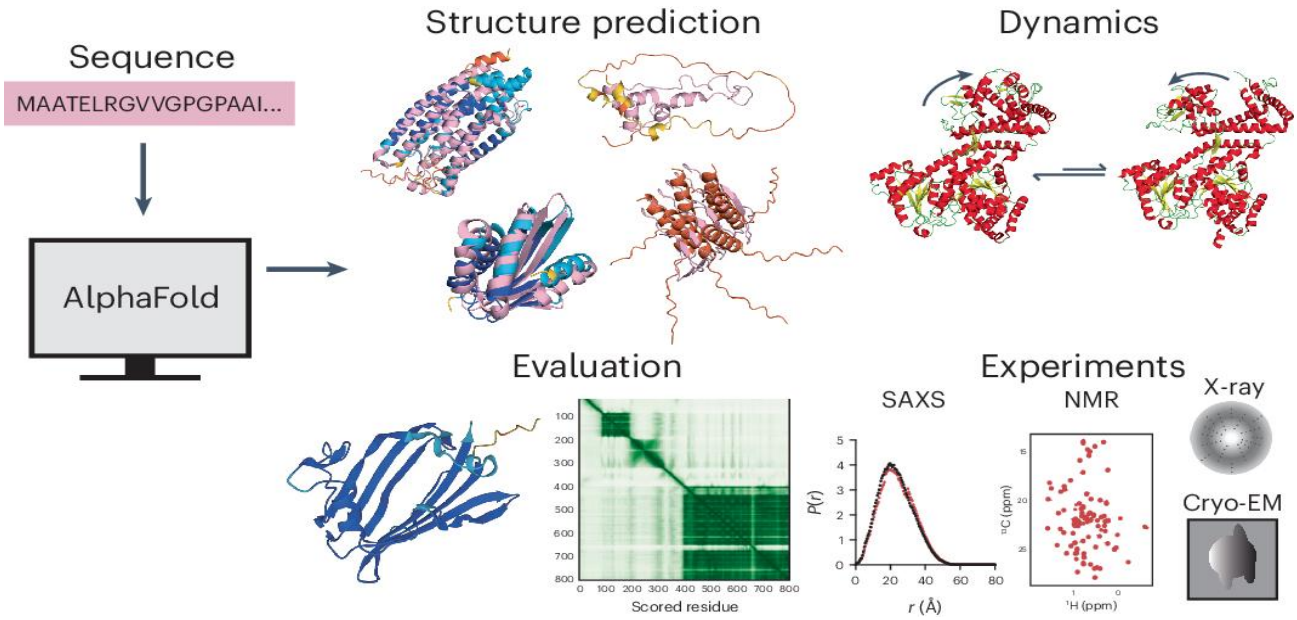


Figure 132: The power and pitfalls of AlphaFold2 for structure prediction beyond rigid globular proteins. (Agarwal et al. 2024)

4.4 Phylogenetic Analysis: MEGA, PhyML, and MrBayes use evolutionary algorithms to reconstruct phylogenetic trees, supporting research on species evolution and genetic diversity.

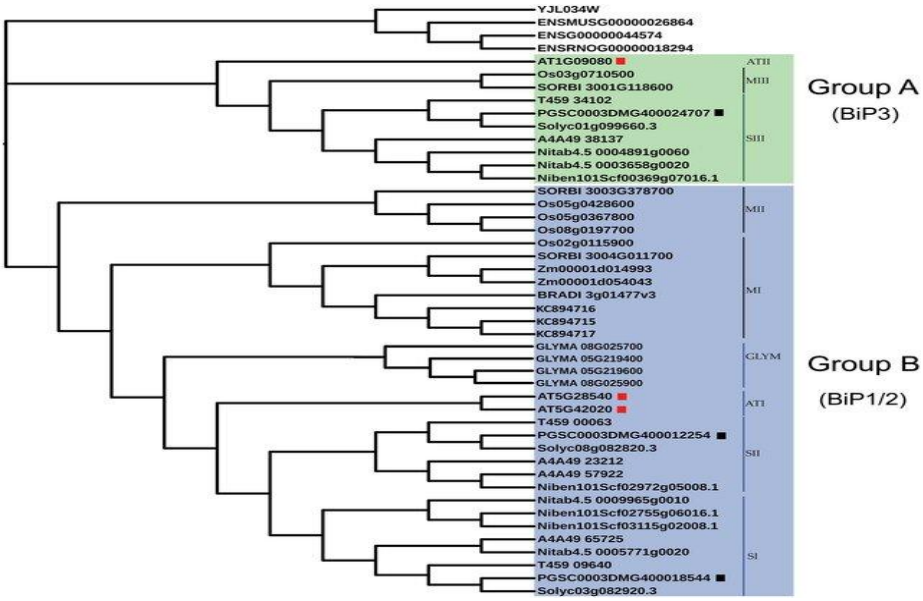


Figure 133: Phylogenetic tree constructed using the PhyML method (v1.5) (Herath et al. 2020)

4.5 Image Analysis: Image-processing algorithms in software such as ImageJ and CellProfiler support cell counting, tissue analysis, and medical imaging.

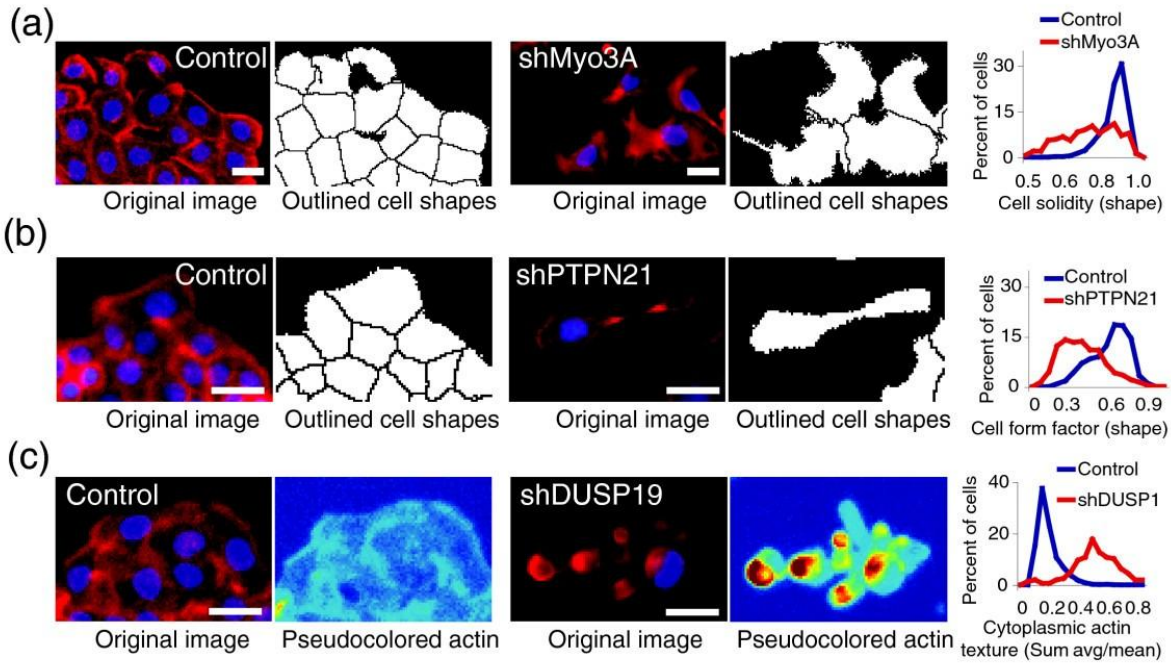


Figure: 134: CellProfiler; image analysis software for identifying and quantifying cell phenotypes (Carpenter et al. 2006)

Conclusion:

Algorithms and computer software drive progress in modern biology and life sciences. They enable researchers to extract reliable information from large, complex datasets in biological and medical fields. These tools have significantly advanced genome analysis, protein structure determination, disease prediction, and drug discovery, greatly improving research speed and accuracy.

The adoption of advanced algorithms, including artificial intelligence and machine learning, has expanded our ability to interpret and predict complex biological networks beyond the limits of traditional methods. As a result, software tools and algorithms are now essential for life scientists, significantly advancing biological research and contributing to medical and societal progress.

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