



FUNDAMENTALS OF COMPUTER SCIENCE

SCHOOL: COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

ENG. O.R.G. Moring

UNIVERSITY OF JUBA
COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
(COMPUTER SCIENCE)

APRIL 23, 2023

INTRODUCTION TO COMPUTER

INTRODUCTION

At the present time, computers are an essential part of our lives. They are used for the reservation of tickets for airplanes and railways, payment of telephone and electricity bills, deposit and withdrawal of money from banks, processing of business data, forecasting of weather conditions, diagnosis of diseases, searching for information on the Internet, etc. Computers are also used extensively in schools, universities, organizations, music industry, movie industry, scientific research, law firms, fashion industry, etc.

The term computer is derived from the word *compute*. The word *compute* means *to calculate*.

DEFINITION

- **A COMPUTER** is an electronic machine that accepts data from the user, processes the data by performing calculations and operations on it, and generates the desired output results. Computer performs both simple and complex operations, with speed and accuracy.
- **A COMPUTER** is an electronic device, operating under the control of instructions (software) stored in its own memory unit, that can accept data (input), manipulate data (process), and produce information (output) from the processing. Generally, the term is used to describe a collection of devices that function together as a system.
- **A COMPUTER** is an electronic machine that follows a set of instructions in order that it may be able to accept and gather data and transform these into information through processing.

WHAT IS SCIENCE?

Science, any system of knowledge that is concerned with the physical world and its phenomena and that entails unbiased observations and systematic experimentation. In general, a science involves a pursuit of knowledge covering general truths or the operations of fundamental laws.

Science can be divided into different branches based on the subject of study. The **physical sciences** study the inorganic world and **comprise** the fields of **astronomy**, **physics**, **chemistry**, and the **Earth sciences**. The biological sciences such as **biology** and **medicine** study the organic world of **life** and its processes. **Social sciences** like **anthropology** and **economics** study the social and cultural aspects of **human behavior**.

Science is further treated in a number of articles. For the history of Western and Eastern science, see **science**, **history of**. For the **conceptualization** of science and its interrelationships with **culture**, see **science, philosophy of**. For the basic aspects of the scientific approach, see **physical science**, **principles of**; and **scientific method**.

Science is the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence.

In an era where practices such as homeopathy are becoming widespread, and 'detox' is an acceptable aim for a diet, a definition creates a clear distinction between what is genuine science, and what is pseudoscience.

Science is an activity, related to the creation of new knowledge, rather than established knowledge itself.

Science is seen as a species of research. Yet a definition of science needs to define the nature of the knowledge not the means of its creation only.

And, "The definition would include historical research and indeed some journalism! It does not demarcate something called science from the humanities. This is a good and sensible thing

"Because 'science' denotes such a very wide range of activities a definition of it needs to be general; it certainly needs to cover investigation of the social as well as natural worlds; it needs the words "systematic" and "evidence"; and it needs to be simple and short. The definition succeeds in all these respects admirably, and I applaud it therefore."

Scientific methodology includes the following:

- Objective observation: Measurement and data (possibly although not necessarily using mathematics as a tool)
- Evidence
- Experiment and/or observation as benchmarks for testing hypotheses
- Induction: reasoning to establish general rules or conclusions drawn from facts or examples
- Repetition
- Critical analysis

Verification and testing: critical exposure to scrutiny, peer review and assessment.

WHAT IS COMPUTER SCIENCE?

Computer Science, the study of computers and computing, including their theoretical and algorithmic foundations, hardware and software, and their uses for processing information. The discipline of computer science includes the ***study of algorithms and data structures, computer and network design, modeling data and information processes, and artificial intelligence.***

Computer science draws some of its foundations from mathematics and engineering and therefore incorporates techniques from areas such as queueing theory, probability and statistics, and electronic circuit design.

Computer science also makes heavy use of hypothesis testing and experimentation during the conceptualization, design, measurement, and refinement of new algorithms, information structures, and computer architectures.

Computer science is considered as part of a family of five separate yet interrelated disciplines: computer engineering, computer science, information systems, information technology, and software engineering. This family has come to be known collectively as the discipline of computing. These five disciplines are interrelated in the sense that computing is their object of study, but they are separate since each has its own research

perspective and curricular focus. (Since 1991 the Association for Computing Machinery [ACM], the IEEE Computer Society [IEEE-CS], and the Association for Information Systems [AIS] have collaborated to develop and update the taxonomy of these five interrelated disciplines and the guidelines that educational institutions worldwide use for their undergraduate, graduate, and research programs.)

The major subfields of computer science include the traditional study of computer architecture, programming languages, and software development. However, they also include computational science (the use of algorithmic techniques for modeling scientific data), graphics and visualization, human-computer interaction, databases and information systems, networks, and the social and professional issues that are unique to the practice of computer science. As may be evident, some of these subfields overlap in their activities with other modern fields, such as bioinformatics and computational chemistry. These overlaps are the consequence of a tendency among computer scientists to recognize and act upon their field's many interdisciplinary connections.

Development of computer science

Computer science emerged as an independent discipline in the early 1960s, although the electronic digital computer that is the object of its study was invented some two decades earlier. The roots of computer science lie primarily in the related fields of mathematics, electrical engineering, physics, and management information systems.

Mathematics is the source of two key concepts in the development of the computer—the idea that all information can be represented as sequences of zeros and ones and the abstract notion of a “stored program.” In the binary number system, numbers are represented by a sequence of the binary digits 0 and 1 in the same way that numbers in the familiar decimal system are represented using the digits 0 through 9. The relative ease with which two states (e.g., high and low voltage) can be realized in electrical and electronic devices led naturally to the binary digit, or bit, becoming the basic unit of data storage and transmission in a computer system.

Electrical engineering provides the basics of circuit design—namely, the idea that electrical impulses input to a circuit can be combined using Boolean algebra to produce arbitrary outputs. (The Boolean algebra developed in the 19th century supplied a formalism for designing a circuit with binary input values of zeros and ones [false or true, respectively, in the terminology of logic] to yield any desired combination of zeros and ones as output.) The invention of the transistor and the miniaturization of circuits, along with the invention of electronic, magnetic, and optical media for the storage and transmission of information, resulted from advances in electrical engineering and physics.

Finally, a particular concern of computer science throughout its history is the unique societal impact that accompanies computer science research and technological advancements. With the emergence of the Internet in the 1980s, for example, software developers needed to address important issues related to information security, personal privacy, and system reliability. In addition, the question of whether computer software constitutes intellectual property and the related question “Who owns it?” gave rise to a whole new legal area of licensing and licensing standards that applied to software and related artifacts. These concerns and others form

the basis of social and professional issues of computer science, and they appear in almost all the other fields identified above.

TYPES OF COMPUTER

A computer is one of the most brilliant inventions of mankind. Thanks to computer technology, we were able to achieve storage and processing of huge amounts of data; we could rest our brains by employing computer memory capacities for storage of information. Owing to computers, we have been able speed up daily work, carry out critical transactions and achieve accuracy and precision at work. Computers of the earlier times were of the size of a large room and were required to consume huge amounts of electric power. However, with the advancing technology, computers have shrunk to the size of a small watch. Therefore, computers are of the following types:

On the basis of working principle (Operational Based)

- 1. Digital computer**
- 2. Analog computer**
- 3. Hybrid computer**

TYPES OF COMPUTERS BASED ON THE OPERATIONAL PRINCIPLE

Based on the operational (working) principle of computers, they are categorized as analog, digital and hybrid computers.

Digital Computer

They use digital circuits and are designed to operate on two states, namely bits 0 and 1. They are analogous to states ON and OFF. Data on these computers is represented as a series of 0s and 1s. Digital computers are suitable for complex computation and have higher processing speeds. They are programmable. Digital computers are either general purpose computers or special purpose ones. General purpose computers, as their name suggests, are designed for specific types of data processing while general purpose computers are meant for general use.

Digital computers were invented to perform different calculations and logical operations at a very high speed. These computers accept the raw data as input, done in binary numbers (0 and 1) or digitals.

After that, the device processes the information with programs that are already stored in the device's memory. This process is followed to generate the output. Some examples of digital computers include laptops, desktops, and other electronic devices like smartphones.

There are many advantages of digital computers. Some of those advantages are mentioned below.

- Digital computers allow users to store a large amount of information. The stored information can be retrieved whenever it is required.
- New features can easily be added to the digital systems.
- Ability to change the program without making any changes in the hardware of the system.

- The cost of the hardware of digital computers is often less because of the advancement in the Integrated Circuit (IC) technology.
- These systems process data digitally at a very high speed.
- Digital computers use error correction codes because of which these systems are very reliable.
- The output is not affected by humidity, noise, temperature, or other natural properties, leading to the results' high reproducibility.

A digital computer is kind of computer that uses distinct values to represent the data internally. All information are represented using the digits 0s and 1s. The computers that we use at our homes and offices are digital computers.



Digital Computers

Analog Computer

An analog computer (spelt analogue in British English) is a form of computer that uses continuous physical phenomena such as electrical, mechanical, or hydraulic quantities to model the problem being solved. These are almost extinct today. These are different from a digital computer because an analog computer can perform several mathematical operations simultaneously. It uses continuous variables for mathematical operations and utilizes mechanical or electrical energy.

These computers were specifically designed to process analogue data. For readers who are not familiar with the term, analogue data is a type of continuous data that continually changes and does not have discrete values.

It can also be said that analogue computers are used when the users are not familiar with the exact values like temperature, speed, current, and pressure. An intriguing feature of analogue computers is accepting the measuring device's data without converting it into relevant codes and numbers.

This feature allows analogue computers to measure continuous changes in physical quantity. In most cases, the output of these computers is read on a dial or scale. Some examples of analogue computers are the mercury thermometer and speedometer.

There are many advantages of using analog computers. Some of those advantages are as follows.

- These computers allow real-time computation and operations at the same time. Further, it continuously represents all data within the range of the analog computer system.

- In some applications, analog computers help perform calculations without using transducers to convert both the inputs and outputs to a digital electronic form and vice versa.
- Programmers can also scale the problem for the dynamic range of analog computers. This provides excellent insight into the actual situation. It also helps in learning about any errors and their effects.

There are different types of analog computers. The various types of analog computers are discussed below.

- **Slide Rules**

The slide rule is one of the simplest types of mechanical analog computer systems. It was developed initially to perform necessary mathematical calculations. These computer systems consist of two rods. When the computer performs any calculation, the hashed rod slides to line up with the specific markings placed on another rod.

- **Differential Analyzers**

Differential analyzers are used to perform differential calculations. These computer systems perform integration by using a wheel-and-disc mechanism. This helps in solving differential calculations.

- **Castle Clock**

According to various sources, the first castle clock was invented by Al-Jara. This computer system was made to save all programming instructions. The original machine's height was around 11 feet, and it came with the display of zodiac, time, and the lunar and solar orbits. These devices can also allow users to set the length of the day according to the current season.

- **Electronic Analog Computer**

An electronic analog computer is a type of analog computer in which electrical signals flow through resistors and capacitors. This simulates different physical phenomena. In these devices, mechanical interactions of computers do not take place. Also, the voltage of the electrical signal is used to generate the correct displays in these devices.

Analog computer is a kind of computer that represents data as variable across a continuous range of values.

The earliest computers were analog computers. Analog computers are used for measuring of parameters that vary continuously in real time, such as temperature, pressure and voltage. Analog computers may be more flexible but generally less precise than digital computers. Slide rule is an example of an analog computer.



Analog Computers

Hybrid Computer

These computers are a combination of both digital and analog computers. In this type of computers, the digital segments perform process control by conversion of analog signals to digital ones. A hybrid computer system setup offers a cost effective method of performing complex simulations.

Hybrid computers are devices that have features of both digital and analog computers. These devices are similar in speed to analog computers and are identical to digital computers in their memory and accuracy. Hybrid computers can process both discrete and continuous data. These devices work by accepting analog signals and converting those signals into a digital form before processing. This is why these devices are popularly used in specialized applications where both analog and digital data has to be processed.

For example, the processors used in petrol pumps convert fuel flow into values for both quantity and price. Similar devices are used in hospitals, airplanes, and many scientific applications.

There are many benefits of using hybrid computers. A few of those benefits are mentioned below.

- The computing speed of hybrid computers is very high. This is due to the all-parallel configuration of the analog subsystem.
- These computers help in online data processing.
- Hybrid computers can manage and solve large equations in real-time.
- The results are produced quickly and in a more efficient manner. The final results are both accurate and useful.

Hybrid computer is a type of computer that offers the functionalities of both a digital and an analog computer. It is designed to include a working analog unit that is powerful for calculations, yet has a readily available digital memory. In large industries and businesses, a hybrid computer can be used to incorporate logical operations as well as provide efficient processing of differential equations.



Hybrid Computers

CHARACTERISTICS OF COMPUTER

The main characteristics of a computer are:

1. Speed

A computer device's speed is extremely fast, as it can perform any calculation in seconds. This is one of the key characteristics of computers. This computer characteristic also enhances the versatility of the computer.

It can open any website or application in the blink of an eye. In real life, the computer is like our superhero, Flash. It can travel at the speed of light.

The computer can process data very fast, at the rate of millions of instructions per second. Some calculations that would have taken hours and days to complete otherwise, can be completed in a few seconds using the computer. For example, calculation and generation of salary slips of thousands of employees of an organization, weather forecasting that requires analysis of a large amount of data related to temperature, pressure and humidity of various places, etc.

2. Accuracy

This is an incredible characteristic of computers, which is their high level of accuracy. It is capable of performing 100% accurate calculations. Nothing in this world is perfect or accurate, but the computer proves these statements false with its precise results, calculations, and logic. The computer is comparable to our own Avenger Hawkeye, whose shooting accuracy is unrivaled.

Computer provides a high degree of accuracy. For example, the computer can accurately give the result of division of any two numbers up to 10 decimal places.

3. Diligence

When used for a longer period of time, the computer does not get tired or fatigued. It can perform long and complex calculations with the same speed and accuracy from the start till the end.

A computer is free of fatigue, lack of concentration, and so on. It can work for hours without making any mistakes. It's like a superman who can fly and fight for hours and hours without tiring.

4. Storage Capability

Large volumes of data and information can be stored in the computer and also retrieved whenever required. A limited amount of data can be stored, temporarily, in the primary memory. Secondary storage devices like floppy disk and compact disk can store a large amount of data permanently.

5. Versatility

Computer is versatile in nature. It can perform different types of tasks with the same ease. At one moment you can use the computer to prepare a letter document and in the next moment you may play music or print a document.

6. Communication

Computers have the ability to communicate, but of course there needs some sort of connection (either Wired or Wireless connection). Two computers can be connected to send & receive data. Special software's are used for text and video chat. Friends & family can connect over the internet and share files, photos & videos online.

7. Multitasking

Multitasking is also a computer characteristic. Computers can perform several tasks at a time. For example you can listen to songs, download movies, and prepare word documents all at the same time.

8. Reliability

A computer is a dependable machine that is capable of performing all tasks and operations at high speeds and with near-perfect accuracy. Just like humans, computer software and hardware respond to the requests or demands made by users. Spiderman and Iron Man have a relationship in which they are like mentors and students, and they completely trust each other. Similarly, we are computer mentors, and the computer learns from us and is completely dependable.

9. Memory

Memory on computers is comparable to that in the human brain. It is used to store data and directions. Computer memory is the storage space on the computer where data to be processed and processing instructions are stored. It has both primary and secondary memories.

The task we are currently working on is saved in the main memory, and the task we saved is saved until we delete it.

10. Logical

A computer system has certain characteristics, such as the capability of thinking, reasoning, and learning. These characteristics of computers help them perform tasks logically and these characteristics have been further developed into what we today know as Artificial Intelligence.

For example, Batman uses his logical thinking and intelligence to create various gadgets using artificial intelligence.

11. Automation

Automation is the use of technology to complete a task with as little human interaction as possible.

In computing, automation is typically accomplished through the use of a program, a script, or batch processing. As in Guardians of the Galaxy, we have a baby Groot who can perform all of these tasks automatically without the assistance of other people thanks to the available programming data stored in it. Computers also automatically complete the instructed tasks.

12. Consistency

In the context of databases, consistency means that data cannot be written because it would violate the database's own rules for valid data.

Like Captain America, he follows the rules consistently, even if it means opposing everyone in the world. The computer shows consistency through the set of rules already assigned.

13. Remembrance Power

A computer is capable of storing an unlimited amount of information or data. Any information can be stored and retrieved for as long as you need it, for an unlimited number of years.

It is entirely up to you how much data you want to store on a computer and when you want to lose or retrieve it. Hulk is a scientist with an exceptional memory. When necessary, he remembers and recalls everything. Similarly, another excellent computer feature is its ability to recall and memorize information. Precisely. All these features of computers are responsible for providing the versatility of computers.

ADVANTAGES AND DISADVANTAGES OF COMPUTER

Advantages

- Computer is a very fast device. It is capable of performing calculation of very large amount of data within a shorter time.
- It can perform millions of calculations in a few seconds as compared to man who will spend many months to perform the same task.
- In addition to being very fast, computers are very accurate. Computers perform all jobs with 100% accuracy provided that the input is correct.
- Unlike human beings, a computer is free from monotony, tiredness, and lack of concentration. It can work continuously without any error and boredom.
- It can perform repeated tasks with the same speed and accuracy.
- This machine can be used to solve the problems related to various fields. At one instance, it may be solving a complex scientific problem and the very next moment it may be playing a card game.
- A computer is a very versatile machine. A computer is very flexible in performing the jobs to be done.
- A computer is a reliable machine. Modern electronic components have long lives.
- Computers are designed to make maintenance easy.
- Computer is an automatic machine. Automation is the ability to perform a given task automatically.
- Reduction in Paper Work and Cost. The use of computers for data processing in an organization leads to reduction in paper work and results in speeding up the process.
- As data in electronic files can be retrieved as and when required, the problem of maintenance of large number of paper files gets reduced.
- Though the initial investment for installing a computer is high, it substantially reduces the cost of each of its transaction.

Disadvantages

- **No I.Q.**
 - A computer is a machine that has no intelligence to perform any task.

- Each instruction has to be given to the computer.
- A computer cannot take any decision on its own.
- **Dependency**
 - It functions as per the user's instruction, thus it is fully dependent on humans.
- **Environment**
 - The operating environment of the computer should be dust free and suitable.
- **No Feeling**
 - Computers have no feelings or emotions. It cannot make judgment based on feeling, taste, experience, and knowledge unlike humans.
- **Online Cyber-Crimes**
 - As with any device, cybercrimes occur on computers. Data stealing is one of the major threats in the world of computers. It may occur online or via an offline removable device like that a USB.
- **Health-Issues**
 - Prolonged use of personal computers results in many health-related issues. Eye strain, headache, back pain, etc. are some of them.
- **Fake News**
 - Computers enable a wide array of data-sharing options. But, this becomes a medium for the spread of spurious news. Many cases are there when fake news is shared among people using messaging apps.
- **E-waste**
 - The use of computers is nothing but a form of e-waste. This contributes negatively by releasing harmful toxic materials.
- **Lack of Concentration and Irritation**
 - As multitasking makes our lives easier, but it comes with its disadvantages. We try to focus on multiple tasks and notifications. This leads to a decrease in attention span and a lack of concentration on one particular task. Also, addictive games played on the computer contribute to irritability when not allowed to play.

HISTORY OF COMPUTERS

People used sticks, stones, and bones as counting tools before computers were invented. More computing devices were produced as technology advanced and the human intellect improved over time. Let us look at a few of the early-age computing devices used by mankind.

1. Abacus

Abacus was invented by the Chinese around 4000 years ago. It's a wooden rack with metal rods with beads attached to them. The abacus operator moves the beads according to certain guidelines to complete arithmetic computations.

2. Napier's Bone

John Napier devised Napier's Bones, a manually operated calculating apparatus. For calculating, this instrument used 9 separate ivory strips (bones) marked with numerals to multiply and divide. It was also the first machine to calculate using the decimal point system.

3. Pascaline

Pascaline was invented in 1642 by Blaise Pascal, a French mathematician and philosopher. It is thought to be the first mechanical and automated calculator. It was a wooden box with gears and wheels inside.

4. Stepped Reckoner or Leibniz wheel

In 1673, a German mathematician-philosopher named Gottfried Wilhelm Leibniz improved on Pascal's invention to create this apparatus. It was a digital mechanical calculator known as the stepped reckoner because it used fluted drums instead of gears.

5. Difference Engine

In the early 1820s, Charles Babbage created the Difference Engine. It was a mechanical computer that could do basic computations. It was a steam-powered calculating machine used to solve numerical tables such as logarithmic tables.

6. Analytical Engine

Charles Babbage created another calculating machine, the Analytical Engine, in 1830. It was a mechanical computer that took input from punch cards. It was capable of solving any mathematical problem and storing data in an indefinite memory.

7. Tabulating machine

An American Statistician – Herman Hollerith invented this machine in the year 1890. Tabulating Machine was a punch card-based mechanical tabulator. It could compute statistics and record or sort data or information. Hollerith began manufacturing these machines in his company, which ultimately became International Business Machines (IBM) in 1924.

8. Differential Analyzer

Vannevar Bush introduced the first electrical computer, the Differential Analyzer, in 1930. This machine is made up of vacuum tubes that switch electrical impulses in order to do calculations. It was capable of performing 25 calculations in a matter of minutes.

GENERATIONS OF COMPUTER

The computer has evolved from a large-sized simple calculating machine to a smaller but much more powerful machine. The evolution of computer to the current state is defined in terms of the generations of computer. Each generation of computer is designed based on a new technological development, resulting in better, cheaper and smaller computers that are more powerful, faster and efficient than their predecessors. Currently, there are five generations of computer. In the following subsections, we will discuss the generations of computer in terms of

1. *The technology used by them (hardware and software)*
2. *Computing characteristics (speed, i.e., number of instructions executed per second)*
3. *Physical appearance*
4. *Their applications*

First Generation (1940 to 1956): Using Vacuum Tubes

- **Hardware Technology** The first generation of computers used vacuum tubes (Figure 1.4) for circuitry and magnetic drums for memory. The input to the computer was through punched cards and paper tapes. The output was displayed as printouts.



Figure 1.4 Vacuum tube

- **Software Technology** The instructions were written in machine language. Machine language uses 0s and 1s for coding of the instructions. The first generation computers could solve one problem at a time.
- **Computing Characteristics** The computation time was in milliseconds.
- **Physical Appearance** These computers were enormous in size and required a large room for installation.
- **Application** They were used for scientific applications as they were the fastest computing device of their time.
- **Examples** UNIVersal Automatic Computer (UNIVAC), Electronic Numerical Integrator And Calculator (ENIAC), and Electronic Discrete Variable Automatic Computer (EDVAC).

The first generation computers used a large number of vacuum tubes and thus generated a lot of heat. They consumed a great deal of electricity and were expensive to operate. The machines were prone to frequent

malfunctioing and required constant maintenance. Since first generation computers used machine language, they were difficult to program.

Second Generation (1956 to 1963): Using Transistors

- ***Hardware Technology*** Transistors (Figure 1.5) replaced the vacuum tubes of the first generation of computers. Transistors allowed computers to become smaller, faster, cheaper, energy efficient and reliable. The second generation computers used *magnetic core technology* for primary memory. They used magnetic tapes and magnetic disks for secondary storage. The input was still through punched cards and the output using printouts. They used the concept of a stored program, where instructions were stored in the memory of computer.



Figure 1.5 Transistors

- ***Software Technology*** The instructions were written using the *assembly language*. Assembly language uses mnemonics like ADD for addition and SUB for subtraction for coding of the instructions. It is easier to write instructions in assembly language, as compared to writing instructions in machine language. High-level programming languages, such as early versions of COBOL and FORTRAN were also developed during this period.
- ***Computing Characteristics*** The computation time was in microseconds.
- ***Physical Appearance*** Transistors are smaller in size compared to vacuum tubes, thus, the size of the computer was also reduced.
- ***Application*** The cost of commercial production of these computers was very high, though less than the first generation computers. The transistors had to be assembled manually in second generation computers.
- ***Examples*** PDP-8, IBM 1401 and CDC 1604.

Second generation computers generated a lot of heat but much less than the first generation computers. They required less maintenance than the first generation computers.

Third Generation (1964-1971)

Third Generation (1964 to 1971): Using Integrated Circuits

- **Hardware Technology** The third generation computers used the *Integrated Circuit (IC)* chips. Figure 1.6 shows IC chips. In an IC chip, multiple transistors are placed on a silicon chip. Silicon is a type of semiconductor. The use of IC chip increased the speed and the efficiency of computer, manifold. The keyboard and monitor were used to interact with the third generation computer, instead of the punched card and printouts.



Figure 1.6 IC chips

- **Software Technology** The keyboard and the monitor were interfaced through the *operating system*. Operating system allowed different applications to run at the same time. *High-level languages* were used extensively for programming, instead of machine language and assembly language.
- **Computing Characteristics** The computation time was in nanoseconds.
- **Physical Appearance** The size of these computers was quite small compared to the second generation computers.
- **Application** Computers became accessible to mass audience. Computers were produced commercially, and were smaller and cheaper than their predecessors. **Examples** IBM 370, PDP 11.

The third generation computers used less power and generated less heat than the second generation computers. The cost of the computer reduced significantly, as individual components of the computer were not required to be assembled manually. The maintenance cost of the computers was also less compared to their predecessors.

Fourth Generation (1971-Present)

Fourth Generation (1971 to present): Using Microprocessors

- **Hardware Technology** They use the *Large Scale Integration (LSI)* and the *Very Large Scale Integration (VLSI)* technology. Thousands of transistors are integrated on a small silicon chip using LSI technology. VLSI allows hundreds of thousands of components to be integrated in a small chip. This era is marked by the development of microprocessor. *Microprocessor* is a chip containing millions of transistors and components, and designed using LSI and VLSI technology. A microprocessor chip is shown in Figure 1.7. This generation of computers gave rise to Personal Computer (PC). Semiconductor memory replaced the earlier magnetic core memory, resulting in fast random access to memory. Secondary storage device like magnetic disks became smaller in physical size and larger in capacity. The *linking of computers* is another key development of this era. The computers were linked to form networks that led

to the emergence of the Internet. This generation also saw the development of pointing devices like mouse, and handheld devices.



Figure 1.7 Microprocessors

- **Software Technology** Several new operating systems like the MS-DOS and MS-Windows developed during this time. This generation of computers supported *Graphical User Interface (GUI)*. GUI is a user-friendly interface that allows user to interact with the computer via menus and icons. High-level programming languages are used for the writing of programs.

- **Computing Characteristics** The computation time is in picoseconds.
- **Physical Appearance** They are smaller than the computers of the previous generation. Some can even fit into the palm of the hand.
- **Application** They became widely available for commercial purposes. Personal computers became available to the home user.
- **Examples** The Intel 4004 chip was the first microprocessor. The components of the computer like Central Processing Unit (CPU) and memory were located on a single chip. In 1981, IBM introduced the first computer for home use. In 1984, Apple introduced the Macintosh.

The microprocessor has resulted in the fourth generation computers being smaller and cheaper than their predecessors. The fourth generation computers are also portable and more reliable. They generate much lesser heat and require less maintenance compared to their predecessors.

GUI and pointing devices facilitate easy use and learning on the computer. Networking has resulted in resource sharing and communication among different computers.

Fifth Generation (Present and Next): Using Artificial Intelligence

The goal of fifth generation computing is to develop computers that are capable of learning and self-organization. The fifth generation computers use *Super Large Scale Integrated (SLSI)* chips that are able to store millions of components on a single chip. These computers have large memory requirements.

This generation of computers uses *parallel processing* that allows several instructions to be executed in parallel, instead of serial execution. Parallel processing results in faster processing speed. The Intel dual core microprocessor uses parallel processing.

The fifth generation computers are based on *Artificial Intelligence (AI)*. They try to simulate the human way of thinking and reasoning. Artificial Intelligence includes areas like Expert System

(ES), Natural Language Processing (NLP), speech recognition, voice recognition, robotics, etc.

CLASSIFICATION OF COMPUTERS

Micro Computers

Microcomputers are small, low-cost and single-user digital computer. They consist of CPU, input unit, output unit, storage unit and the software. Although microcomputers are stand-alone machines, they can be connected together to create a network of computers that can serve more than one user. IBM PC based on Pentium microprocessor and Apple Macintosh are some examples of microcomputers. Microcomputers include desktop computers, notebook computers or laptop, tablet computer, handheld computer, smart phones and netbook.



Microcomputers

Desktop Computer or Personal Computer (PC)

Desktop Computer or Personal Computer (PC) is the most common type of microcomputer. It is a stand-alone machine that can be placed on the desk. Externally, it consists of three units—keyboard, monitor, and a system unit containing the CPU, memory, hard disk drive, etc. It is not very expensive and is suited to the needs of a single user at home, small business units, and organizations. Apple, Microsoft, HP, Dell and Lenovo are some of the PC manufacturers.

Notebook Computers or Laptop

Notebook Computers or Laptop resemble a notebook. They are portable and have all the features of a desktop computer. The advantage of the laptop is that it is small in size (can be put inside a briefcase), can be carried anywhere, has a battery backup and has all the functionality of the desktop. Laptops can be placed on the lap while working (hence the name). Laptops are costlier than the desktop machines.

Netbook

Netbook These are smaller notebooks optimized for low weight and low cost, and are designed for accessing web-based applications. Starting with the earliest netbook in late 2007, they have gained significant popularity now.

Netbooks deliver the performance needed to enjoy popular activities like streaming videos or music, emailing, Web surfing or instant messaging. The word netbook was created as a blend of Internet and notebook.

Tablet Computer

Tablet Computer has features of the notebook computer but it can accept input from a stylus or a pen instead of the keyboard or mouse. It is a portable computer. Tablet computer are the new kind of PCs.

Handheld Computer or Personal Digital Assistant (PDA)

Handheld Computer or Personal Digital Assistant (PDA) is a small computer that can be held on the top of the palm. It is small in size. Instead of the keyboard, PDA uses a pen or a stylus for input. PDAs do not have a disk drive. They have a limited memory and are less powerful. PDAs can be connected to the Internet via a wireless connection. Casio and Apple are some of the manufacturers of PDA. Over the last few years, PDAs have merged into mobile phones to create smart phones.

Smart Phones

Smart Phones are cellular phones that function both as a phone and as a small PC. They may use a stylus or a pen, or may have a small keyboard. They can be connected to the Internet wirelessly. They are used to access the electronic-mail, download music, play games, etc. Blackberry, Apple, HTC, Nokia and LG are some of the manufacturers of smart phones.

Mini Computers

Minicomputers are digital computers, generally used in multi-user systems. They have high processing speed and high storage capacity than the microcomputers. It is a class of small computers that was introduced into the world in the mid-1960s. A midsized computer, in size and power, minicomputers lie between workstations and mainframes. In the past decade, the distinction between large minicomputers and small mainframes has blurred, however, as has the distinction between small minicomputers and workstations. But in general, a minicomputer is a multiprocessing system.

A minicomputer is a midsize, multi-processing system. Minicomputers are capable of supporting up to 4 - 200 users at the same time. The users can access the minicomputer through their PCs or terminal. They are used for real-time applications in industries, research centers, etc. PDP 11, IBM (8000 series) are some of the widely used minicomputers. Usually, these devices have two or more processors.

It is common for minicomputers to be employed in institutes and departments related to accounting, inventory management, and billing. Some experts also believe that minicomputers lie somewhere between a microcomputer and a mainframe because minicomputers are smaller than a mainframe but more extensive than a microcomputer. Minicomputers are lighter in weight. These devices can easily fit anywhere and are portable. These devices are less expensive and very fast compared to their size. Minicomputers tend to remain charged for long intervals and can function in an environment without controlled operations.

You might also want to learn that minicomputers are primarily used to perform three functions. These three functions are mentioned below.

- **Processing Control**

Minicomputers are mainly used to possess control in manufacturing. These devices performed the functions of collecting data and feedback. In case of any abnormalities during the process, the minicomputer detects the abnormality and makes the necessary adjustment to fix the situation.

- **Managing Data**

Small organizations use minicomputers to collect, store, and share data. For example, local hotels and hospitals use minicomputers to record their customers and patients, respectively.

- **Communications Portal**

Minicomputers also can play the role of a communication device in larger organizations. A minicomputer achieves this aim by serving as a portal between the central processor or computer and the human operator.



Minicomputer

Advantages of minicomputer

- » They are easy to use
- » They can fit anywhere
- » They are small and very portable
- » They are easy to carry
- » As compared to their size, they are fast
- » They hold a charge for a long time
- » They did not require a carefully controlled operational environment
- » They are more reliable

Disadvantages of minicomputer

- » Some minicomputers don't have USB ports
- » Minicomputers do not have any CD/DVD drive
- » The user may not be familiar with the operating system

- » The keyboard can be small for fast typists
- » In this, generally, there is not much storage on board
- » It can be too small to do certain projects

Mainframe Computers

Mainframe computers are multi-user, multi-programming and high performance computers. They operate at a very high speed, have very large storage capacity and can handle the workload of many users. Mainframe computers are large and powerful systems generally used in centralized databases. The user accesses the mainframe computer via a terminal that may be a dumb terminal, an intelligent terminal or a PC. A dumb terminal cannot store data or do processing of its own. It has the input and output device only. An intelligent terminal has the input and output device, can do processing, but, cannot store data of its own. The dumb and the intelligent terminal use the processing power and the storage facility of the mainframe computer. Mainframe computers are used in organizations like banks or companies, where many people require frequent access to the same data. Some examples of mainframes are CDC 6600 and IBM ES000 series.

A mainframe can be described as a costly and extensive computer system. A mainframe is usually capable of supporting hundreds and thousands of users at the same time. These devices concurrently execute various programs and support multiple simultaneous executions of programs.

Due to these above-mentioned features, mainframe computers are usually used in large organizations that need to process and manage high volumes of data - For example, telecom and banking sector industries.

Mainframe computers usually have a very long life. A mainframe device can run smoothly for up to 50 years after its installation. It can also provide excellent performance with large-scale memory management.

Mainframe computers also can distribute or share their workload among other processors or input and output terminals. When it comes to errors, then there are fewer chances of errors in these devices.

However, if any error occurs, then it is quickly fixed by the system. These devices protect the stored data and any ongoing exchange of data or information. From this extensive description, it must be quite evident that mainframe computers have a lot of applications. We have created a list of some of those applications, and that list is given below.

- In the field of defense, mainframe computers allow defense departments to share a large amount of sensitive information with other branches of defense.
- In the retail sector, large retail organizations often have a vast customer base. This is why departments use mainframe computers to execute and handle information related to their customer management, inventory management, and huge transactions within a short period.

- In health care, mainframe computers help hospitals by maintaining an extensive record of millions of patients. This feature goes a long way in assisting hospitals in contacting their patients for treatment or any other appointment related to medicine or disease updates.
- In the field of education, mainframe devices allow large educational institutes to store, manage, and retrieve data related to admissions, courses, teachers, students, affiliated schools, affiliated colleges, and employees.



Mainframe Computers

Advantages of mainframe computer

- » High response time
- » Increased processing power
- » This type of computer can be divided into different logical partitions i.e. virtual machines
- » Reliability, availability, and serviceability (RAS)
- » These systems have an extra level of security for protecting organization data
- » High-end scalability
- » Continuing compatibility
- » Long lasting performance

Disadvantages of mainframe computer

- » High skilled people are required to manage these systems
- » Such computers have not good user interface (Not good GUI)
- » The cost of this system is significantly high.
- » As these computers are large in size as compared to PC they require more space.
- » Due to high performance, such computers need to be placed in a cool place where they do not heat up quickly.

Super Computers

The goal of fifth generation computing is to develop computers that are capable of learning and self-organization. The fifth generation computers use Super Large Scale Integrated (SLSI) chips that are able to store millions of components on a single chip. These computers have large memory requirements.

This generation of computers uses parallel processing that allows several instructions to be executed in parallel, instead of serial execution. Parallel processing results in faster processing speed. The Intel dual-core microprocessor uses parallel processing.



Symbolic Image of Artificial Intelligence

The fifth generation computers are based on Artificial Intelligence (AI). They try to simulate the human way of thinking and reasoning. Artificial Intelligence includes areas like Expert System (ES), Natural Language Processing (NLP), speech recognition, voice recognition, robotics, etc.



Fifth Generation Computer

Advantages of Fifth Generation of Computer

- » Very large storage capacity.
- » Long bit processor builds.
- » Artificial Intelligence Language developed.
- » Advancement in Parallel Processing.
- » Advancement in Superconductor technology.

» These computers are much smaller in size than other generation computers

Disadvantages of Fifth Generation of Computer

- » They can give more power to companies to watch what you are doing and even allow them to infect your computer.
- » They tend to be sophisticated and complex tools.

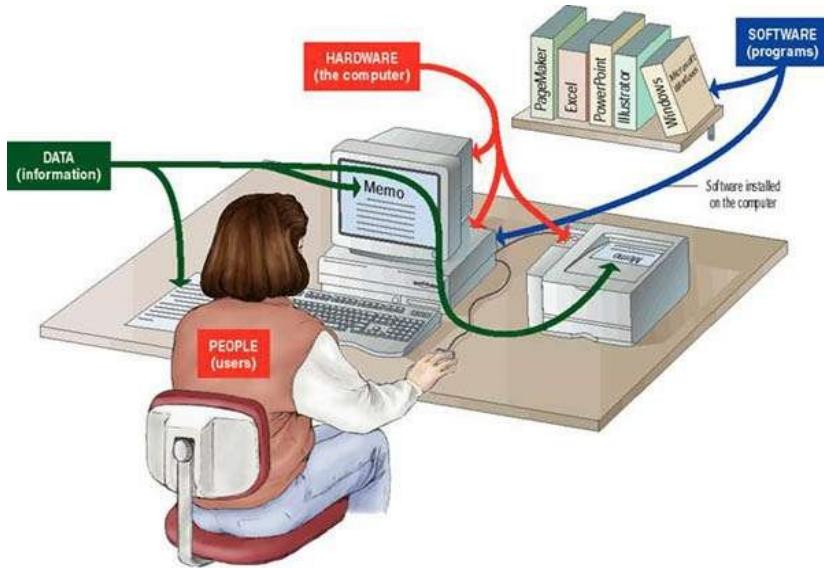
COMPUTER SYSTEM

Computer is an advanced electronic device that takes raw data as input from the user and processes these data under the control of set of instructions (called program) and gives the result (output) and saves output for the future use. It can process both numerical and non-numerical (arithmetic and logical) calculations with speed and accuracy.

Computer is derived from a Latin word "computare" which means to "to calculate", "to count", "to sum up" or "to think together". So, more precisely the word computer means a "device that performs computation".

Charles Babbage is called the "Grand Father" of the computer. The First mechanical computer designed by Charles Babbage was called Analytical Engine. It uses read-only memory in the form of punch cards.

The computer system consists of four parts:



HARDWARE

The Hardware consists of the mechanical parts that make up the computer as a machine. The hardware consists of physical devices of the computer. The devices are required for input, output, storage and processing of the data. Keyboard, monitor, hard disk drive, floppy disk drive, printer, processor and motherboard are some of the hardware devices.

SOFTWARE

Software is a set of instructions that tells the computer about the tasks to be performed and how these tasks are to be performed. Program is a set of instructions, written in a language understood by the computer, to perform a specific task. A set of programs and documents are collectively called software. The hardware of the computer system cannot perform any task on its own. The hardware needs to be instructed about the task to be performed. Software instructs the computer about the task to be performed. The hardware carries out these tasks. Different software can be loaded on the same hardware to perform different kinds of tasks.

DATA

Data are isolated values or raw facts, which by themselves have no much significance. For example, the data like 29, January, and 2023 just represent values. The data is provided as input to the computer, which is processed to generate some meaningful information. For example, 29, January and 2023 are processed by the computer to give the date of birth of a person.

USERS

Users are people who write computer programs or interact with the computer. They are also known as skinware, liveware, humanware or peopleware. Programmers, data entry operators, system analyst and computer hardware engineers fall into this category.

THE INPUT-PROCESS-OUTPUT CONCEPT

Conventional and assistive computer technologies *are similar* in that both employ the core concepts of *input*, *information processing*, and *output* (ATA, 2000). Understanding these concepts is essential to understanding how AT helps individuals with disabilities access a computer. Each system first must have a means to input information. This information is then processed. From the processed information, the computer produces some type of output. Input or output devices can be modified to provide access to individuals with disabilities who cannot use standard input or output devices. To provide a better understanding of input, output, and processing, these concepts are defined as follows.

Input - the information entered into a computer system, examples include: typed text, mouse clicks, etc.

Processing - the process of transforming input information into and output.

Output – the visual, auditory, or tactile perceptions provided by the computer after processing the provided information. Examples include: text, images, sound, or video displayed on a monitor or through speaker as well as text or Braille from printers or embossers.

Input Device – any device that enters information into a computer from a external source. Examples include: keyboards, touch screens, mouse, trackballs, microphones, scanners, etc.

Processing Device – the electronics that process or transform information provided as an input to a computer to an output. Examples include: the Central Processing Unit (CPU), operating systems (e.g. Windows, Apple software), microprocessors (e.g. Intel, Pentium), memory cards (RAM), graphic and other production application or programs (Adobe, Microsoft Word, etc.).

Output Device - a device used by a computer to communicate information in a usable form. Examples include: monitors, speakers, and printers, etc.

The following is an example showing how these three concepts work together:

To access a website, the user opens an internet browser and, using the keyboard, enters a web address into the browser (*input*). The computer then uses that information to find the correct website (*information processing*) and the content of the desired site is displayed in the web browser (*output*).

AT for computer access can be applied by adapting either the input or output component of a computer system. Doing this provides an individual with a disability with a tool that utilizes his or her abilities to access a computer. An example of adapting an input device is providing an individual who does not have use of his or her hands with speech recognition software to enter text into a computer as opposed to a keyboard. As for adapting an output device, an individual with a visual impairment can use either a screen magnifier or screen reader to access output on a computer screen. Information processing, in terms of a computer, does not involve a human element and thus does not require assistive technology adaptations.

DATA AND INFORMATION

What is data?

Data refers to the raw information. In the context of information technology (IT) and computing, it is information that a software application collects and records. Data is typically stored in a database and includes the fields, records and other information that make up the database. It can be accessed and manipulated digitally, and it is quick and easy to transfer among computers.

Data is collected from a variety of sources, such as computers, sensors and devices. It is typically used in business, science and engineering. Data is often presented in the form of numbers, but it can also come as text, visuals, graphics and sounds. Data can also be analyzed and used to create information that could not be obtained by just looking at the original data.

The most common types of data in data science are the following:

- **Quantitative data** is numerical data, or data that can be expressed mathematically. Discrete and continuous data are types of quantitative data.
- **Qualitative data** is data that cannot be measured, counted or easily expressed with numbers. It is data that comes from text, audio or images. It can be shared using data visualization tools, such as timelines, infographics and word clouds.

- **Nominal data** is the simplest form of data in statistics. It is data that is used to name or label a variable; it isn't used to measure things or put them in any order. Examples of nominal data include ethnicity, gender, eye color.
- **Ordinal data** is data that takes on values within a known range and follows a natural order. A common example of ordinal data is income levels where incomes are ranked in specific ranges, such as \$0-\$50K, \$50K-\$75K, \$75K-\$100K, etc. The purpose of ordinal data is to rank items in order of priority or value. The numbers are not used for calculations.
- **Discrete data**, also called categorical data, is data that is divided into discrete categories, or groups, that are distinctly different from each other. With discrete data, only a specific number of values are possible, and those values cannot be subdivided. For example, the number of people a company employs is a discrete data point.
- **Continuous data** is a term used to describe data that is measurable and observable in real time. It can be measured on a scale or a continuum and subdivided into finer values. Continuous data is often recorded at set intervals and then analyzed using statistical software. The amount of time it takes to complete a task is an example of continuous data.

What is the data processing cycle?

The data processing cycle is the framework that data center managers use to make data accessible and useful to users. It is a portion of the data lifecycle. Data enters the data center where it is processed, and then it is sent to the user who makes use of it in a business application.

The part of the data lifecycle referred to as the data processing cycle is divided into the following three stages:

1. This is the stage where data is collected from multiple sources -- point-of-sale locations, call centers and sensors, for example.
2. The data is sorted, organized, cleansed and entered into a database or system. It is then transformed into a format that users can understand and make use of.
3. The newly processed and transformed data is sent to users or stored in a way that they will have access to it when needed.

Converting data to information

Data and information are not the same. Data refers to numerical and qualitative observations. Information is created when data is presented in a way that has meaning to the recipient. To turn data into information, it must be processed and organized. Presenting data in a way that has meaning and value is called information design, and it is an important field in both Information architecture and human-computer interaction.

Five characteristics of data quality and high-quality information in a database include the following:

- Information must come from a reliable source of information.
- Information cannot be partial or have details missing.

- Mechanisms must be in place to ensure that new data doesn't contradict existing data.
- Information must be distinctive and add value to a database.
- Information in a database must be timely and up to date.

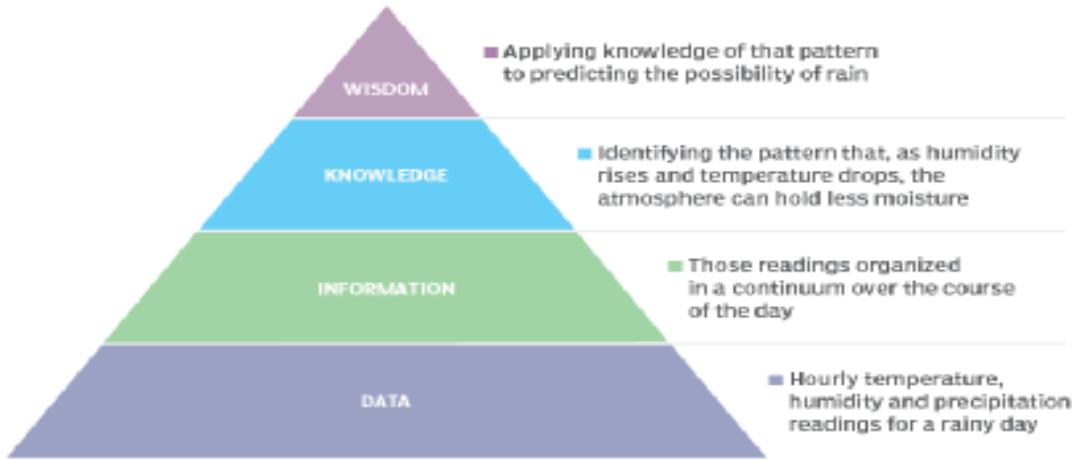
What is information?

Information is stimuli that has meaning in some context for its receiver. When information is entered into and stored in a computer, it is generally referred to as data. After processing -- such as formatting and printing -- output data can again be perceived as information. When information is compiled or used to better understand something or to do something, it becomes knowledge.

The data-information-knowledge-wisdom model illustrates this hierarchy. Structured as a pyramid, the model was created to show that data can be captured in different formats, analyzed and converted into different forms. Each level of the pyramid represents a different perspective or level of abstraction as follows:

- The discrete, raw facts about a given situation with no analysis or interpretation applied.
- Applying description and meaning to data to make it useful.
- Information that has insight, context and a frame of reference applied so it can be interpreted.
- Knowledge is converted into wisdom by applying judgment and action to the information.

An example of data-information-knowledge-wisdom



See how a real-world example of the data-information-knowledge-wisdom pyramid works.

What is data?

Data refers to the raw information. In the context of information technology (IT) and computing, it is information that a software application collects and records. Data is typically stored in a database and includes the fields, records and other information that make up the database. It can be accessed and manipulated digitally, and it is quick and easy to transfer among computers.

Data is collected from a variety of sources, such as computers, sensors and devices. It is typically used in business, science and engineering. Data is often presented in the form of numbers, but it can also come as text, visuals, graphics and sounds. Data can also be analyzed and used to create information that could not be obtained by just looking at the original data.

The most common types of data in data science are the following:

- **Quantitative data** is numerical data, or data that can be expressed mathematically. Discrete and continuous data are types of quantitative data.
- **Qualitative data** is data that cannot be measured, counted or easily expressed with numbers. It is data that comes from text, audio or images. It can be shared using data visualization tools, such as timelines, infographics and word clouds.
- **Nominal data** is the simplest form of data in statistics. It is data that is used to name or label a variable; it isn't used to measure things or put them in any order. Examples of nominal data include ethnicity, gender, eye color.
- **Ordinal data** is data that takes on values within a known range and follows a natural order. A common example of ordinal data is income levels where incomes are ranked in specific ranges, such as \$0-\$50K, \$50K-\$75K, \$75K-\$100K, etc. The purpose of ordinal data is to rank items in order of priority or value. The numbers are not used for calculations.
- **Discrete data**, also called categorical data, is data that is divided into discrete categories, or groups, that are distinctly different from each other. With discrete data, only a specific number of values are possible, and those values cannot be subdivided. For example, the number of people a company employs is a discrete data point.
- **Continuous data** is a term used to describe data that is measurable and observable in real time. It can be measured on a scale or a continuum and subdivided into finer values. Continuous data is often recorded at set intervals and then analyzed using statistical software. The amount of time it takes to complete a task is an example of continuous data.

What is the data processing cycle?

The data processing cycle is the framework that data center managers use to make data accessible and useful to users. It is a portion of the data lifecycle. Data enters the data center where it is processed, and then it is sent to the user who makes use of it in a business application.

The part of the data lifecycle referred to as the data processing cycle is divided into the following three stages:

1. This is the stage where data is collected from multiple sources -- point-of-sale locations, call centers and sensors, for example.
2. The data is sorted, organized, cleansed and entered into a database or system. It is then transformed into a format that users can understand and make use of.

3. The newly processed and transformed data is sent to users or stored in a way that they will have access to it when needed.



Get to know the six steps of the data lifecycle.

Converting data to information

Data and information are not the same. Data refers to numerical and qualitative observations. Information is created when data is presented in a way that has meaning to the recipient. To turn data into information, it must be processed and organized. Presenting data in a way that has meaning and value is called information design, and it is an important field in both Information architecture and human-computer interaction.

Five characteristics of data quality and high-quality information in a database include the following:

- Information must come from a reliable source of information.
- Information cannot be partial or have details missing.
- Mechanisms must be in place to ensure that new data doesn't contradict existing data.
- Information must be distinctive and add value to a database.
- Information in a database must be timely and up to date.

Converting information to knowledge and wisdom

Knowledge is information that has been processed, analyzed and interpreted, and can be used to make decisions. The concept of knowledge involves not just the information, but the ability to access it, as well. For example, most applications, including models and simulations, include a form of stored knowledge.

Wisdom is the synthesis of information, knowledge and experience in a way that applies knowledge to real-life situations. The concept of wisdom enables the understanding of patterns and their driving factors. It ultimately enables the prediction of future events.

Artificial intelligence (AI) has enabled computers to learn, problem-solve and perform tasks that usually require human intelligence. These technologies enable computers to take actions based on what the data provided indicates is the best course of action. AI is used in expert systems to diagnose disease, buy and sell stock and play chess better than a human. However, IT has not yet attained a level of human wisdom.

Learn how AI technology is evolving to combine symbolic reasoning and deep learning to capitalize on the power of neural networks.

HOW COMPUTER KNOWS WHAT TO DO

- It must be given a detailed list of instructions, called a **computer program** or **software** that tells it exactly what to do.
- Before processing a specific job, the computer program corresponding to that job must be stored in memory.
- Once the program is stored in memory the computer can start the operation by executing the program instructions one after the other.

AREAS OF APPLICATION OF COMPUTER

It is a binding fact that computers are very productive, efficient and make our personal and professional lives more rewarding. These 'magical' machines can do just about anything imaginable, moreover they really excel in certain areas. Below is the list of some of the principal applications of the computer systems:

Businesses

Businessmen make bar graphs and pie charts from tedious figures to convey information with far more impact than numbers alone can convey. Furthermore, computers help businesses to predict their future sales, profits, costs etc. making companies more accurate in their accounts. Computers may also play a vital role in aiding thousands of organizations to make judgmental and hard-provoking decisions concerning financial problems and prospective trends.

Buildings

Architects use computer animated graphics to experiment with possible exteriors and to give clients a visual walk-through of their proposed buildings. The computers provide architects a numerous amount of facilities to create different buildings with greater accuracy, better designing and editing tools, and work done at the fastest speed possible. Finally, a new kind of artist has emerged, one who uses computers to express his or her creativity.

Education

Most good schools in the world have computers available for use in the classroom. It has been proved that learning with computers has been more successful and this is why numerous forms of new teaching methods have been

introduced. This enhances the knowledge of the student at a much faster pace than the old traditional methods. Likewise, colleges and various universities have extended the use of computers as many educators prefer the 'learning by doing' method - an approach uniquely suited to the computer.

Energy

Energy companies use computers to locate oil, coal, natural gas and uranium. With the use of these technological machines, these companies can figure out the site of a natural resource, its concentration and other related figures. Electric companies use computers to monitor vast power networks. In addition, meter readers use hand held computers to record how much energy is used each month in homes and offices.

Law Enforcement

Recent innovation in computerized law enforcement include national fingerprint files, a national file on the mode of operation of serial killers, and computer modeling of DNA, which can be used to match traces from an alleged criminal's body, such as blood at a crime scene. In addition, computers also contain a complete databases of all the names, pictures and information of such people who choose to break the law.

Transportation

Computers are used in cars to monitor fluid levels, temperatures and electrical systems. Computers are also used to help run rapid transit systems, load containerships and track railroads cars across the country. An important part is the air control traffic systems, where computers are used to control the flow of traffic between airplanes which needs a lot of precision and accuracy to be dealt with.

Money

Computers speed up record keeping and allow banks to offer same-day services and even do-it yourself banking over the phone and internet. Computers have helped fuel the cashless economy, enabling the widespread use of credit cards, debit cards and instantaneous credit checks by banks and retailers. There is also a level of greater security when computers are involved in money transactions as there is a better chance of detecting forged bank cheque and using credit/debit cards illegally etc.

Agriculture

Farmers use small computers to help with billing, crop information, and cost per acre, feed combinations, and market price checks. Cattle ranchers can also use computers for information about livestock breeding and performance.

Government

Among other tasks, the federal government uses computers to forecast the weather, to manage parks and historical sites, to process immigrants, to produce social security checks and to collect taxes. The most important use of the computer system in this field is perhaps the Army, the Air Force and the Navy. The computers have to be very powerful and in order to be run they have to be very accurate and precise. E.g. in the use of missiles and other likes, every nanosecond counts, which may save trillions of lives on this planet. The government also uses computers in various simulations like the spread of influenza in a particular locality.

The Home

People having a computer in the home justifies the fact that it is not only useful and efficient, but it is also revered as a learning system. Personal computers are being used for innumerable tasks nowadays, for example, to keep records, write letters and memos, prepare budgets, produce presentations, draw pictures, publish newsletters and most importantly - connect with other in the rest of plant earth.

Health and Medicine

Computers are helping immensely to monitor thee extremely ill in the intensive care unit and provide cross-sectional views of the body. This eliminates the need for hired nurses to watch the patient twenty-four hours a day, which is greatly tiring and error prone. Doctors use computers to assist them in diagnosing certain diseases of the sort. This type of computer is called the Expert System, which is basically a collection of accumulated expertise in a specific area of field. Computers are now able to map, in exquisite detail, the structure of the human cold virus - the first step towards the common cold. Furthermore, computers are used greatly in managing patients, doctors, wards and medicine records, as well as deal with making appointments, scheduling surgeries and other likes.

Manufacturing Industries

Computers have made their way towards jobs that were unpleasant or too dangerous for humans to do, such as working hundreds of feet below the earth or opening a package that might contain an explosive device. In other industries, computers are used to control the production of resources very precisely. All robots and machinery are now controlled by various computers, making the production process faster and cheaper. All the stages of manufacturing, from designing to production, can be done with the use of computer technology with greater diversity.

The Human connection

The computers have evolved in such prosperity that it is now able to assist or aid with humans who are disabled - both physically and mentally. The handicapped are now able to express their missing sense with the aid of computer technology. For example, a deaf and dumb person is able to communicate extensively with other people by using a specially designed computer system. This gives the disabled a chance to live out life and gradually catch up with the other fortunate people living on earth.

Scientific Research

This is very important for mankind and with the development of computers; scientific research has propelled towards the better a great deal. Because of high-speed characteristics of computer systems, systems, researchers can simulate environments, emulate physical characteristics and allow scientists to proof of their theories in a cost-effective manner. Also many test lab animals are spared since computers have taken over their roles in extensive research.

Communication with the World

The computers are most popular for their uses to connect with others on the World Wide Web. Therefore, communication between two or more parties is possible which is relatively cheap considering the old fashioned methods. Emailing, teleconferencing and the use of voice messages are very fast, effective and surprisingly cheaper as well. When connected to the Internet, people can gain various amounts of knowledge, and know about world events as they occur. Purchasing on the Internet is also becoming very popular, and has numerous advantages over the traditional shopping methods.

Training

It is much cheaper and effective to teach pilots how to fly in a computerized cockpit or simulators, than is real airplanes. This is because the learning pilots will feel much more relaxed and confident due to the fact that no life is at risk at that moment. Railway engineers can also be given some kind of training on how to run a train with the help of a computerized system. Training simulations are relatively cheaper and are always available on one-to-one basis making way for personal training.

Paperwork

Computer systems will increasingly cut down the paperwork that is involved in millions of industries around the world. If a business is run on a manual system, then the amount of papers or registers involved is a great deal, making the administration process more tedious and error prone. If it is replaced by a computer system, then all the necessary data and information is transferred into the memory of the computer. This makes managing various tasks easier, faster and more effective than the manual system. Organizations that involve administrative tasks such as a hotel, school, hospitals, clubs, libraries etc. will become more efficient if a computer system is implemented.

Real Time systems

Many computers provide an environment, which is completely based on real time. This means processing of one entity is done so quickly and effectively, that another entity is not effected. For example Airline systems and Banking systems will come under this category. These systems are immensely huge because they interact with all other airlines or banking systems in the world. A computer system, therefore, becomes more than just necessary in daily uses.

There are so many applications of computers, that it is impractical to mention all of them. This is the Computer Age and these machines are beginning to affect our lives in many ways. Computers are now becoming faster, more reliable, effective and whole lot cheaper than they had been ever before.

THE COMPUTER SYSTEM

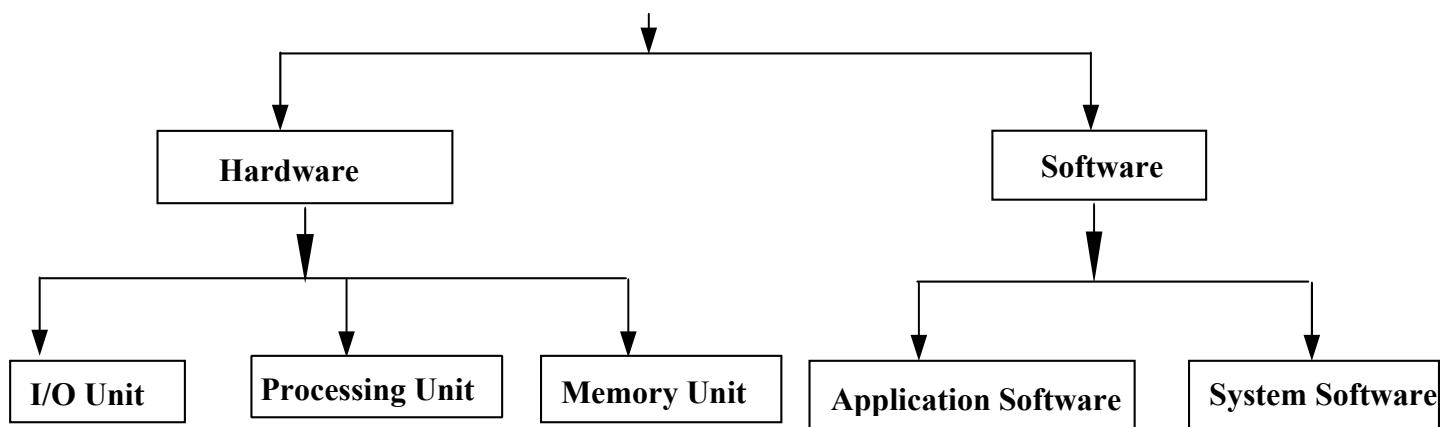
Definition

Computer system means the composition of computer. Computer system components are classified as hardware and software. The physical equipment that goes together to make up a computer is usually referred to as hardware.

Hardware: is the part that you can touch or the physical make up of the computer.

Software: is the set of instruction called a program that directs the computer.

Computer System



It is a collection of entities (hardware, software and liveware) that are designed to receive, process, manage and present information in a meaningful format.

A computer system is a set of integrated devices that input, output, process, and store data and information.

Computer systems are currently built around at least one digital processing device.

Computer Hardware

Computer hardware is a collection of separate items working together as team. Some of these components are essential: others simply make working more pleasant and efficient. Adding extra item expands the variety of tasks you accomplish with your machine. Your hardware computer system is classified in to two parts:

Main or basic components: parts of the hardware that must be present so that the computer performs its basic operator.

Hardware refers to the physical, tangible computer equipment and devices, which provide support for major functions such as input, processing (internal storage, computation and control), output, secondary storage (for data and programs), and communication.

Input / Output device

An input/output (I/O) device is a hardware device that has the ability to accept inputted, outputted or other processed data. It also can acquire respective media data as input sent to a computer or send computer data to storage media as storage output.

Input devices provide input to a computer, while output devices provide a way for a computer to output data for communication with users or other computers. An I/O device is a device with both functionalities.

Because I/O device data is bi-directional, such devices are usually categorized under storage or communications. Examples of I/O storage devices are CD/DVD-ROM drives, USB flash drives and hard disk drives. Examples of communication I/O devices are network adapters, Bluetooth adapters/dongles and modems.

The input devices

All computer peripheral devices which use to input data and instructions to the computer are called Input Devices. An Input devices accept data and instructions from the user and convert information or data in to a form which can be understood by the computer.

A good input device should provide accurate, timely and useful data to the main memory of the computer for processing.

Following are few of the important input devices which are used in a computer:

Keyboard, Mouse, Light Pen, Trackball, Joystick, Scanners, Optical Mark Reader, Optical Character Reader, Barcode Reader, Magnetic Ink Character Recognition, Voice Recognition Systems and Digital Cameras

The output devices

An output device is an electromechanical device that receives information from the CPU and presents it to the user in the desired form. The processed data, stored in the memory of the computer is sent to the output unit, which then converts it into a form that can be understood by the user.

Output Device can be broadly classified into following categories:

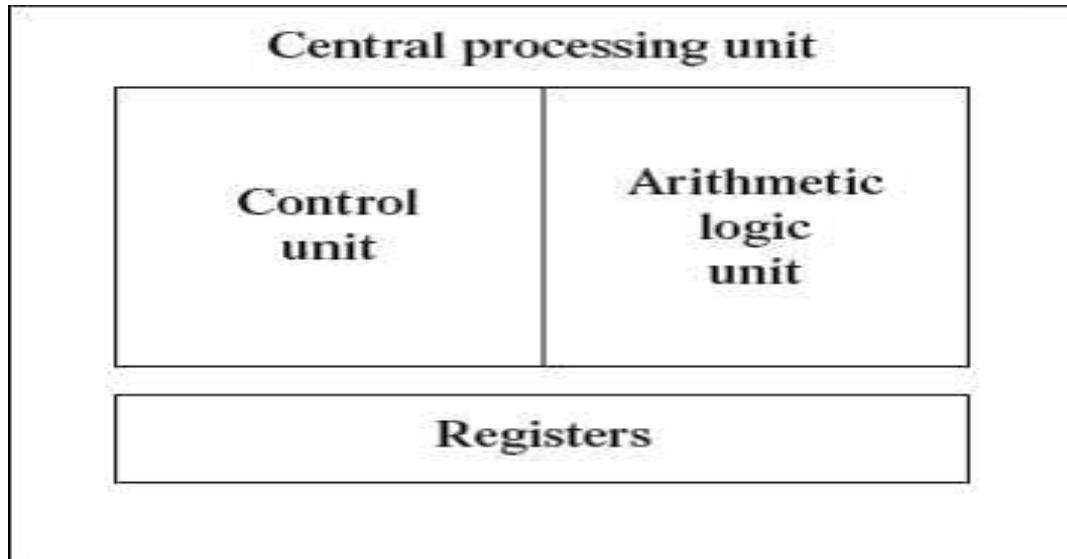
- Hard Copy Devices
 - » Printer
 - » Plotter
 - » Computer Output on Microfilm (microfiche)
- Soft Copy Devices
 - » Monitor
 - » Visual Display Terminal
 - » Video Output
 - » Audio Response

CPU (Processing Unit)

Central Processing Unit (CPU) or the processor is also often called the brain of computer. CPU consists of Arithmetic Logic Unit (ALU) and Control Unit (CU). In addition, CPU also has a set of registers which are temporary storage areas for holding data, and instructions. ALU performs the arithmetic and logic operations on the data that is made available to it. CU is responsible for organizing the processing of data and instructions. CU controls and coordinates the activity of the other units of computer. CPU uses the registers to store the data, instructions during processing.

CPU executes the stored program instructions, i.e. instructions and data are stored in memory before execution. For processing, CPU gets data and instructions from the memory. It interprets the program instructions and performs the arithmetic and logic operations required for the processing of data. Then, it sends the processed data or result to the memory. CPU also acts as an administrator and is responsible for supervising operations of other parts of the computer.

The CPU is fabricated as a single Integrated Circuit (IC) chip, and is also known as the microprocessor. The microprocessor is plugged into the motherboard of the computer (Motherboard is a circuit board that has electronic circuit etched on it and connects the microprocessor with the other hardware components).



Central Processing Unit

Arithmetic Logic Unit

- » ALU consists of two units — arithmetic unit and logic unit.
- » The arithmetic unit performs arithmetic operations on the data that is made available to it. Some of the arithmetic operations supported by the arithmetic unit are—addition, subtraction, multiplication and division.
- » The logic unit of ALU is responsible for performing logic operations. Logic unit performs comparisons of numbers, letters and special characters. Logic operations include testing for greater than, less than or equal to condition.
- » ALU performs arithmetic and logic operations, and uses registers to hold the data that is being processed.

Control Unit

- » The control unit of a computer does not do any actual processing of data. It organizes the processing of data and instructions. It acts as a supervisor and, controls and coordinates the activity of the other units of computer.
- » CU coordinates the input and output devices of a computer. It directs the computer to carry out stored program instructions by communicating with the ALU and the registers. CU uses the instructions in the Instruction Register (IR) to decide which circuit needs to be activated. It also instructs the ALU to perform the arithmetic or logic

operations. When a program is run, the Program Counter (PC) register keeps track of the program instruction to be executed next.

» CU tells when to fetch the data and instructions, what to do, where to store the results, the sequencing of events during processing etc.

» CU also holds the CPU's Instruction Set, which is a list of all operations that the CPU can perform.

The function of a (CU) can be considered synonymous with that of a conductor of an orchestra. The conductor in an orchestra does not perform any work by itself but manages the orchestra and ensures that the members of orchestra work in proper coordination.

CPU Registers

» Registers are high-speed storage areas within the CPU, but have the least storage capacity. Registers are not referenced by their address, but are directly accessed and manipulated by the CPU during instruction execution.

» Registers store data, instructions, addresses and intermediate results of processing. Registers are often referred to as the CPU's working memory.

» The data and instructions that require processing must be brought in the registers of CPU before they can be processed. For example, if two numbers are to be added, both numbers are brought in the registers, added and the result is also placed in a register.

» Registers are used for different purposes, with each register serving a specific purpose.

Some of the important registers in CPU are as follows —

- Accumulator (ACC) stores the result of arithmetic and logic operations.
- Instruction Register (IR) contains the current instruction most recently fetched.
- Program Counter (PC) contains the address of next instruction to be processed.
- Memory Address Register (MAR) contains the address of next location in the memory to be accessed.
- Memory Buffer Register (MBR) temporarily stores data from memory or the data to be sent to memory.
- Data Register (DR) stores the operands and any other data.

Memory Unit

The computer's memory stores data, instructions required during the processing of data, and output results. Storage may be required for a limited period of time, instantly, or, for an extended period of time. Different types of memories, each having its own unique features, are available for use in a computer. The cache memory, registers, and RAM are fast memories and store the data and instructions temporarily during the processing of data and instructions. The secondary memory like magnetic disks and optical disks have large storage capacities and store the data and instructions permanently, but are slow memory devices. The memories are organized in the computer in a manner to achieve high levels of performance at the minimum cost.

Following are generally Computer Memory:

1. Primary Memory/Main Memory
2. Secondary Memory
3. CPU Registers
4. Cache Memory

PRIMARY MEMORY

Primary storage, also known as main storage or memory, is the main area in a computer in which data is stored for quick access by the computer's processor. It is a chip mounted on the motherboard of computer.

Primary memory is categorized into two main types-

- Random Access Memory (RAM)
- Read Only Memory (ROM)

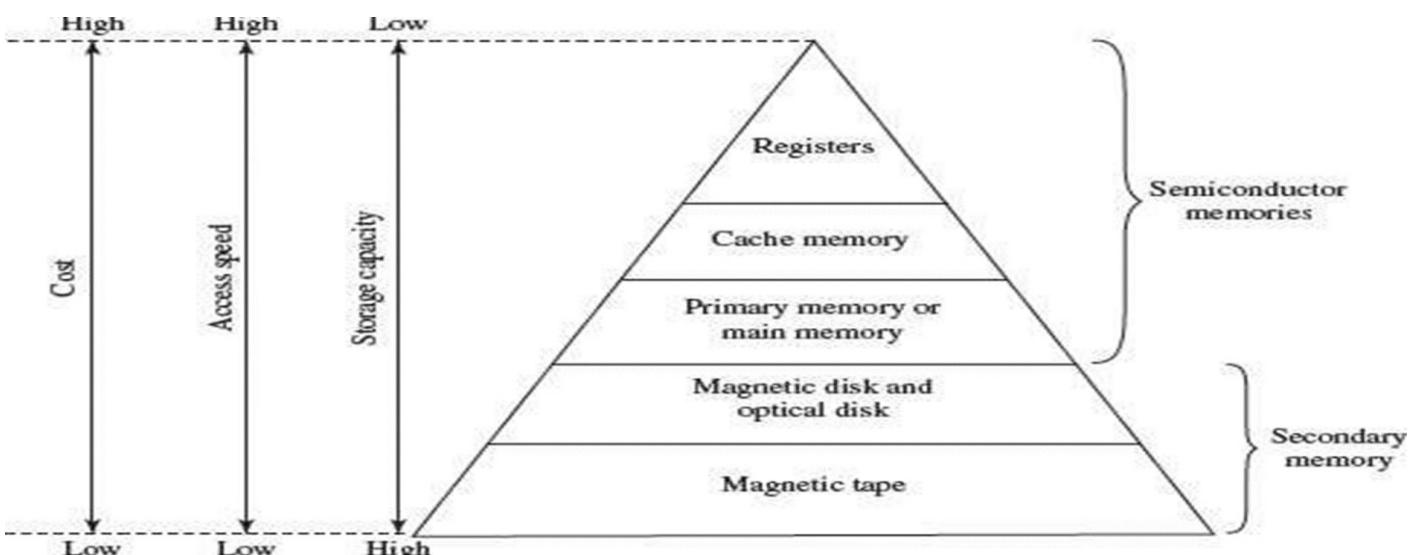
SECONDARY MEMORY

The secondary memory is also called the storage device of computer. Secondary storage devices, as indicated by the name, save data after it has been saved by the primary storage device. Secondary storage is non-volatile and has lower cost per bit stored but it generally has an operating speed far slower than that of primary storage. It is used primarily to store large volume of data on permanent basis that can be partially transferred to primary storage, whenever required for processing.

General Secondary Memories are:

- Hard Disk
- Floppy Disk
- Zip Disk
- Optical Disk
- Magnetic Disk

Memory Hierarchy



DATA REPRESENTATION

Data refers to the symbols that represent people, events, things, and ideas. Data can be a name, a number, the colors in a photograph, or the notes in a musical composition.

Data Representation refers to the form in which data is stored, processed, and transmitted. • Devices such as smartphones, iPods, and computers store data in digital formats that can be handled by electronic circuitry

Digitization is the process of converting information, such as text, numbers, photo, or music, into digital data that can be manipulated by electronic devices.

The Digital Revolution has evolved through four phases, beginning with big, expensive, standalone computers, and progressing to today's digital world in which small, inexpensive digital devices are everywhere.

The 0s and 1s used to represent digital data are referred to as binary digits — from this term we get the word bit that stands for binary digit.

A bit is a 0 or 1 used in the digital representation of data.

A digital file, usually referred to simply as a file, is a named collection of data that exists on a storage medium, such as a hard disk, CD, DVD, or flash drive.

NUMBER SYSTEM

The number system or the numeral system is the system of naming or representing numbers. We know that a number is a mathematical value that helps to count or measure objects and it helps in performing various mathematical calculations. There are different types of number systems in Maths like decimal number system, binary number system, octal number system, and hexadecimal number system. In this article, we are going to learn what is a number system in Maths, different types, and conversion procedures with many number system examples in detail. Also, check [mathematics for grade 12](#) here.

What is Number System in Maths?

A number system is defined as a system of writing to express numbers. It is the mathematical notation for representing numbers of a given set by using digits or other symbols in a consistent manner. It provides a unique representation of every number and represents the arithmetic and algebraic structure of the figures. It also allows us to operate arithmetic operations like addition, subtraction, multiplication and division.

The value of any digit in a number can be determined by:

- The digit
- Its position in the number
- The base of the number system

Before discussing the different types of number system examples, first, let us discuss what is a number?

What is a Number?

A number is a mathematical value used for counting or measuring or labelling objects. Numbers are used to performing arithmetic calculations. Examples of numbers are natural numbers, whole numbers, rational and irrational numbers, etc. 0 is also a number that represents a null value.

A number has many other variations such as even and odd numbers, prime and composite numbers. Even and odd terms are used when a number is divisible by 2 or not, whereas prime and composite differentiate between the numbers that have only two factors and more than two factors, respectively.

In a number system, these numbers are used as digits. 0 and 1 are the most common digits in the number system, that are used to represent binary numbers. On the other hand, 0 to 9 digits are also used for other number systems. Let us learn here the types of number systems.

Types of Number Systems

There are various types of number systems in mathematics. The four most common number system types are:

1. Decimal number system (Base- 10)
2. Binary number system (Base- 2)
3. Octal number system (Base-8)
4. Hexadecimal number system (Base- 16)

Now, let us discuss the different types of number systems with examples.

Decimal Number System (Base 10 Number System)

The decimal number system has a base of 10 because it uses ten digits from 0 to 9. In the decimal number system, the positions successive to the left of the decimal point represent units, tens, hundreds, thousands and so on. This system is expressed in [decimal numbers](#). Every position shows a particular power of the base (10).

Example of Decimal Number System:

The decimal number 1457 consists of the digit 7 in the units position, 5 in the tens place, 4 in the hundreds position, and 1 in the thousands place whose value can be written as:

$$(1 \times 10^3) + (4 \times 10^2) + (5 \times 10^1) + (7 \times 10^0)$$

$$(1 \times 1000) + (4 \times 100) + (5 \times 10) + (7 \times 1)$$

$$1000 + 400 + 50 + 7$$

$$1457$$

Binary Number System (Base 2 Number System)

The base 2 number system is also known as the [Binary number system](#) wherein, only two binary digits exist, i.e., 0 and 1. Specifically, the usual base-2 is a radix of 2. The figures described under this system are known as binary numbers which are the combination of 0 and 1. For example, 110101 is a binary number.

We can convert any system into binary and vice versa.

Example

Write $(14)_{10}$ as a binary number.

Solution:

2	14	
2	7	0
2	3	1
	1	1

Base 2 Number System Example

$$\therefore (14)_{10} = 1110_2$$

Octal Number System (Base 8 Number System)

In the **octal number system**, the base is 8 and it uses numbers from 0 to 7 to represent numbers. Octal numbers are commonly used in computer applications. Converting an octal number to decimal is the same as decimal conversion and is explained below using an example.

Example: Convert 215_8 into decimal.

Solution:

$$\begin{aligned}
 215_8 &= 2 \times 8^2 + 1 \times 8^1 + 5 \times 8^0 \\
 &= 2 \times 64 + 1 \times 8 + 5 \times 1 \\
 &= 128 + 8 + 5 \\
 &= 141_{10}
 \end{aligned}$$

Hexadecimal Number System (Base 16 Number System)

In the hexadecimal system, numbers are written or represented with base 16. In the hexadecimal system, the numbers are first represented just like in the decimal system, i.e. from 0 to 9. Then, the numbers are represented using the alphabet from A to F. The below-given table shows the representation of numbers in the **hexadecimal number system**.

Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Number System Chart

In the number system chart, the base values and the digits of different number systems can be found. Below is the chart of the numeral system.

Number System	Base value	Set of digits	Example
Base 3	3	0, 1, 2	$(123)_3$
Base 4	4	0, 1, 2, 3	$(145)_4$
Base 5	5	0, 1, 2, 3, 4	$(425)_5$
Base 6	6	0, 1, 2, 3, 4, 5	$(225)_6$
Base 7	7	0, 1, 2, 3, 4, 5, 6	$(1205)_7$
Base 8	8	0, 1, 2, 3, 4, 5, 6, 7	$(105)_8$
Base 9	9	0, 1, 2, 3, 4, 5, 6, 7, 8	$(25)_9$
Base 10	10	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	$(1125)_{10}$

Number System Chart

Number System Conversion

Numbers can be represented in any of the number system categories like binary, decimal, hexadecimal, etc. Also, any number which is represented in any of the number system types can be easily converted to another. Check the detailed lesson on the **conversions of number systems** to learn how to convert numbers in decimal to binary and vice versa, hexadecimal to binary and vice versa, and octal to binary and vice versa using various examples. With the help of the different conversion procedures explained above, now let us discuss in brief about the conversion of one number system to the other number system by taking a random number.

Assume the number 349. Thus, the number 349 in different number systems is as follows:

1. The number 349 in the binary number system is 101011101
2. The number 349 in the decimal number system is 349.
3. The number 349 in the octal number system is 535.
4. The number 349 in the hexadecimal number system is 15D

Number System Solved Examples

Example 1:

Convert $(1056)_{16}$ to an octal number.

Solution:

Given, 1056_{16} is a hex number.

First we need to convert the given hexadecimal number into decimal number

$$(1056)_{16}$$

$$= 1 \times 16^3 + 0 \times 16^2 + 5 \times 16^1 + 6 \times 16^0$$

$$= 4096 + 0 + 80 + 6$$

$$= (4182)_{10}$$

Now we will convert this decimal number to the required octal number by repetitively dividing by 8.

8	4182	Remainder
8	522	6
8	65	2
8	8	1
8	1	0
	0	1

Therefore, taking the value of the remainder from bottom to top, we get;

$$(4182)_{10} = (10126)_8$$

Therefore,

$$(1056)_{16} = (10126)_8$$

Example 2:

Convert $(1001001100)_2$ to a decimal number.

Solution:

$$(1001001100)_2$$

$$= 1 \times 2^9 + 0 \times 2^8 + 0 \times 2^7 + 1 \times 2^6 + 0 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$$

$$= 512 + 64 + 8 + 4$$

$$= (588)_{10}$$

Example 3:

Convert 10101_2 into an octal number.

Solution:

Given,

10101_2 is the binary number

We can write the given binary number as,

$$010 \ 101$$

Now as we know, in the octal number system,

$$010 \rightarrow 2$$

$$101 \rightarrow 5$$

Therefore, the required octal number is $(25)_8$

Example 4:

Convert hexadecimal 2C to decimal number.

Solution:

We need to convert $2C_{16}$ into binary numbers first.

$2C \rightarrow 00101100$

Now convert 00101100_2 into a decimal number.

$$101100 = 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$$

$$= 32 + 8 + 4$$

$$= 44$$

$$6,727$$

Number System Questions

1. Convert $(242)_{10}$ into hexadecimal. [Answer: $(F2)_{16}$]
2. Subtract 1101_2 and 1010_2 . [Answer: 0010]
3. Represent $5C6$ in decimal. [Answer: 1478]
4. Represent binary number 1.1 in decimal. [Answer: 1.5]

Computer Numeral System (Number System in Computers)

When we type any letter or word, the computer translates them into numbers since computers can understand only numbers. A computer can understand only a few symbols called digits and these symbols describe different values depending on the position they hold in the number. In general, the binary number system is used in computers. However, the octal, decimal and hexadecimal systems are also used sometimes.

More Topics Related to Number Systems

Frequently Asked Questions on Number System

Q1

What is Number System and it's Types?

The number system is simply a system to represent or express numbers. There are various types of number systems and the most commonly used ones are decimal number system, binary number system, octal number system, and hexadecimal number system.

Q2

Why is the Number System Important?

The number system helps to represent numbers in a small symbol set. Computers, in general, use binary numbers 0 and 1 to keep the calculations simple and to keep the amount of necessary circuitry less, which results in the least amount of space, energy consumption and cost.

Q3

What is Base 1 Number System Called?

The base 1 number system is called the unary numeral system and is the simplest numeral system to represent natural numbers.

Q4

What is the equivalent binary number for the decimal number 43?

To find the equivalent binary number, we need to divide 43 by 2, until we get 0 as the result. Therefore, $(43)_{10} = 101011_2$

Q5

How to convert 30_8 into a decimal number?

$$30_8 = (3 \times 8^1) + (0 \times 8^0) = 24$$

A number system in base r or radix r uses unique symbols for r digits. One or more digits are combined to get a number. The base of the number decides the valid digits that are used to make a number. In a number, the position of digit starts from the right-hand side of the number. The rightmost digit has position 0, the next digit on its left has position 1, and so on. The digits of a number have two kinds of values

- Face value
- Position value

Face Value

The face value of a digit is the digit located at that position. For example, in decimal number 52, face value at position 0 is 2 and face value at position 1 is 5.

Position Value

The position value of a digit is $(\text{base}^{\text{position}})$.

Example: In decimal number 52, the position value of digit 2 is 100 and the position value of digit 5 is 10^1 . Decimal numbers have a base of 10.

The number is calculated as the sum of, face value * $\text{base}^{\text{position}}$, of each of the digits. For decimal number 52, the number is $5*10^1 + 2*10^0 = 50 + 2 = 52$.

In computers, we are concerned with four kinds of number systems, as follows

- Decimal Number System — Base 10
- Binary Number System — Base 2
- Octal Number System — Base 8
- Hexadecimal Number System — Base 16

The numbers given as input to computer and the numbers given as output from the computer, are generally in decimal number system, and are most easily understood by humans. However, computer understands the binary number system, i.e., numbers in terms of 0s and 1s. The binary data is also represented, internally, as octal numbers and hexadecimal numbers due to their ease of use.

KINDS OF NUMBER SYSTEMS

1. Decimal Number System

- It consists of 10 digits—0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.
- All numbers in this number system are represented as combination of digits 0—9.

Example: 34, 5965 and 867321.

- The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	10^3	10^2	10^1	10^0	.	10^{-1}	10^{-2}	10^{-3}
Quantity:	1000	100	10	1	.	1/10	1/100	1/1000

2. Binary Number System

- The binary number system consists of two digits—0 and 1.
- All binary numbers are formed using combination of 0 and 1.

Example: 1001, 11000011 and 10110101.

- The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	2^3	2^2	2^1	2^0	.	2^{-1}	2^{-2}	2^{-3}
Quantity:	8	4	2	1	.	1/2	1/4	1/8

3. Octal Number System

- The octal number system consists of eight digits—0 to 7.
- All octal numbers are represented using these eight digits.

Example: 273, 103, 2375, etc.

- The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	8^3	8^2	8^1	8^0	.	8^{-1}	8^{-2}	8^{-3}
Quantity:	512	64	8	1	.	1/8	1/64	1/512

4. Hexadecimal Number System

- The hexadecimal number system consists of sixteen digits—0 to 9, A, B, C, D, E, F, where (A is for 10, B is for 11, C-12, D-13, E-14, F-15).
- All hexadecimal numbers are represented using these 16 digits.

Example: 3FA, 87B, 113, etc.

- The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	16^3	16^2	16^1	16^0	.	16^{-1}	16^{-2}	16^{-3}
Quantity:	4096	256	16	1	.	1/16	1/256	1/4096

Converting Decimal Integer to Binary, Octal, Hexadecimal

A decimal integer is converted to any other base, by using the division operation. To convert a decimal integer to—

- **Binary** - divide by 2
- **Octal** - divide by 8
- **Hexadecimal** - divide by 16

Convert 25 from Base 10 to Base 2 (Decimal to Binary).

1. Make a table as shown below. Write the number in center and to Base on the left side.

**to Base Number Remainder
(Quotient)**

2 25

2. Divide the number with to Base. After each division, write the remainder on right-side column and quotient in the next line in the middle column. Continue dividing till the quotient is 0.

**to Base Number Remainder
(Quotient)**

2	25	
2	12	1
2	6	0
2	3	0
2	1	1
	0	1

3. Write the digits in remainder column starting from downwards to upwards,

**to Base Number Remainder
(Quotient)**

2	25	
2	12	1
2	6	0
2	3	0
2	1	1
	0	1



The binary equivalent of number $(25)_{10}$ is $(11001)_2$.

Note: The steps shown above are followed to convert a decimal integer to a number in any other base.

Convert 23 from Base 10 to Base 2, 8, 16

to Base	Number	Remainder	to Base	Number	Remainder	to Base	Number	Remainder
(Quotient)			(Quotient)			(Quotient)		
2	23		8	23		16	23	
2	11	1	8	2	7	16	1	7
2	5	1		0	2		0	1
2	2	1	The octal equivalent of $(23)_{10}$ is $(27)_8$			The hexadecimal equivalent of $(23)_{10}$ is $(17)_{16}$		
2	1	0						
	0	1						

The binary equivalent of $(23)_{10}$ is $(10111)_2$

Converting Decimal Fraction to Binary, Octal, Hexadecimal

A fractional number is a number less than 1. It may be .5, .00453, .564, etc. We use the multiplication operation to convert decimal fraction to any other base.

To convert a decimal fraction to—

- **Binary** - multiply by 2
- **Octal** - multiply by 8
- **Hexadecimal** - multiply by 16

Steps for conversion of a decimal fraction to any other base are—

1. Multiply the fractional number with the Base, to get a resulting number.
2. The resulting number has two parts, non-fractional part and fractional part.
3. Record the non-fractional part of the resulting number.
4. Repeat the above steps at least four times.
5. Write the digits in the non-fractional part starting from upwards to downwards.

Convert 0.2345 from Base 10 to Base 2

$$\begin{array}{r} 0.2345 \\ \times 2 \\ \hline 0.4690 \end{array}$$

$$\begin{array}{r} .4690 \\ \times 2 \\ \hline 0.9380 \end{array}$$

$$\begin{array}{r} .9380 \\ \times 2 \\ \hline 1.8760 \end{array}$$

$$\begin{array}{r} .8760 \\ \times 2 \\ \hline 1.7520 \end{array}$$

$$\begin{array}{r} .7520 \\ \times 2 \\ \hline 1.5040 \end{array}$$

$$\begin{array}{r} .5040 \\ \times 2 \\ \hline 1.0080 \end{array}$$



The binary equivalent of $(0.2345)_{10}$ is $(0.001111)_2$.

Convert 0.865 from Base 10 to Base 2, 8 and 16.

$$\begin{array}{r} 0.865 \\ \times 2 \\ \hline 1.730 \end{array}$$

$$\begin{array}{r} 1.730 \\ \times 2 \\ \hline 3.460 \end{array}$$

$$\begin{array}{r} 3.460 \\ \times 2 \\ \hline 6.920 \end{array}$$

$$\begin{array}{r} 6.920 \\ \times 2 \\ \hline 1.360 \end{array}$$

$$\begin{array}{r} 0.865 \\ \times 8 \\ \hline 6.920 \end{array}$$

$$\begin{array}{r} 6.920 \\ \times 8 \\ \hline 7.360 \end{array}$$

$$\begin{array}{r} 7.360 \\ \times 8 \\ \hline 5.880 \end{array}$$

$$\begin{array}{r} 5.880 \\ \times 8 \\ \hline 7.040 \end{array}$$

The octal equivalent of $(0.865)_{10}$ is $(.6727)_8$

$$\begin{array}{r} 0.865 \\ \times 16 \\ \hline 5190 \end{array}$$

$$\begin{array}{r} 5190 \\ \times 16 \\ \hline 865 \times \end{array}$$

$$\begin{array}{r} 865 \times \\ 13.840 \\ \times 16 \\ \hline 5040 \end{array}$$

$$\begin{array}{r} 5040 \\ \times 16 \\ \hline 840 \times \end{array}$$

$$\begin{array}{r} 840 \times \\ 13.440 \\ \times 16 \\ \hline 2640 \end{array}$$

$$\begin{array}{r} 2640 \\ \times 16 \\ \hline 440 \times \end{array}$$

$$7.040$$

The binary equivalent of $(0.865)_{10}$ is $(.110111)_2$

The number 13 in hexadecimal is D.

The hexadecimal equivalent of $(0.865)_{10}$ is $(.DD7)_{16}$

Converting Decimal Integer Fraction to Binary, Octal, Hexadecimal

A decimal integer fraction number has both integer part and fraction part. The steps for conversion of a decimal integer fraction to any other base are—

1. Convert decimal integer part to the desired base following the steps shown in Converting Decimal Integer to Binary, Octal, and Hexadecimal.
2. Convert decimal fraction part to the desired base following the steps shown in Converting Decimal Fraction to Binary, Octal, and Hexadecimal.

3. The integer and fraction part in the desired base is combined to get integer fraction.

Convert 34.4674 from Base 10 to Base 2.

to Base	Number (Quotient)	Remainder	
2	34		0.4674
2	17	0	$\times 2$
2	8	1	0.9348
2	4	0	$\times 2$
2	2	0	1.8696
2	1	0	$\times 2$
	0	1	1.7392

The binary equivalent of $(34)_{10}$ is $(100010)_2$

0.4674
$\times 2$
0.9348
$\times 2$
1.8696
$\times 2$
1.7392
$\times 2$
1.4784
$\times 2$
0.9568
$\times 2$
1.8136

The binary equivalent of $(0.4674)_{10}$ is $(.011101)_2$

The binary equivalent of $(34.4674)_{10}$ is $(100010.011101)_2$

Convert 34.4674 from Base 10 to Base 8.

to Base	Number (Quotient)	Remainder	
8	34		0.4674
8	4	2	$\times 8$
	0	4	3.7392

The octal equivalent of $(34)_{10}$ is $(42)_8$

0.4674
$\times 8$
3.7392
$\times 8$
5.9136
$\times 8$
7.3088
$\times 8$
2.4704

The octal equivalent of $(0.4674)_{10}$ is $(.3572)_8$

The octal equivalent of $(34.4674)_{10}$ is $(42.3572)_8$

Convert 34.4674 from Base 10 to Base 16.

to Base	Number (Quotient)	Remainder	
16	34		0.4674
16	4	2	$\times 16$
	0	2	28044

The hexadecimal equivalent of $(34)_{10}$ is $(22)_{16}$

0.4674
$\times 16$
28044
$4674x$
9.4784
$\times 16$
28704
$4784x$
7.6544
$\times 16$
39264
$6544x$
10.4904
$\times 16$
29424
$4904x$
7.8464

The hexadecimal equivalent of $(0.4674)_{10}$ is $(.97A7)_{16}$

The hexadecimal equivalent of $(34.4674)_{10}$ is $(22.97A7)_{16}$

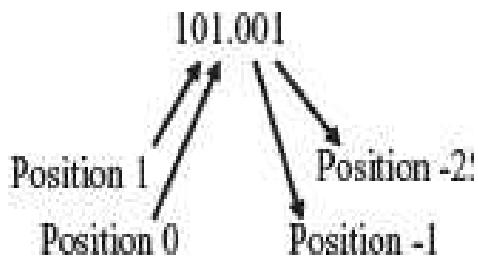
Conversion of Binary, Octal, Hexadecimal to Decimal

A binary, octal or hexadecimal number has two parts — integer part and fraction part. For example, a binary number could be 10011, 0.011001 or 10011.0111. The numbers 45, .362 or 245.362 are octal numbers. A hexadecimal number could be A2, .4C2 or A1.34.

The method used for the conversion of integer part and fraction part of binary, octal or hexadecimal number to decimal number is the same; multiplication operation is used for the conversion. The conversion mechanism uses the face value and position value of digits. The steps for conversion are as follows—

Find the sum of the Face Value * (from Base) ^{position} for each digit in the number.

1. In a non-fractional number, the rightmost digit has position 0 and the position increases as we go towards the left.
2. In a fractional number, the first digit to the left of decimal point has position 0 and the position increases as we go towards the left. The first digit to the right of the decimal point has position -1 and it decreases as we go towards the right (-2, -3, etc.)



Example

Convert 1011 from Base 2 to Base 10.

Convert 62 from Base 8 to Base 10.

Convert C15 from Base 16 to Base 10.

1011 from Base 2 to Base 10

$$\begin{aligned}1011 &= 1*2^3 + 0*2^2 + 1*2^1 + 1*2^0 \\&= 1*8 + 0*4 + 1*2 + 1*1 \\&= 8 + 0 + 2 + 1 \\&= 11\end{aligned}$$

The decimal equivalent of $(1011)_2$ is 11.

62 from Base 8 to Base 10

$$\begin{aligned}62 &= 6*8^1 + 2*8^0 \\&= 6*8 + 2*1 \\&= 48 + 2 \\&= 50\end{aligned}$$

The decimal equivalent of $(62)_8$ is 50.

C15 from Base 16 to Base 10

$$\begin{aligned}C15 &= C*16^2 + 1*16^1 + 5*16^0 \\&= 12*256 + 1*16 + 5*1 \\&= 3072 + 16 + 5 \\&= 3093\end{aligned}$$

The decimal equivalent of $(C15)_{16}$ is 3093

Conversion of Binary to Octal, Hexadecimal

A binary number can be converted into octal or hexadecimal number using a shortcut method.

The shortcut method is based on the following information—

- An octal digit from 0 to 7 can be represented as a combination of 3 bits, since $2^3 = 8$.
- A hexadecimal digit from 0 to 15 can be represented as a combination of 4 bits, since $2^4 = 16$.

The Steps for Binary to Octal Conversion are—

1. Partition the binary number in groups of three bits, starting from the right-most side.
2. For each group of three bits, find its octal number.
3. The result is the number formed by the combination of the octal numbers.

The Steps for Binary to Hexadecimal Conversion are—

1. Partition the binary number in groups of four bits, starting from the right-most side.
2. For each group of four bits, find its hexadecimal number.
3. The result is the number formed by the combination of the hexadecimal numbers.

Convert the binary number 1110101100110 to octal.

Given binary number 1110101100110

1. Partition binary number in groups of three bits, starting from the right-most side.

1 110 101 100 110

2. For each group find its octal number.

1 110 101 100 110
1 6 5 4 6

3. The octal number is 16546.

Convert the binary number 1110101100110 to hexadecimal

Given binary number - 1110101100110

1. Partition binary number in groups of four bits, starting from the right-most side.

1 1101 0110 0110

- 2 For each group find its hexadecimal number.

1 1101 0110 0110
1 D 6 6

- 3 The hexadecimal number is 1D66.

Conversion of Octal, Hexadecimal to Binary

The conversion of a number from octal and hexadecimal to binary uses the inverse of the steps defined for the conversion of binary to octal and hexadecimal.

The Steps for Octal to Binary Conversion are—

1. Convert each octal number into a three-digit binary number.
2. The result is the number formed by the combination of all the bits.

The Steps for Hexadecimal to Binary Conversion are—

1. Convert each hexadecimal number into a four-digit binary number.
2. The result is the number formed by the combination of all the bits.

Convert the hexadecimal number 2BA3 to binary.

1. Given number is 2BA3
2. Convert each hexadecimal digit into four digit binary number.

2	B	A	3
0010	1011	1010	0011

3. Combine all the bits to get the result 0010101110100011.

Convert the octal number 473 to binary.

1. Given number is 473
2. Convert each octal digit into three digit binary number.

4	7	3
100	111	011

3. Combine all the bits to get the result 100111011.

How to convert octal to hexadecimal

Using the below two methods, we can convert the octal number system into the hexadecimal number system.

1. Convert the octal number into **binary** and then convert the binary into hexadecimal.
2. Convert the octal number into **decimal** and then convert the decimal into hexadecimal.

Let's convert the octal number into the hexadecimal number system.

Octal Binary Hexadecimal

Let's convert $(56)_8$ into hexadecimal

Step 1: Convert $(56)_8$ into Binary

In order to convert the octal number into binary, we need to express every octal value using 3 binary bits.

Binary equivalent of **5** is $(101)_2$.

Binary equivalent of **6** is $(110)_2$.

$$= (56)_8$$

$$= (101)(110)$$

$$= (101110)_2$$

Step 2: Convert $(101110)_2$ into Hexadecimal

In order to convert the binary number into hexadecimal, we need to group every 4 binary bits and calculate the value [From left to right].

$(101110)_2$ in hexadecimal

$$= (101110)_2$$

$$= (10)(1110)$$

$$= (2)(14)$$

$$= (2e)_{16}$$

14 equivalent hexadecimal is e.

This method is relatively easy compared to the below method.

Octal Decimal Hexadecimal

Step 1: Convert (56)₈ into Decimal

$$= 5*8^1 + 6*8^0$$

$$= 40 + 6$$

$$= (46)_{10}$$

Step 2: Convert (46)₁₀ into hexadecimal

$$16 \mid 46$$

$$16 \mid 2 - 14$$

$$= (2e)_{16}$$

Binary to Octal Conversion

In binary to octal conversion, we learn to convert base 2 number system into base 8 number system. We cannot directly convert binary to octal, so we first convert binary to decimal, then the decimal number to the equivalent [octal number system](#). Binary numbers are commonly used in computers, in the form of bits and bytes, since the computer understand the language of 0 and 1 only. At the same time, octal numbers are used in electronics. Before going to the conversion, we have to learn about octal and binary numbers.

What are Binary Numbers?

Numbers to base 2 is called binary numbers. It uses only two digits, 0 and 1. It is denoted by a_2 , where a is a number with 0's and 1's.

Examples:

- 111110₂
- 1111111₂
- 1011001₂

What are Octal numbers?

The number to the base 8 is called octal numbers. It uses the numbers from 0 to 7. The numbers 8 and 9 are not included in the octal number system. It is denoted by a_8 where a is a number with digits 0 to 7.

Examples:

- 2145_8
- 7165_8
- 46_8

Conversion from Binary to Octal

In [number system](#), you will come across different types of numbers such as binary, octal, decimal and hexadecimal. To convert binary numbers to octal numbers, follow the below steps:

- Take the given binary number
- Multiply each digit by 2^{n-1} where n is the position of the digit from the decimal
- The resultant is the equivalent decimal number for the given binary number
- Divide the decimal number by 8
- Note the remainder
- Continue the above two steps with the quotient till the quotient is zero
- Write the remainder in the reverse order
- The resultant is the required octal number for the given binary number

Also read:

- [Number System Conversion](#)
- [Convert Octal To Binary](#)
- [Convert Decimal To Octal](#)

Here is a table for decimal number and equivalent octal number, to solve the problems based on their conversion more quickly.

Decimal Number	Octal Number
0	0
1	01
2	010
3	011
4	100
5	101
6	110
7	111

Binary to Octal conversion Examples

Example 1: Convert 1010101_2 to octal

Solution:

Given binary number is 1010101_2

First, we convert given binary to decimal

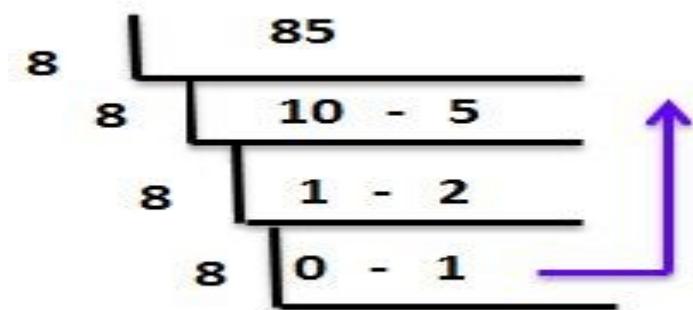
$$1010101_2 = (1 * 2^6) + (0 * 2^5) + (1 * 2^4) + (0 * 2^3) + (1 * 2^2) + (0 * 2^1) + (1 * 2^0)$$

$$= 64 + 0 + 16 + 0 + 4 + 0 + 1$$

$$= 64 + 21$$

$$010101_2 = 85 \text{ (Decimal form)}$$

Now we will convert this decimal to octal form



Therefore, the equivalent octal number is 125_8 .

Example 2: Convert 01101_2 to octal**Solution:**

Given binary number is 01101_2

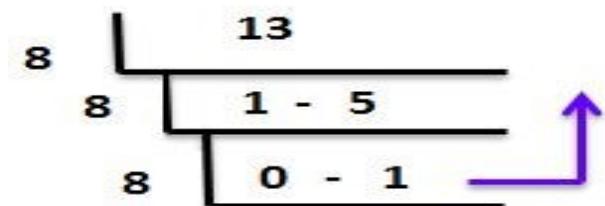
First we convert given binary to decimal

$$01101_2 = (0 * 2^4) + (1 * 2^3) + (1 * 2^2) + (0 * 2^1) + (1 * 2^0)$$

$$= 0 + 8 + 4 + 0 + 1$$

$$01101_2 = 13 \text{ (Decimal form)}$$

Now we will convert this decimal to octal form



Therefore, the equivalent octal number is 15_8 .

USER AND COMPUTER INTERACTION

SOFTWARE

Computer needs to be given instructions to perform any task. A set of instructions for a specific task is termed a routine and a complete set of instructions to execute a related set of tasks is a program. Software refers to the set of computer programs, procedures that describe the programs, how they are to be used. We can say that it is the collection of programs, which increase the capabilities of the hardware. Software guides the computer at every step where to start and stop during a particular job. The process of software development is called programming.

What is a software?

Software can be best defined as a set of instructions, technically referred to as programs, that perform operations and specific tasks based on the commands of the user. Every single task that a user intends to perform is regulated by software. Made of binary language (ones and zeroes), there is a variety of software for different tasks. With that said, here's everything about software that you should know.

- Software is a set of instructions that tells the computer about the tasks to be performed and how these tasks are to be performed.
- **Program** is a set of instructions, written in a language understood by the computer, to perform a specific task.
- A set of programs and documents are collectively called software. Software instructs the computer about the task to be performed.
- Different software can be loaded on the same hardware to perform different kinds of tasks.

System Software

System software are general programs designed for performing tasks such as controlling all operations required to move data into and out of the computer. It communicates with printers, card reader, disk, tapes etc. monitor the use of various hardware like memory, CPU etc. Also system software are essential for the development of applications software. System Software allows application packages to be run on the computer with less time and effort.

Remember that it is not possible to run application software without system software.

System Software are three types:

1. System Management Programs
2. System Support Programs

3. System Development Programs

Types of System Software

- **Operating systems:** - Operating system software helps you for the effective utilization of all hardware and software components of a computer system.
- **Programming language translators:** - Transforms the instructions prepared by developers in a programming language into a form that can be interpreted or compiled and executed by a computer system.
- **Communication Software:** – Communication software allows us to transfer data and programs from one computer system to another.
- **Utility programs:** – Utility programs are a set of programs that help users in system maintenance tasks, and in performing tasks of routine nature.

Features of System Software

An important feature of System Software are:

- System Software is closer to the system
- Generally written in a low-level language
- The system software is difficult to design and understand
- Fast in speed
- Less interactive
- Smaller in size
- Hard to manipulate

Application Software

Application Software is a set of programs to carry out operations for a specific application. For example, payroll is an application software for an organization to produce pay slips as an output. Application software is useful for word processing, billing system, accounting, producing statistical report, analysis of numerous data in research, weather forecasting, etc. In later modules you will learn about MS WORD, Lotus 1-2-3 and BASE III Plus. All these are application software.

Types of Application Software

Here, are some important types of Application Software

- **Word-processing software:** - It makes use of a computer for creating, modifying, viewing, storing, retrieving, and printing documents.

- **Spreadsheet software:** - Spreadsheet software is a numeric data-analysis tool that allows you to create a computerized ledger.
- **Database software:** - A database software is a collection of related data that is stored and retrieved according to user demand.
- **Graphics software:** - It allows computer systems for creating, editing, drawings, graphs, etc.
- **Education software:** - Education software allows a computer to be used as a learning and teaching tool.
- **Entertainment software:** - This type of app allows a computer to be used as an entertainment tool.

Features of Application Software

An important feature of Application Software:

- Perform more specialized tasks like word processing, spreadsheets, email, photo editing, etc.
- It needs more storage space as it is bigger in size
- Easy to design and more interactive for the user
- Generally written in a high-level language

OPERATING SYSTEMS

INTRODUCTION

An Operating System (OS) acts as an interface connecting a computer user with the computer's hardware. An operating system falls under the category of system software that performs all the fundamental tasks like file management, memory handling, process management, handling the input/output, and governing and managing the peripheral devices like disk drives, networking hardware, printers, etc. Some well-liked Operating Systems are Linux, Windows, OS X, Solaris, OS/400, Chrome OS, etc.

FEATURES OF OPERATING SYSTEM

Here is a list of some significant functions of an Operating System, which is found common in almost all operating systems:

1. **Resource management:** Operating systems manage the computer's resources, such as its memory, processor, and storage, and allocate them to different tasks as needed.
2. **Memory management:** Operating systems manage the computer's memory and ensure that each program or process has access to the memory it needs to run.
3. **Process management:** Operating systems create and manage processes, which are units of work executed by the computer.
4. **File management:** Operating systems manage the files on the computer, including organizing them and providing access for different programs and users.

5. **Security:** Operating systems include security features to protect the computer from unauthorized access and viruses.
6. **User interface:** Operating systems provide an interface for users to interact with the computer, such as through a graphical user interface (GUI) or command-line interface (CLI).
7. **Networking:** Many operating systems include support for networking, allowing the computer to communicate and exchange data with other devices over a network, such as the internet or a local area network (LAN).
8. **Device management:** Operating systems manage the devices connected to the computer, such as printers, keyboards, and storage devices.
9. **Power management:** Operating systems include features to manage the power usage of the computer and conserve energy when possible.
10. **Software installation and updates:** Operating systems provide a mechanism for installing and updating software applications.

Functions of OS

Operating system is a large and complex software consisting of several components. Each component of the operating system has its own set of defined inputs and outputs. Different components of OS perform specific tasks to provide the overall functionality of the operating system

Main functions of the operating system are as follows:



Process Management

The process management activities handled by the OS are—

1. Control access to shared resources like file, memory, I/O and CPU

2. Control execution of applications
3. Create, execute and delete a process (system process or user process)
4. Cancel or resume a process
5. Schedule a process
6. Synchronization, communication and deadlock handling for processes.

Memory Management

The activities of memory management handled by OS are—

1. Allocate memory
2. Free memory
3. Re-allocate memory to a program when a used block is freed
4. Keep track of memory usage

File Management

The file management tasks include —

1. Create and delete both files and directories
2. Provide access to files
3. Allocate space for files
4. Keep back-up of files
5. Secure files

Device Management

The device management tasks handled by OS are—

1. Open, close and write device drivers
2. Communicate, control and monitor the device driver

Protection and Security

OS protects the resources of system. User authentication, file attributes like read, write, encryption, and back-up of data are used by OS to provide basic protection.

User Interface or Command Interpreter

Operating system provides an interface between the computer user and the computer hardware. The user interface is a set of commands or a graphical user interface via which the user interacts with the applications and the hardware.

These are just a few examples of features commonly found in operating systems. The specific features of an operating system depend on the particular system and its intended use.

OBJECTIVES OF OPERATING SYSTEM

An operating system consists of unique programs that control the execution of software. The OS acts as an intermediary between applications and hardware components. OS can be thought of as having three objectives. These are:

- **Convenience:** It makes a computer more suitable to use.
- **Efficiency:** It provides the computer system resources with efficiency and in easy to use format.
- **Ability to develop:** It should be built in such a way that it permits the efficient development, testing, and installation of new system functions without interfering with service.

BASIC ELEMENTS OF COMPUTER SYSTEMS

At an upper level of any computer architecture, a computer is supposed to have a processor, memory, and some I/O components, with one or more quantities of each type. These components are interrelated and connected in a way to achieve the significant function of the computer, which is to execute programs.

There are four key structural elements of any computer. These are:

- **Processor:** It controls the processes within the computer and carries out its data processing functions. When there is only one processor available, it is in combination termed as the central processing unit (CPU), which you must be familiar with.
- **Main memory:** It stores data and programs within it. This memory is typically volatile and is also called primary memory. This is because when the computer is shut down, the contents within the memory get lost. In contrast, the contents of disk memory are kept hold of even when the computer system is turned off, which you call a shutting down of the Operating system or computer. Main memory is also termed real memory.
- **Input/output (I/O) devices:** This moves the data within the computer to its peripheral external environment. The external environment is supposed to have a variety of devices, including secondary memory devices (e.g., pen drives, CDs, etc.), communications equipment (such as LAN cable), terminals, etc.
- **System bus:** It provides communication between processors, main memory, and I/O modules.

These are some of the essential elements of a computer system. There may be other components, depending on the specific design and configuration of the system.

OPERATING SYSTEM SERVICES

An Operating System supplies different kinds of services to both the users and to the programs as well. It also provides application programs (that run within an Operating system) an environment to execute it freely. It provides users the services run various programs in a convenient manner.

Here is a list of common services offered by an almost all operating systems:

- User Interface

- Program Execution
- File system manipulation
- Input / Output Operations
- Communication
- Resource Allocation
- Error Detection
- Accounting
- Security and protection

This chapter will give a brief description of what services an operating system usually provide to users and those programs that are and will be running within it.

User Interface of Operating System

Usually Operating system comes in three forms or types. Depending on the interface their types have been further subdivided. These are:

- Command line interface
- Batch based interface
- Graphical User Interface

Let's get to know in brief about each of them.

The command line interface (CLI) usually deals with using text commands and a technique for entering those commands. The batch interface (BI): commands and directives are used to manage those commands that are entered into files and those files get executed. Another type is the graphical user interface (GUI): which is a window system with a pointing device (like mouse or trackball) to point to the I/O, choose from menus driven interface and to make choices viewing from a number of lists and a keyboard to entry the texts.

Program Execution in Operating System

The operating system must have the capability to load a program into memory and execute that program. Furthermore, the program must be able to end its execution, either normally or abnormally / forcefully.

File System Manipulation in Operating System

Programs need has to be read and then write them as files and directories. File handling portion of operating system also allows users to create and delete files by specific name along with extension, search for a given file and / or list file information. Some programs comprise of permissions management for allowing or denying access to files or directories based on file ownership.

I/O operations in Operating System

A program which is currently executing may require I/O, which may involve file or other I/O device. For efficiency and protection, users cannot directly govern the I/O devices. So, the OS provide a means to do I/O Input / Output operation which means read or write operation with any file.

Communication System of Operating System

Process needs to swap over information with other process. Processes executing on same computer system or on different computer systems can communicate using operating system support. Communication between two processes can be done using shared memory or via message passing.

Resource Allocation of Operating System

When multiple jobs running concurrently, resources must need to be allocated to each of them. Resources can be CPU cycles, main memory storage, file storage and I/O devices. CPU scheduling routines are used here to establish how best the CPU can be used.

Error Detection

Errors may occur within CPU, memory hardware, I/O devices and in the user program. For each type of error, the OS takes adequate action for ensuring correct and consistent computing.

Accounting

This service of the operating system keeps track of which users are using how much and what kinds of computer resources have been used for accounting or simply to accumulate usage statistics.

Protection and Security

Protection includes in ensuring all access to system resources in a controlled manner. For making a system secure, the user needs to authenticate him or her to the system before using (usually via login ID and password).

DATABASES

WHAT IS A DATABASE?

Database defined

A database is a collection of logically-related and similar data. Database stores similar kind of data, for a specific purpose that is organized in such a manner that any information can be derived from it, when needed. The database is accessed for the retrieval, insertion, deletion, or updating of data. Database Management System (DBMS) is a software system for creating, organizing, and managing the database. DBMS provides an environment to the user to perform operations on the database for creation, insertion, deletion, updating, and retrieval of data.

A database management system (DBMS) refers to the technology for creating and managing databases. DBMS is a software tool to organize (create, retrieve, update, and manage) data in a database.

The main aim of a DBMS is to supply a way to store up and retrieve database information that is both convenient and efficient. By data, we mean known facts that can be recorded and that have embedded meaning. Usually, people use software such as DBASE IV or V, Microsoft ACCESS, or EXCEL to store data in the form of a database. A datum is a unit of data. Meaningful data combined to form information. Hence, information is

interpreted data - data provided with semantics. MS. ACCESS is one of the most common examples of database management software.

More on Data, Information, and Knowledge

Knowledge refers to the useful use of information. As you know, that information can be transported, stored, and shared without any problems and difficulties, but the same cannot be said about knowledge. Knowledge necessarily involves personal experience and practice.

Database systems are meant to handle an extensive collection of information. Management of data involves both defining structures for storage of information and providing mechanisms that can do the manipulation of those stored information. Moreover, the database system must ensure the safety of the information stored, despite system crashes or attempts at unauthorized access.

Why Use DBMS?

- To develop software applications in less time.
- Data independence and efficient use of data.
- For uniform data administration.
- For data integrity and security.
- For concurrent access to data, and data recovery from crashes.
- To use user-friendly declarative query language.

Where is a Database Management System (DBMS) being used?

- Airlines: reservations, schedules, etc.
- Telecom: calls made, customer details, network usage, etc.
- Universities: registration, results, grades, etc.
- Sales: products, purchases, customers, etc.
- Banking: all transactions etc.

Advantages of DBMS

A DBMS manages data and has many benefits. These are:

- Data independence: Application programs should be as free or independent as possible from details of data representation and storage. DBMS can supply an abstract view of the data for insulating application code from such facts.
- Efficient data access: DBMS utilizes a mixture of sophisticated concepts and techniques for storing and retrieving data competently. This feature becomes important in cases where the data is stored on external storage devices.

- Data integrity and security: If data is accessed through the DBMS, the DBMS can enforce integrity constraints on the data.
- Data administration: When several users share the data, integrating the administration of data can offer significant improvements. Experienced professionals understand the nature of the data being managed and can be responsible for organizing the data representation to reduce redundancy and make the data to retrieve efficiently.

Components of DBMS

- Users: Users may be of any kind such as DB administrator, System developer, or database users.
- Database application: Database application may be Departmental, Personal, organization's and / or Internal.
- DBMS: Software that allows users to create and manipulate database access,
- Database: Collection of logical data as a single unit.

A database is an organized collection of structured information, or data, typically stored electronically in a computer system. A database is usually controlled by a database management system (DBMS). Together, the data and the DBMS, along with the applications that are associated with them, are referred to as a database system, often shortened to just database.

Data within the most common types of databases in operation today is typically modeled in rows and columns in a series of tables to make processing and data querying efficient. The data can then be easily accessed, managed, modified, updated, controlled, and organized. Most databases use structured query language (SQL) for writing and querying data.

What is Structured Query Language (SQL)?

SQL is a programming language used by nearly all relational databases to query, manipulate, and define data, and to provide access control. SQL was first developed at IBM in the 1970s with Oracle as a major contributor, which led to implementation of the SQL ANSI standard, SQL has spurred many extensions from companies such as IBM, Oracle, and Microsoft. Although SQL is still widely used today, new programming languages are beginning to appear.

Evolution of the database

Databases have evolved dramatically since their inception in the early 1960s. Navigational databases such as the hierarchical database (which relied on a tree-like model and allowed only a one-to-many relationship), and the network database (a more flexible model that allowed multiple relationships), were the original systems used to store and manipulate data. Although simple, these early systems were inflexible. In the 1980s, relational databases became popular, followed by object-oriented databases in the 1990s. More recently, NoSQL databases came about as a response to the growth of the internet and the need for faster speed and processing of

unstructured data. Today, cloud databases and self-driving databases are breaking new ground when it comes to how data is collected, stored, managed, and utilized.

What's the difference between a database and a spreadsheet?

Databases and spreadsheets (such as Microsoft Excel) are both convenient ways to store information. The primary differences between the two are:

- How the data is stored and manipulated
- Who can access the data
- How much data can be stored

Spreadsheets were originally designed for one user, and their characteristics reflect that. They're great for a single user or small number of users who don't need to do a lot of incredibly complicated data manipulation. Databases, on the other hand, are designed to hold much larger collections of organized information—massive amounts, sometimes. Databases allow multiple users at the same time to quickly and securely access and query the data using highly complex logic and language.

Types of databases

There are many different types of databases. The best database for a specific organization depends on how the organization intends to use the data.

Relational databases

- Relational databases became dominant in the 1980s. Items in a relational database are organized as a set of tables with columns and rows. Relational database technology provides the most efficient and flexible way to access structured information.

Object-oriented databases

- Information in an object-oriented database is represented in the form of objects, as in object-oriented programming.

Distributed databases

- A distributed database consists of two or more files located in different sites. The database may be stored on multiple computers, located in the same physical location, or scattered over different networks.

Data warehouses

- A central repository for data, a data warehouse is a type of database specifically designed for fast query and analysis.

NoSQL databases

- A NoSQL, or nonrelational database, allows unstructured and semistructured data to be stored and manipulated (in contrast to a relational database, which defines how all data inserted into the database must be composed). NoSQL databases grew popular as web applications became more common and more complex.

Graph databases

- A graph database stores data in terms of entities and the relationships between entities.
- **OLTP databases.** An OLTP database is a speedy, analytic database designed for large numbers of transactions performed by multiple users.

These are only a few of the several dozen types of databases in use today. Other, less common databases are tailored to very specific scientific, financial, or other functions. In addition to the different database types, changes in technology development approaches and dramatic advances such as the cloud and automation are propelling databases in entirely new directions. Some of the latest databases include

Open source databases

- An open source database system is one whose source code is open source; such databases could be SQL or NoSQL databases.

Cloud databases

- A cloud database is a collection of data, either structured or unstructured, that resides on a private, public, or hybrid cloud computing platform. There are two types of cloud database models: traditional and database as a service (DBaaS). With DBaaS, administrative tasks and maintenance are performed by a service provider.

Multimodel database

- Multimodel databases combine different types of database models into a single, integrated back end. This means they can accommodate various data types.

Document/JSON database

- Designed for storing, retrieving, and managing document-oriented information, document databases are a modern way to store data in JSON format rather than rows and columns.

Self-driving databases

- The newest and most groundbreaking type of database, self-driving databases (also known as autonomous databases) are cloud-based and use machine learning to automate database tuning, security, backups, updates, and other routine management tasks traditionally performed by database administrators.

Learn more about self-driving databases

What is database software?

Database software is used to create, edit, and maintain database files and records, enabling easier file and record creation, data entry, data editing, updating, and reporting. The software also handles data storage, backup and reporting, multi-access control, and security. Strong database security is especially important today, as data theft becomes more frequent. Database software is sometimes also referred to as a “database management system” (DBMS).

Database software makes data management simpler by enabling users to store data in a structured form and then access it. It typically has a graphical interface to help create and manage the data and, in some cases, users can construct their own databases by using database software.

What is a database management system (DBMS)?

A database typically requires a comprehensive database software program known as a database management system (DBMS). A DBMS serves as an interface between the database and its end users or programs, allowing users to retrieve, update, and manage how the information is organized and optimized. A DBMS also facilitates oversight and control of databases, enabling a variety of administrative operations such as performance monitoring, tuning, and backup and recovery.

Some examples of popular database software or DBMSs include MySQL, Microsoft Access, Microsoft SQL Server, FileMaker Pro, Oracle Database, and dBASE.

What is a MySQL database?

MySQL is an open source relational database management system based on SQL. It was designed and optimized for web applications and can run on any platform. As new and different requirements emerged with the internet, MySQL became the platform of choice for web developers and web-based applications. Because it's designed to process millions of queries and thousands of transactions, MySQL is a popular choice for ecommerce businesses that need to manage multiple money transfers. On-demand flexibility is the primary feature of MySQL.

MySQL is the DBMS behind some of the top websites and web-based applications in the world, including Airbnb, Uber, LinkedIn, Facebook, Twitter, and YouTube.

Using databases to improve business performance and decision-making

With massive data collection from the Internet of Things transforming life and industry across the globe, businesses today have access to more data than ever before. Forward-thinking organizations can now use databases to go beyond basic data storage and transactions to analyze vast quantities of data from multiple systems. Using database and other computing and business intelligence tools, organizations can now leverage the data they collect to run more efficiently, enable better decision-making, and become more agile and scalable. Optimizing access and throughput to data is critical to businesses today because there is more data volume to track. It's critical to have a platform that can deliver the performance, scale, and agility that businesses need as they grow over time.

The self-driving database is poised to provide a significant boost to these capabilities. Because self-driving databases automate expensive, time-consuming manual processes, they free up business users to become more proactive with their data. By having direct control over the ability to create and use databases, users gain control and autonomy while still maintaining important security standards.

Database challenges

Today's large enterprise databases often support very complex queries and are expected to deliver nearly instant responses to those queries. As a result, database administrators are constantly called upon to employ a wide variety of methods to help improve performance. Some common challenges that they face include:

- **Absorbing significant increases in data volume.** The explosion of data coming in from sensors, connected machines, and dozens of other sources keeps database administrators scrambling to manage and organize their companies' data efficiently.
- **Ensuring data security.** Data breaches are happening everywhere these days, and hackers are getting more inventive. It's more important than ever to ensure that data is secure but also easily accessible to users.
- **Keeping up with demand.** In today's fast-moving business environment, companies need real-time access to their data to support timely decision-making and to take advantage of new opportunities.
- **Managing and maintaining the database and infrastructure.** Database administrators must continually watch the database for problems and perform preventative maintenance, as well as apply software upgrades and patches. As databases become more complex and data volumes grow, companies are faced with the expense of hiring additional talent to monitor and tune their databases.
- **Removing limits on scalability.** A business needs to grow if it's going to survive, and its data management must grow along with it. But it's very difficult for database administrators to predict how much capacity the company will need, particularly with on-premises databases.
- **Ensuring data residency, data sovereignty, or latency requirements.** Some organizations have use cases that are better suited to run on-premises. In those cases, engineered systems that are pre-configured and pre-optimized for running the database are ideal. Customers achieve higher availability, greater performance and up to 40% lower cost with Oracle Exadata, according to Wikibon's recent analysis (PDF).

Addressing all of these challenges can be time-consuming and can prevent database administrators from performing more strategic functions.

How autonomous technology is improving database management

Self-driving databases are the wave of the future—and offer an intriguing possibility for organizations that want to use the best available database technology without the headaches of running and operating that technology.

Self-driving databases use cloud-based technology and machine learning to automate many of the routine tasks required to manage databases, such as tuning, security, backups, updates, and other routine management tasks. With these tedious tasks automated, database administrators are freed up to do more strategic work. The self-driving, self-secur ing, and self-repairing capabilities of self-driving databases are poised to revolutionize how companies manage and secure their data, enabling performance advantages, lower costs, and improved security.

Future of databases and autonomous databases

The first autonomous database was announced in late 2017, and multiple independent industry analysts quickly recognized the technology and its potential impact on computing.

A Wikibon 2021 report (PDF) praised autonomous database technology, saying, "**Oracle has by far the best Tier-1 Cloud Database Platform** **Wikibon believes Oracle has the strongest Cloud Database Platform with Autonomous Database.**"

And Kuppinger Cole's 2021 Leadership Compass (PDF) said, "The Oracle Autonomous Database, which completely automates provisioning, management, tuning, and upgrade processes of database instances without any downtime, **not just substantially increases security and compliance of sensitive data stored in Oracle Databases but makes a compelling argument for moving this data to the Oracle Cloud.**" Because Oracle Autonomous Database is built on the highly available and scalable architecture of Oracle Exadata, it's possible to easily scale the database deployment as needs grow.

COMPUTER NETWORKS AND THE INTERNET

COMPUTER NETWORK

A computer network is defined as a system that connects two or more computing devices for transmitting and sharing information.

What Is a Computer Network?

A computer network is a system that connects two or more computing devices for transmitting and sharing information. Computing devices include everything from a mobile phone to a server. These devices are connected using physical wires such as fiber optics, but they can also be wireless.

The first working network, called ARPANET, was created in the late 1960s and was funded by the U.S. Department of Defense. Government researchers used to share information at a time when computers were large and difficult to move. We have come a long way today from that basic kind of network. Today's world revolves around the internet, which is a network of networks that connects billions of devices across the world. Organizations of all sizes use networks to connect their employees' devices and shared resources such as printers. An example of a computer network at large is the traffic monitoring systems in urban cities. These systems alert officials and emergency responders with information about traffic flow and incidents. A simpler example is using collaboration software such as Google Drive to share documents with colleagues who work remotely. Every time we connect via a video call, stream movies, share files, chat with instant messages, or just access something on the internet, a computer network is at work.

Computer networking is the branch of computer science that deals with the ideation, architecture, creation, maintenance, and security of computer networks. It is a combination of computer science, computer engineering, and telecommunication.

A computer network is interconnection of various computer systems located at different places. In computer network two or more computers are linked together with a medium and data communication devices for the purpose of communication data and sharing resources. The computer that provides resources to other computers

on a network is known as server. In the network the individual computers, which access shared network resources, are known as nodes.

Parts of a network

There are five basic components of a network: clients, servers, channels, interface devices and operating systems:

» Servers

Sometimes called host computers, servers are powerful computers that store data or applications and connect to resources that are shared by the users of a network.

» Clients

These computers are used by the users of the network to access the servers and shared resources (such as hard disks and printers). These days, it is typical for a client to be a personal computer that the users also use for their own non-network applications.

» Channels

Called the network circuit, the channel is the pathway over which information travels between the different computers (clients and servers) that comprises the network.

» Interface devices

These are hardware devices that connect clients and servers (and sometimes other networks) to the channel.

Examples include modems and network interface cards.

» Operating systems

The network operating system is the software of the network. It serves a similar purpose that the operating system serves in a stand-alone computer.

Importance of Networking

Networking of computers provides a communication link between the users, and provides access to information.

» Resource Sharing

In an organization, resources such as printers, fax machines and scanners are generally not required by each person at all times. Moreover, for small organizations it may not be feasible to provide such resources to each individual. Such resources can be made available to different users of the organization on the network. It results in availability of the resource to different users regardless of the physical location of the resource or the user, enhances optimal use of the resource, leads to easy maintenance, and saves cost too.

» Sharing of Information

In addition to the sharing of physical resources, networking facilitates sharing of information. Information stored on networked computers located at same or different physical locations, becomes accessible to the computers connected to the network.

» As a Communication Medium

Networking helps in sending and receiving of electronic-mail (email) messages from anywhere in the world. Data in the form of text, audio, video and pictures can be sent via e-mail. This allows the users to communicate online

in a faster and cost effective manner. Video conferencing is another form of communication made possible via networking. People in distant locations can hold a meeting, and they can hear and see each other simultaneously.

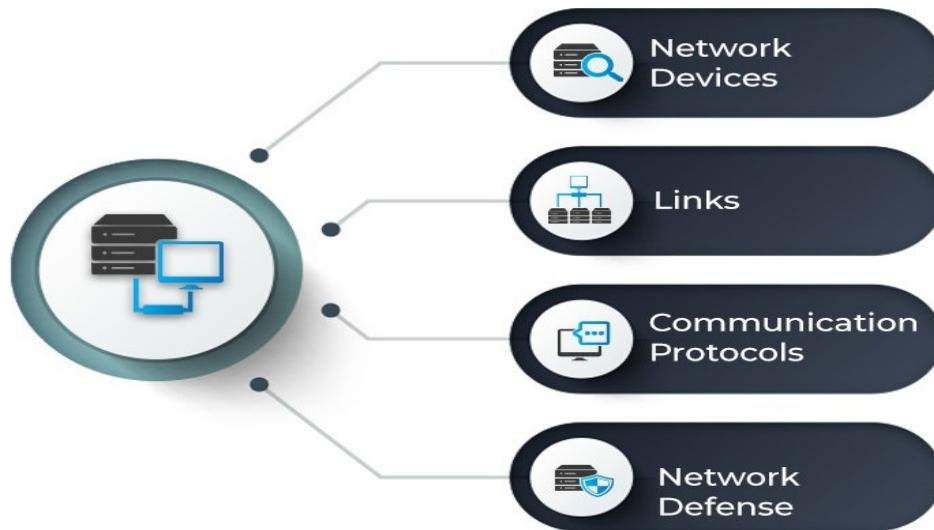
» For Back-up and Support

Networked computers can be used to take back-up of critical data. In situations where there is a requirement of always-on computer, another computer on the network can take over in case of failure of one computer.

Components of a Computer Network

From a broader lens, a computer network is built with two basic blocks: nodes or network devices and links. The links connect two or more nodes with each other. The way these links carry the information is defined by communication protocols. The communication endpoints, i.e., the origin and destination devices, are often called ports.

KEY COMPONENTS OF A COMPUTER NETWORK



Main Components of a Computer Network

1. Network Devices

Network devices or nodes are computing devices that need to be linked in the network. Some network devices include:

- **Computers, mobiles, and other consumer devices:** These are end devices that users directly and frequently access. For example, an email originates from the mailing application on a laptop or mobile phone.
- **Servers:** These are application or storage servers where the main computation and data storage occur. All requests for specific tasks or data come to the servers.
- **Routers:** Routing is the process of selecting the network path through which the data packets traverse. Routers are devices that forward these packets between networks to ultimately reach the destination. They add efficiency to large networks.

- **Switches:** Repeaters are to networks what transformers are to electricity grids—they are electronic devices that receive network signals and clean or strengthen them. Hubs are repeaters with multiple ports in them. They pass on the data to whichever ports are available. Bridges are smarter hubs that only pass the data to the destination port. A switch is a multi-port bridge. Multiple data cables can be plugged into switches to enable communication with multiple network devices.
- **Gateways:** Gateways are hardware devices that act as ‘gates’ between two distinct networks. They can be firewalls, routers, or servers.

2. Links

Links are the transmission media which can be of two types:

- **Wired:** Examples of wired technologies used in networks include coaxial cables, phone lines, twisted-pair cabling, and optical fibers. Optical fibers carry pulses of light to represent data.
- **Wireless:** Network connections can also be established through radio or other electromagnetic signals. This kind of transmission is called ‘wireless’. The most common examples of wireless links include communication satellites, cellular networks, and radio and technology spread spectrums. Wireless LANs use spectrum technology to establish connections within a small area.

3. Communication protocols

A communication protocol is a set of rules followed by all nodes involved in the information transfer. Some common protocols include the internet protocol suite (TCP/IP), IEEE 802, Ethernet, wireless LAN, and cellular standards. TCP/IP is a conceptual model that standardizes communication in a modern network. It suggests four functional layers of these communication links:

- **Network access layer:** This layer defines how the data is physically transferred. It includes how hardware sends data bits through physical wires or fibers.
- **Internet layer:** This layer is responsible for packaging the data into understandable packets and allowing it to be sent and received.
- **Transport layer:** This layer enables devices to maintain a conversation by ensuring the connection is valid and stable.
- **Application layer:** This layer defines how high-level applications can access the network to initiate data transfer.

Most of the modern internet structure is based on the TCP/IP model, though there are still strong influences of the similar but seven-layered open systems interconnection (OSI) model.

IEEE802 is a family of IEEE standards that deals with local area networks (LAN) and metropolitan area networks (MAN). Wireless LAN is the most well-known member of the IEEE 802 family and is more widely known as WLAN or Wi-Fi.

4. Network Defense

While nodes, links, and protocols form the foundation of a network, a modern network cannot exist without its defenses. Security is critical when unprecedented amounts of data are generated, moved, and processed across networks. A few examples of network defense tools include firewall, intrusion detection systems (IDS), intrusion prevention systems (IPS), network access control (NAC), content filters, proxy servers, anti-DDoS devices, and load balancers.

Types of Computer Networks

Computer networks can be classified based on several criteria, such as the transmission medium, the network size, the topology, and organizational intent. Based on a geographical scale, the different types of networks are:

1. **Nanoscale networks**: These networks enable communication between minuscule sensors and actuators.
2. **Personal area network (PAN)**: PAN refers to a network used by just one person to connect multiple devices, such as laptops to scanners, etc.
3. **Local area network (LAN)**: The local area network connects devices within a limited geographical area, such as schools, hospitals, or office buildings.
4. **Storage area network (SAN)**: SAN is a dedicated network that facilitates block-level data storage. This is used in storage devices such as disk arrays and tape libraries.
5. **Campus area network (CAN)**: Campus area networks are a collection of interconnected LANs. They are used by larger entities such as universities and governments.
6. **Metropolitan area network (MAN)**: MAN is a large computer network that spans across a city.
7. **Wide area network (WAN)**: Wide area networks cover larger areas such as large cities, states, and even countries.
8. **Enterprise private network (EPN)**: An enterprise private network is a single network that a large organization uses to connect its multiple office locations.
9. **Virtual private network (VPN)**: VPN is an overlay private network stretched on top of a public network.
10. **Cloud network**: Technically, a cloud network is a WAN whose infrastructure is delivered via cloud services.

Based on organizational intent, networks can be classified as:

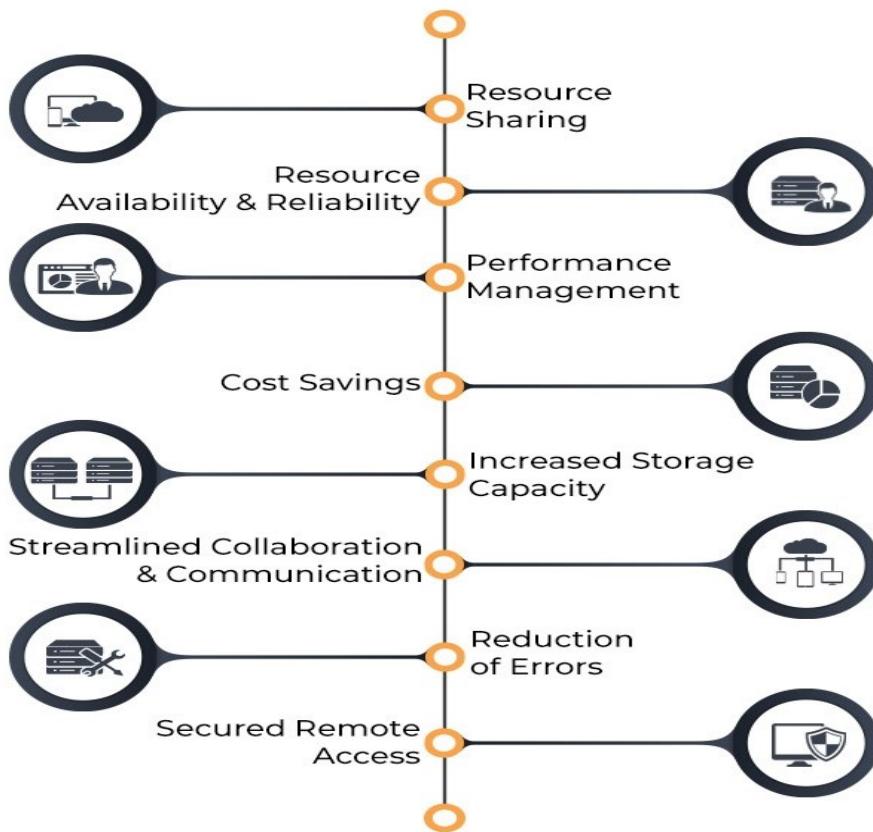
1. **Intranet**: Intranet is a set of networks that is maintained and controlled by a single entity. It is generally the most secure type of network, with access to authorized users alone. An intranet usually exists behind the router in a local area network.
2. **Internet**: The internet (or the internetwork) is a collection of multiple networks connected by routers and layered by networking software. This is a global system that connects governments, researchers, corporates, the public, and individual computer networks.
3. **Extranet**: An extranet is similar to the intranet but with connections to particular external networks. It is generally used to share resources with partners, customers, or remote employees.

4. **Darknet:** The darknet is an overlay network that runs on the internet and can only be accessed by specialized software. It uses unique, customized communication protocols.

Objectives of Creating and Deploying a Computer Network

There is no industry—education, retail, finance, tech, government, or healthcare—that can survive without well-designed computer networks. The bigger an organization, the more complex the network becomes. Before taking on the onerous task of creating and deploying a computer network, here are some key objectives that must be considered.

KEY OBJECTIVES OF DEPLOYING A COMPUTER NETWORK



Objectives of Deploying a Computer Network

1. Resource sharing

Today's enterprises are spread across the globe, with critical assets being shared across departments, geographies, and time zones. Clients are no more bound by location. A network allows data and hardware to be accessible to every pertinent user. This also helps with interdepartmental data processing. For example, the marketing team analyzes customer data and product development cycles to enable executive decisions at the top level.

2. Resource availability & reliability

A network ensures that resources are not present in inaccessible silos and are available from multiple points. The high reliability comes from the fact that there are usually different supply authorities. Important resources must be backed up across multiple machines to be accessible in case of incidents such as hardware outages.

3. Performance management

A company's workload only increases as it grows. When one or more processors are added to the network, it improves the system's overall performance and accommodates this growth. Saving data in well-architected databases can drastically improve lookup and fetch times.

4. Cost savings

Huge mainframe computers are an expensive investment, and it makes more sense to add processors at strategic points in the system. This not only improves performance but also saves money. Since it enables employees to access information in seconds, networks save operational time, and subsequently, costs. Centralized network administration also means that fewer investments need to be made for IT support.

5. Increased storage capacity

Network-attached storage devices are a boon for employees who work with high volumes of data. For example, every member in the data science team does not need individual data stores for the huge number of records they crunch. Centralized repositories get the job done in an even more efficient way. With businesses seeing record levels of customer data flowing into their systems, the ability to increase storage capacity is necessary in today's world.

6. Streamlined collaboration & communication

Networks have a major impact on the day-to-day functioning of a company. Employees can share files, view each other's work, sync their calendars, and exchange ideas more effectively. Every modern enterprise runs on internal messaging systems such as Slack for the uninhibited flow of information and conversations. However, emails are still the formal mode of communication with clients, partners, and vendors.

7. Reduction of errors

Networks reduce errors by ensuring that all involved parties acquire information from a single source, even if they are viewing it from different locations. Backed-up data provides consistency and continuity. Standard versions of customer and employee manuals can be made available to a large number of people without much hassle.

8. Secured remote access

Computer networks promote flexibility, which is important in uncertain times like now when natural disasters and pandemics are ravaging the world. A secure network ensures that users have a safe way of accessing and working on sensitive data, even when they're away from the company premises. Mobile handheld devices registered to the network even enable multiple layers of authentication to ensure that no bad actors can access the system.

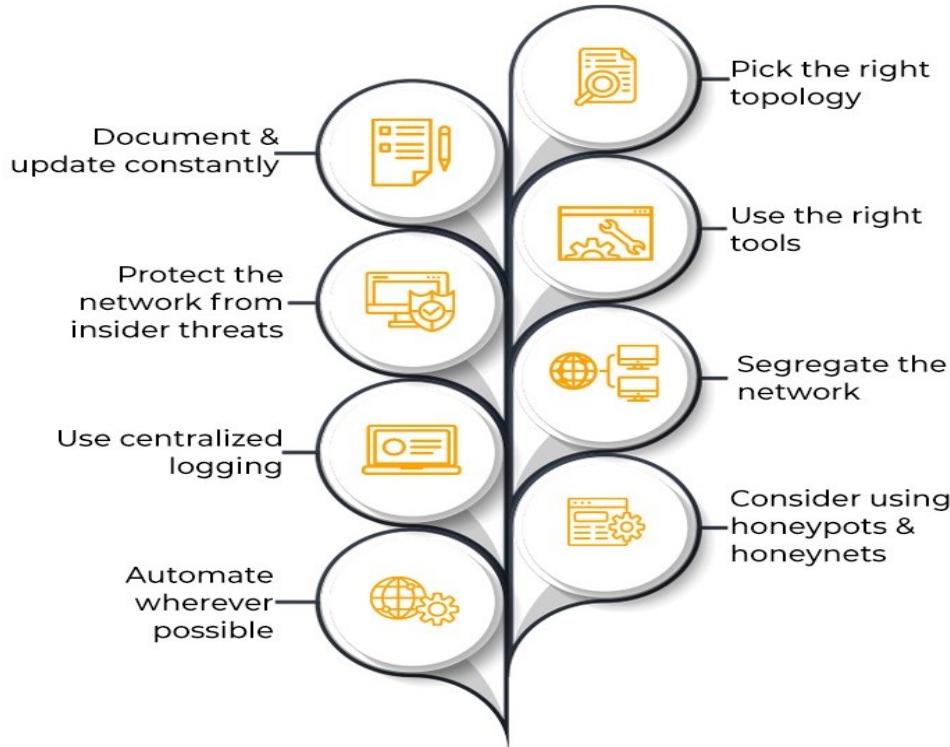
Computer Network Management

Network management is the process of configuring, monitoring, and troubleshooting everything that pertains to a network, be it hardware, software, or connections. The five functional areas of network management are fault

management, configuration management, performance management, security management, and (user) accounting management.

Computer networks can quickly become unruly mammoths if not designed and maintained from the beginning. Here are the top 10 practices for proper computer network management.

NETWORK MANAGEMENT



Network Management Best Practices

1. Pick the right topology

Network topology is the pattern or hierarchy in which nodes are connected to each other. The topology can speed up, slow down, or even break the network based on the company's infrastructure and requirements. Before setting up a network from scratch, network architects must choose the right one. Some common topologies include:

- **Bus network:** Each node is linked to only one other node.
- **Ring network:** Each node is linked to two other nodes, thus forming a ring.
- **Mesh network:** Each node must strive to be connected to every other node in the system.
- **Star network:** A central node server is linked to multiple other nodes. This is faster since data doesn't have to travel through each node.
- **Tree network:** Here, nodes are arranged in hierarchies.

2. Document & update constantly

Documentation of the network is vital since it is the backbone of operations. The documentation must include:

- Technical specifications of equipment, including wires, cables, and connectors
- Hardware

- The software used to enable the hardware and the smooth and secure flow of data
- Firmware
- A formal record of policies and procedures with respect to network operators and users

This must be audited at scheduled intervals or during rehabs. Not only does this make network management easier, but it also allows for smoother compliance audits.

3. Use the right tools

The network topology is just the first step toward building a robust network. To manage a highly available and reliant network, the appropriate tools must be placed at the right locations. Must-have tools in a network are:

- **Network monitoring solutions:** A network monitoring solution gives complete visibility into the network. Visual maps help gauge network performance. It can track packets, provide a granular look into network traffic, and help spot anomalies. Newer monitoring systems leverage artificial intelligence to predict scaling requirements and cyber threats using historic and real-time data.
- **Configuration management tools:** A network contains many components that interface with each other. This results in a lot of configuration parameters to keep track of. Configuration management tools resolve this by providing configuration tools that span across the entire network. They also allow network managers to ensure that all compliance requirements have been fulfilled.
- **IP address managers:** Bigger networks need to have an IP address manager (IPAM) to plan, track, and manage information associated with a network's IP addresses.
- **Security solutions:** Firewalls, content filtering systems, intrusion detection and prevention systems—these are all tools that safeguard networks that are carrying increasingly sensitive loads. No network is complete without them. However, just acquiring these tools is not enough. They must also be properly placed within the network. For example, a firewall must be placed at every network junction. Anti-DDoS devices must be placed at the perimeters of the network. Load balancers need to be placed at strategic locations based on the infrastructure, such as before a cluster of database servers. This must be an explicit part of the network architecture.

4. Establish baseline network & abnormal behavior

A baseline allows admins to know how the network normally behaves in terms of traffic, user accesses, etc. With an established baseline, alerts can be set up in appropriate places to flag anomalies immediately. The normal range of behavior must be documented at both, user and organizational levels. Data required for the baseline can be acquired from routers, switches, firewalls, wireless APs, sniffers, and dedicated collectors.

5. Protect the network from insider threats

Firewalls and intrusion prevention systems ensure that bad actors remain out of the network. However, insider threats need to be addressed as well, particularly with cybercriminals targeting those with access to the network using various social engineering ploys. One way of doing this is to operate on a least-privilege model for access management and control. Another is to use stronger authentication mechanisms such as single sign-on

(SSO) and two-factor authentication (2FA). Besides this, employees also need to undergo regular training to deal with security threats. Proper escalation processes must be documented and circulated widely.

6. Use multiple vendors for added security

While it makes sense to stick to one hardware vendor, a diverse range of network security tools is a major plus for a large network. Security is a dynamic and ever-involving landscape. Hardware advancements are rapid and cyber threats also evolve with them. It is impossible for one vendor to be up to date on all threats. Additionally, different intrusion detection solutions use different detection algorithms. A good mix of these tools strengthens security; however, you must ensure that they are compatible and allow for common logging and interfacing.

7. Segregate the network

Enterprise networks can become large and clunky. Segregation allows them to be divided into logical or functional units, called zones. Segregation is usually done using switches, routers, and virtual LAN solutions. One advantage of a segregated network is that it reduces potential damage from a cyberattack and keeps critical resources out of harm's way. Another plus is that it allows for more functional classification of networks, such as separating programmer needs from human resources needs.

8. Use centralized logging

Centralized logs are key to capturing an overall view of the network. Immediate log analysis can help the security team flag suspicious logins and IT admin teams to spot overwhelmed systems in the network.

9. Consider using honeypots & honeynets

Honeypots are separate systems that appear to have legitimate processes and data but are actually a decoy for insider and outsider threats. Any breach of this system does not cause the loss of any real data. A honeynet is a fake network segment for the same cause. While this may come at an additional cost to the network, it allows the security team to keep an eye out for malicious players and make appropriate adjustments.

10. Automate wherever possible

New devices are added to systems regularly, and old ones are retired. Users and access controls keep changing frequently. All of these must be automated to ensure that human error does not occur and there are no vulnerable zombie systems in the network, costing money and security. Automation with respect to security is also crucial. It is a good practice to automate responses to attacks, including blocking IP addresses, terminating connections, and gathering additional information about attacks.

Takeaway

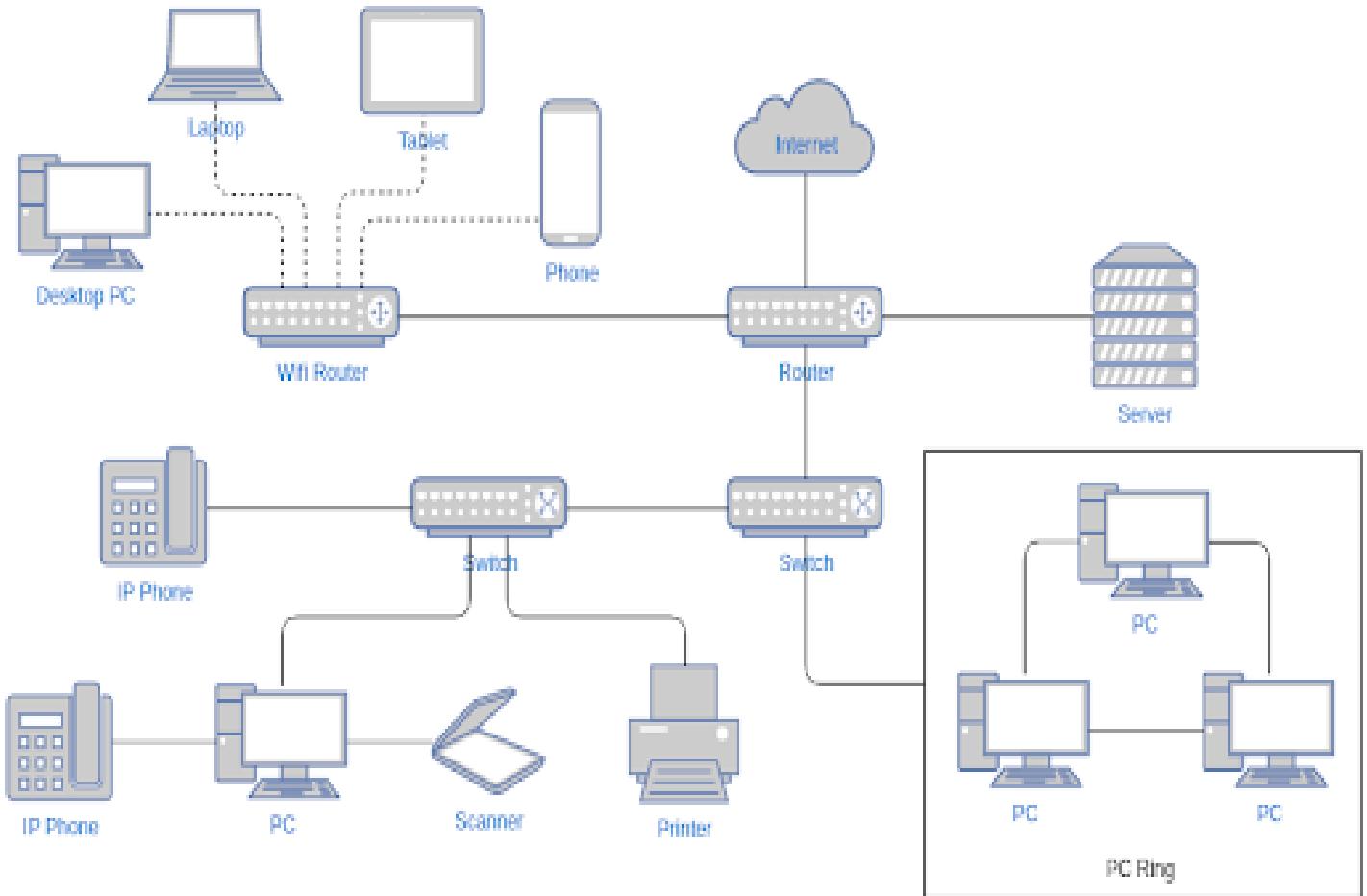
A successful network enhances productivity, security, and innovation with the least overhead costs. This comes only with robust design and implementation with a clear picture of the business needs. While network creation may purely seem like a technical endeavor, it requires business input, especially in the beginning stages. Network management also involves evolving workflows and growing and morphing with evolving technologies.

THE INTERNET

- The internet is defined as a global network of linked computers, servers, phones, and smart appliances that communicate with each other using the transmission control protocol (TCP) standard to enable the fast exchange of information and files, along with other types of services.

What Is the Internet?

The internet is a global network of interconnected computers, servers, phones, and smart appliances that communicate with each other using the transmission control protocol (TCP) standard to enable a fast exchange of information and files, along with other types of services.



How Internet Works

The internet is a global hub of computer networks — a network of connections wherein users at any workstation may, with authorization, receive data from every other system (and often interact with users working on other computers).

Internet infrastructure comprises optical fiber data transmission cables or copper wires, as well as numerous additional networking infrastructures, such as local area networks (LAN), wide area networks (WAN), metropolitan area networks (MAN), etc. Sometimes wireless services such as 4G and 5G or WiFi necessitate similar physical cable installations for internet access.

Internet Corporation for Assigned Names and Numbers (ICANN) in the United States controls the internet and its associated technologies, such as IP addresses.

How was the internet developed?

The internet was first envisioned in the form of ARPANET by the Advanced Research Projects Agency (ARPA) of the U.S. government in 1969. The initial goal was to create a network that would enable users of a research computer at one institution to “communicate” with research computers at another institution. Since communications can be sent or diverted across several directions, ARPANet could continue to operate even if a military strike or any other calamity damages portions of the network.

ARPANET used the new packet switching technology to create low-cost, interactive interactions between computers, which generally communicate in short data bursts. Packet switching broke down large transmissions (or portions of computer data) into smaller, more manageable parts (called packets) that could travel independently across any accessible circuit to the destination where they were reassembled. Consequently, unlike conventional voice services, packet switching doesn’t require a separate dedicated connection between a pair of users.

In the 1970s, corporate packet networks were launched, although their primary purpose was to enable efficient access to distant computers through specialized terminals. They replaced expensive long-distance modem connections with “virtual” lines via packet networks.

Today, the internet is a globally accessible, collaborative, and self-sustaining public resource available to tens of millions of individuals. Countless people utilize it as their primary source of data consumption, spurring the development and expansion of their own community through social networking and content exchange. However, private versions of the internet do exist, which are primarily used by large organizations for secure and regulated information exchange.

See More: [What Is NAS \(Network Attached Storage\)? Working, Features, and Use Cases](#)

Key features of the internet

The internet is a vast, interconnected network of computers and other network-enabled devices, which is:

- **Globally available:** The internet is an international service with universal access. People living in isolated areas of an archipelago or even in the depths of Africa can now access the internet.
- **Easy to use:** The software used to connect to the internet (web browser) is user-friendly and easy to understand. It’s also relatively easy to create.
- **Compatible with other types of media:** The internet provides a high level of engagement with photos and videos, among other media.
- **Affordable:** Internet service development, as well as maintenance costs, are modest.
- **Flexible:** Internet-based communication is highly adaptable. It supports text, audio, and video communication. These services are available at both individual and organizational levels.

How Does the Internet Work?

The internet delivers different types of information and media across networked devices. It operates using an internet protocol (IP) and a transport control protocol (TCP) packet routing network. Whenever you visit a website, your computer or mobile device requests the server using such protocols.

A server is where web pages are stored, and it functions similarly to the hard drive of a computer, except with far greater processing power. The server accesses the web page and delivers the right information to your computer whenever the request arrives. This is broadly the end-to-end user experience. Let us now look at the more technical details of how the internet works.

1. Connecting computers

The basic foundation of the internet is an interconnected network of computers. When two computers interact, they must be physically (often via an Ethernet connection) or wirelessly connected (via Wi-Fi or Bluetooth). All modern systems can support any of these connections to establish a core network.

2. Scaling computer networks

The computer network, as described above, is not restricted to two PCs. One can link several computers. However, as you expand, it may get more complex. Every machine on a network is connected to a tiny computing device known as a router to address this problem. This router's only function is to operate as a signaler. It ensures that a message transmitted from a particular computer reaches its intended recipient. With the addition of a router, a system of 10 computers needs merely ten wires instead of $10 \times 10 = 100$ connections.

3. Enabling infinite scaling

Let us now discuss interconnecting hundreds of thousands to billions of machines. A single router cannot scale to that extent; nonetheless, a router is an independently programmable computer unit. This implies that two or more routers may be connected, enabling infinite scaling.

4. Utilizing ubiquitous public infrastructure via a modem

By now, we have constructed a network identical to the internet, although it is only intended for individual use and cannot connect with the outside world. This is where public infrastructure comes in. The telephone system links an office to everyone worldwide, making it the ideal wiring configuration for the internet. A modem is necessary for connecting networks to the telephone system. This modem converts data from a network into data that can be managed by the telephony architecture and vice versa.

See More: [What Is URL Filtering? Definition, Process, and Best Practices](#)

5. Sending messages from one network to another

The following step is to transmit the information from your network to the target network. To accomplish this, the network must establish a connection with an internet service provider (ISP). An ISP is a service that administers specified routers that are interconnected and also have access to the routers of other ISPs. Therefore, the data from the host network is delivered to the target network via the web of ISP networks.

To deliver a message to a system, it is important to identify which computer it should be sent to. Therefore, every machine connected to a network has a unique identifying address known as an “IP address” (here, IP refers to

internet protocol). It is an address consisting of four integers separated by periods, such as 192.168.2.10. There are several versions of IP; currently, we are in IPv4 and IPv6 iterations, depending on the region.

6. Assigning domain name to IP addresses

IP addresses are intended for computers, but in an infinitely extensible internet, it would be difficult for people to keep count of an ever-growing number of addresses. To simplify matters, one may designate an IP address with a domain name, a human-readable name. Google.com is an excellent example of this — the domain name is used in conjunction with the IP address 142.250.190.78. Therefore, typing the domain name is the simplest way to access a computer online.

7. Connected the internet to the web

The internet is a network architecture that enables millions of machines to communicate with one another. Several of these machines (web servers) can feed web browsers intelligible messages. The web is an application constructed on top of the internet's infrastructure. It is important to note that additional services, like email, have been developed on top of the internet.

8. Connecting the internet to a private intranet or extranet

Intranets are personal and bespoke networks confined to an organization's members. They offer participants a secure gateway to access shared information, collaborate, and communicate.

Extranets are quite similar to intranets, except that they enable collaboration and sharing with other businesses. Typically, they are employed to safely and confidentially transmit information to customers and other enterprise stakeholders. Frequently, their functions resemble those of an intranet: file and information sharing, collaboration tools, message boards, etc.

Intranets and extranets operate on the same infrastructure and adhere to the same protocols as the internet.

How does the web work?

When we discuss the internet in common parlance, we typically refer to the web – although the two terms are not interchangeable. If the internet can be understood as a network of highways, then the web will be the network of restaurants, toll booths, gas stations, etc., built along it. The main job of the internet is to access the web. However, it can perform other tasks like supporting cloud storage on computers, keeping the software as a service (SaaS) apps online, automatically updating the computer's time, etc.

On the other hand, the web comprises multiple computers connected to the internet called clients and servers.

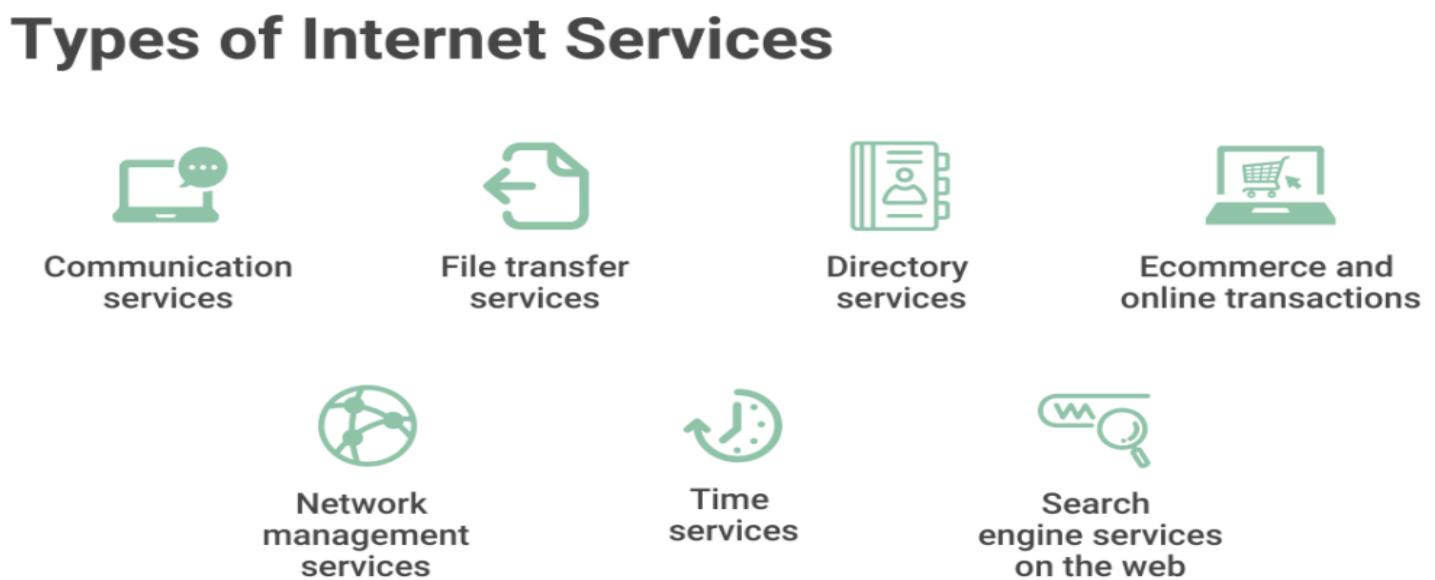
- Clients are internet-connected devices of a web user (such as a computer linked to Wi-Fi or a mobile phone) and the online-accessing software installed on such systems (generally a web browser).
- Servers store websites, applications, and their associated data and activities. When a client device requests access to a website, a replica of the webpage is received from the server to the client's computer. The webpage is then exhibited in the client's web browser.

When a user inputs a domain name or uniform resource locator (URL) in the browser, the domain name system (DNS server) is contacted to get the actual IP address of the website's server.

The browser then transmits an HTTP or HTTPS request message back to the server, asking the server to transmit a copy of the web page to the client. This message and all other data transferred between the client and server are sent via the TCP/IP protocol across your internet connection.

If the server authorizes the client's request, it returns a "200 OK" status code. The server then begins transmitting the site's contents to the client as a sequence of data packets. The browser constructs an entire web page from the packets and starts displaying it. This request, response, and information exchange happens via the internet infrastructure.

Types of Internet Services



As mentioned earlier, the internet can enable various services, not just web access. Some of the key types of internet services are:

1. Communication services

To exchange data/information among individuals or organizations, the internet enables communication services. This mainly includes VoIP and video conferencing.

Voice over internet protocol (VoIP) enables users to place voice calls over the internet compared to a conventional (or analog) phone connection. Other VoIP services allow you to contact anybody with a mobile number, encompassing long-distance, cellular, and even local/international connections.

Video conferencing technology enables two or more individuals in separate locations to connect visually and in real time. It includes persons in different places using video-enabled devices and broadcasting real-time speech, video, texts, and slideshows via the internet.

Other communication services based on the internet include email, internet relay chat (IRC), and list server (LISTSERV) used for asynchronous text communication, instant messaging, and group announcements, respectively.

2. File transfer services

We utilize file transfer to exchange, transmit, or send a document or logical data item among many individuals or computers, both locally and remotely. Data files may comprise documents, videos, photos, text, or PDFs. They may be shared via internet downloading and uploading. File transfer protocol (FTP) is one of the most common internet protocols used for this purpose.

3. Directory services

A directory service is a collection of software that maintains information about the organization, its customers, or both. Directory services are responsible for mapping network resource names to network addresses. It offers administrators and users transparent access to all network computers, printers, servers, and other devices. It is also an important backend service provider for and by the internet.

Domain name system (DNS) and lightweight directory access protocol (LDAP) are the most commonly used directory services. A DNS server stores a map of computer hostnames and other domain names to IP addresses. LDAP is a collection of open protocols to obtain centralized network access to stored data. It is also a mechanism for cross-platform authentication.

See More: [What Is Web Real-Time Communication \(WebRTC\)? Definition, Design, Importance, and Examples](#)

4. Ecommerce and online transactions

Ecommerce allows the customer to purchase a service or product directly from the vendor, at any time or anywhere on the planet. When IBM started offering hardware and software for computers over the internet, it was one of the first instances of ecommerce. Since then, this service has grown in use tremendously. Ecommerce uses the web to enable financial exchanges so that data packets can translate into their real-world monetary equivalents.

5. Services for network management

Network management services are some of the most critical and valuable internet services for IT administrators. They assist in avoiding, monitoring, diagnosing, and resolving network-related issues. Two services are mainly used for this purpose – ping and traceroute.

The ping utility checks the host machine's availability and the time required to react to any and all internet control message protocol (ICMP) transmissions. It guarantees that all requests issued by a computer reach the web server without packet loss. In the meantime, the traceroute identifies and displays all potential paths from query to response, as well as the turnaround time for each route.

6. Time services

Greenwich Mean Time (GMT) or Coordinated Universal Time synchronizes computer clocks (UTC). Network time protocol (NTP) is an established internet time service that syncs and adjusts the computer clock accurately

to all these standards. All Windows time variants released after Windows 2000 synchronize with an NTP server. NTPsec is primarily a secured version of NTP.

7. Search engine services on the web

When users search for a web page through a search engine rather than the domain name, the search engine examines the web crawler's index of all pages. It will study the search phrase and compare it to the database, including how often the search terms appear on a webpage, where they appear on the site, whether they appear together, etc. It analyzes this information to determine which websites best fit your search query.

The results are then shown in order, with those that best fit the search keyword appearing initially. It is important to note that search engines can accept funds from commercial entities to prioritize their websites in the results of a particular query. This is an advert, and the search engine results will be labeled as such.

The internet is one of the critical pillars of modern civilization. It has helped in globalization, fast-tracked digital transformation in education and healthcare, and made information access truly universal. However, global internet penetration is yet to reach 100% and to deliver its benefits worldwide, companies and governments must focus on expanding internet infrastructure.

COMPUTER SECURITY

What is computer security?

Computer security basically is the protection of computer systems and information from harm, theft, and unauthorized use. It is the process of preventing and detecting unauthorized use of your computer system.

There are various types of computer security which is widely used to protect the valuable information of an organization.

What is Computer Security and its types?

One way to ascertain the similarities and differences among Computer Security is by asking what is being secured. For example,

- *Information security* is securing information from unauthorized access, modification & deletion
- *Application Security* is securing an application by building security features to prevent from Cyber Threats such as SQL injection, DoS attacks, data breaches and etc.
- *Computer Security* means securing a standalone machine by keeping it updated and patched
- *Network Security* is by securing both the software and hardware technologies
- *Cybersecurity* is defined as protecting computer systems, which communicate over the computer networks

It's important to understand the distinction between these words, though there isn't necessarily a clear consensus on the meanings and the degree to which they overlap or are interchangeable.

So, **Computer security** can be defined as controls that are put in place to provide confidentiality, integrity, and availability for all components of computer systems. Let's elaborate the definition.

Components of computer system

The components of a computer system that needs to be protected are:

- *Hardware*, the physical part of the computer, like the system memory and disk drive
- *Firmware*, permanent software that is etched into a hardware device's nonvolatile memory and is mostly invisible to the user
- *Software*, the programming that offers services, like operating system, word processor, internet browser to the user

The CIA Triad

Computer security is mainly concerned with three main areas:



- **Confidentiality** is ensuring that information is available only to the intended audience
- **Integrity** is protecting information from being modified by unauthorized parties
- **Availability** is protecting information from being modified by unauthorized parties

In simple language, computer security is making sure information and computer components are usable but still protected from people or software that shouldn't access it or modify it.

Go through our new Ethical Hacking Training Course to explore more about ethical hacking. This course will teach you the most current hacking techniques, tools and methods that hackers use.

Now moving forward with this ‘What is Computer Security?’ article let's look at the most common security threats.

Computer security threats

Computer security threats are possible dangers that can possibly hamper the normal functioning of your computer. In the present age, cyber threats are constantly increasing as the world is going digital. The most harmful types of computer security are:

Viruses



A computer virus is a malicious program which is loaded into the user's computer without user's knowledge. It replicates itself and infects the files and programs on the user's PC. The ultimate goal of a virus is to ensure that the victim's computer will never be able to operate properly or even at all.

Computer Worm



A computer worm is a software program that can copy itself from one computer to another, without human interaction. The potential risk here is that it will use up your computer hard disk space because a worm can replicate in great volume and with great speed.

Phishing



Cyber Security Training

Disguising as a trustworthy person or business, phishers attempt to steal sensitive financial or personal information through fraudulent email or instant messages. Phishing is unfortunately very easy to execute. You are deluded into thinking it's the legitimate mail and you may enter your personal information.

Botnet



A botnet is a group of computers connected to the internet, that have been compromised by a hacker using a computer virus. An individual computer is called 'zombie computer'. The result of this threat is

the victim's computer, which is the bot will be used for malicious activities and for a larger scale attack like DDoS.

Rootkit



A rootkit is a computer program designed to provide continued privileged access to a computer while actively hiding its presence. Once a rootkit has been installed, the controller of the rootkit will be able to remotely execute files and change system configurations on the host machine.

Keylogger



Also known as a keystroke logger, keyloggers can track the real-time activity of a user on his computer. It keeps a record of all the keystrokes made by user keyboard. Keylogger is also a very powerful threat to steal people's login credential such as username and password.

These are perhaps the most common security threats that you'll come across. Apart from these, there are others like **spyware**, **wabbits**, **scareware**, **bluesnarfing** and many more. Fortunately, there are ways to protect yourself against these attacks.

Why is Computer Security Important?

In this digital era, we all want to keep our computers and our personal information secure and hence computer security is important to keep our personal information protected. It is also important to maintain our computer security and its overall health by preventing viruses and malware which would impact on the system performance.

Computer Security Practices

Computer security threats are becoming relentlessly inventive these days. There is much need for one to arm oneself with information and resources to safeguard against these complex and growing computer security threats and stay safe online. Some preventive steps you can take include:

- Secure your computer physically by:
 - Installing reliable, reputable security and anti-virus software
 - Activating your firewall, because a firewall acts as a security guard between the internet and your local area network

- Stay up-to-date on the latest software and news surrounding your devices and perform software updates as soon as they become available
- Avoid clicking on email attachments unless you know the source
- Change passwords regularly, using a unique combination of numbers, letters and case types
- Use the internet with caution and ignore pop-ups, drive-by downloads while surfing
- Taking the time to research the basic aspects of computer security and educate yourself on evolving cyber-threats
- Perform daily full system scans and create a periodic system backup schedule to ensure your data is retrievable should something happen to your computer.

GOOGLE

Originally known as **BackRub**, **Google** is a search engine that started development in 1996 by Sergey Brin and Larry Page as a research project at Stanford University to find files on the Internet. Larry and Sergey later decided the name of their search engine needed to change and chose Google, which is inspired from the term googol. The company is headquartered in Mountain View, California.

Google beginnings

The domain google.com was registered on September 15, 1997, and the company incorporated on September 4, 1998. The picture below is a capture of the site from The Internet Archive of what Google looked like in 1998.

Note

As of August 10, [2015](#), Google is a subsidiary of the [Alphabet Inc.](#)

What helps Google stand out from its competition, helps it continue to grow, and be the number one search engine is its [PageRank](#) technique that sorts search results. While being one of the best search engines on the Internet, Google also incorporates many of its other services, like Google Maps and Google Local, to provide more relevant search results.

How to open Google

To open Google, click this link: google.com, or in your [web browser address bar](#), type "google.com" and press [Enter](#).

Once the Google website is open, in the [search box](#), type a word or phrase, and press Enter or click the **Google Search** button. If done successfully, you'll be given [search results](#).

Most browser's address bars are an [omnibox](#), meaning instead of going to Google.com to search, you can type what you are searching for without going to Google.

Note

Some users may confuse the "Google" with the web browser Google Chrome. If you want to open the Google Chrome web browser, see our [Google Chrome](#) page.

Other Google products and services

- [Android](#) - The most widely used operating system for smartphones.

- **Blogger** - View and create a personal [blog](#).
- **Chromebook** - [Laptop](#) using the Google Chrome OS.
- **Chrome OS** - Operating system developed by Google for laptop and portable computers.
- **Gmail** - Free online e-mail service with over 1 GB of storage and the best [spam](#) protection available.
- **Google Ad Manager** - Originally known as DoubleClick, Google Ad Manager is a service that allows a publisher to manage their ad [inventory](#).
- **Google Ads** - Formerly known as Google AdWords, Google Ads is a service that enables users to pay to advertise on the Google search engine and other websites using Google AdSense.
- **Google AdSense** - A service that pays website publishers or blog developers to show advertisements on their site.
- **Google Alerts** - Create alert text messages sent to an e-mail address each day or as it happens of web searches, news searches, etc.
- **Google Analytics** - Google Analytics allows users to monitor and create reports of visitors to their website.
- **Google App Engine** - A service that provides users the ability to create scalable web services that use Google's resources.
- **Google Assistant** - Digital assistant service by Google that uses artificial intelligence to respond to voice requests.
- **Google Blog** - A [blog](#) maintained by Google that helps give an insight into the company.
- **Google Books** - Another fantastic service from Google containing hundreds of thousands of books that can be searched.
- **Google Calendar** - A way to organize your schedule, synchronize, and share events with your friends.
- **Google Chrome** - The most popular desktop Internet [browser](#).
- **Google Classroom** - Google service that allows students and teachers to participate in a digital class.
- **Google Cloud** - Service for businesses to store data and run applications in the [cloud](#), and backup and disaster recovery.
- **Google CSE (Custom Search Engine)** - Service that lets you create a custom Google Search engine.
- **Google Daydream View** - [VR](#) headset.
- **Google Developer** - A place to find all Google developer documentation, resources, events, and products.
- **Google Docs** - A fantastic free solution from Google that lets you create documents, open [Microsoft Word](#) documents, and share your documents with other users that have Internet access.
- **Google Domains** - Domain registrar service from Google that lets you register a [domain name](#) with more than 300 domain endings.
- **Google Drive** - A cloud storage service from Google introduced on April 24, 2012, that allows users to view, edit, and store their documents and files in the Google cloud.

- **Google Duo** - A cross-platform video calling application for [Android](#) smartphones, and other Google and third-party operating systems.
- **Google Earth** - A fantastic software program that allows a person to view almost everywhere on earth, get directions, find close shops and places of interest, and more.
- **Google Fiber** - A limited service available in some places in the United States that offers a [fiber](#) connection to the Internet.
- **Google Fonts** - A collection of thousands of fonts for use on your web page.
- **Google Forms** - A feature of Google Docs that allows users to create a form that collects information for personal or business use.
- **Google Fuchsia** - An open source operating system.
- **Google Glass** - AR ([augmented reality](#)) glasses.
- **Google Groups** - Google's bulletin board with millions of users and postings.
- **Google Home** - Voice activated virtual digital assistant that assists users with questions.
- **Google Homepage** - Google's main page and search engine.
- **Google Images** - Google search that lets you search for images instead of text.
- **Google Keep** - Fantastic service that lets you keep and store notes and tasks.
- **Google Lens** - An image recognition technology that identifies objects and displays information about them using Google Search.
- **Google Mail** - More well-known as [Gmail](#), the most popular e-mail host.
- **Google Maps** - A great feature that enables users to search for directions from one location to another, search for local businesses, and more.
- **Google Meet** - A video-meeting application that integrates with Google Chat and replaces the functionalities previously found in Hangouts.
- **Google Moon** - In celebration of the first Moon landing, Google created this page with a map of our Moon and each of the moon landings.
- **Google My Maps** - Feature in Google Maps that allows its users to create custom maps for personal use or share with others.
- **Google Nest** - Google home automation and security products, including the [Nest thermostat](#).
- **Google News** - Great news site automatically generated using the results of news sites queried by Google.
- **Google Ngram Viewer** - Great tool that lets you search many books and other printed materials for the frequency of words or phrases.
- **Google Now** - Service primarily used by mobile users that gives the most relevant information relating to you based of your searching and driving habits.
- **Google Patents** - Allows users to search over 7 million patents.

- [**Google Photos**](#) - Online cloud storage for photos and videos, allowing users to upload, organize, and share with other users.
- [**Google Pixel**](#) - Google smartphone.
- [**Google Play Music**](#)- A service that allows users to stream, download, and upload music to a person library, and create and listen to radio stations. It is usable across multiple devices. Additionally, Google Play Music unlimited song streaming for a monthly fee.
- [**Google Scholar**](#) - Allows users to search for scholarly literature.
- [**Google Search Console**](#) - Formerly Google Webmaster Tools, a great service provided by Google that enables webmasters to view, maintain, and control how Google indexes their web page.
- [**Google Sheets**](#) - A fantastic free solution from Google that lets you create spreadsheets, open [Microsoft Excel](#) spreadsheets, and share your spreadsheets with other users that have Internet access.
- [**Google Shopping**](#) - Formerly known as Froogle, Google Shopping is a search service for finding products based on prices, location, type, etc.
- [**Google Sites**](#) - A service that enables users to create and share websites.
- [**Google Slides**](#) - A presentation program similar to [Microsoft PowerPoint](#).
- [**Google SMS**](#) - Enables users to send text messages over their mobile using [SMS](#) to get quick answers, such as driving directions, movie show times, local business listing, etc.
- [**Google Street View**](#) - A great service that allows anyone to drive down the streets around the world.
- [**Google Tag Manager**](#) - A service that allows website publishers to add and remove [tags](#) through a web-based [user interface](#) instead of updating HTML code directly.
- [**Google Takeout**](#) - A utility that allows users to download their Google data from various apps, programs, and services.
- [**Google Translate**](#) - Translate a foreign language web page or text into your language.
- [**Google Trends**](#) - List of the 100 most active search queries and comparison of what people are searching for on Google.
- [**Google Video**](#) - Search for online videos hosted by Google, and transcript text of videos and TV shows.
- [**Google Voice**](#) - Use Google search over the phone using your voice.
- [**Google Wallet**](#) - A payment service developed by Google that allows people to send and receive money from other people.
- [**Google Workspace**](#) - A suite of cloud software for businesses.
- [**Google.org**](#) - The philanthropic arm of Google.
- [**My Activity**](#) - Utility that tracks your history when you use Google's services.
- [**Quick, Draw!**](#) - Drawing game to help test artificial intelligence.
- [**Waze**](#) - A GPS navigation application for mobile devices.
- [**WebP**](#) - Compressed image format.

- [**Wing**](#) - A drone delivery service that delivers light-weight items over short distances.
- [**YouTube**](#) - Video service that allows users to freely upload videos and view others videos.

Tip

We also suggest you visit our [Google tips](#) page for additional tips on using all Google services.

What is a Googler?

When referring to an employee, a **Googler** is a Google employee. When talking about a [user](#), a Googler refers to someone who uses the Google search engine frequently.

Google Easter eggs

Google also has several well-known hidden [Easter eggs](#) throughout its services. Below is a list of these hidden gems.

- [**Google H4x0r**](#) - Display Google's search page and results in [leet speak](#).
- [**Google Klingon**](#) - Display Google's search page and results in Klingon.
- [**Google Pig Latin**](#) - Display Google's search page and results in Pig Latin.

Discontinued Google services

Below is a listing of many discontinued Google services that are no longer supported, deprecated, merged into other products, or sold off to other companies.

- [**Google+**](#) - Google [social networking](#) site that was discontinued for consumers on April 2, [2019](#). Although no longer used by the public, Google+ is still used internally at Google as a way for employees to communicate and share ideas.
- [**Google Allo**](#) was a mobile instant messaging app developed for [Android](#) and [iOS](#) to exchange messages, images, files, and videos. Allo was discontinued on March 12, [2019](#).
- [**Google Answers**](#) - Discontinued in December [2006](#). The site is still online, but can only be read and not edited or have new questions be asked.
- [**Google Base**](#) - A database service provided by Google the service and API was deprecated on December 17, [2010](#).
- [**Google Buzz**](#) - Discontinued on December 15, [2011](#), Google Buzz was a social networking site replaced by [**Google+**](#).
- [**Google Checkout**](#) - Service that provided users and sellers with an easy and secure method of paying each other. The service was discontinued on November 20, [2013](#), and replaced with Google Wallet.
- [**Google Cloud Print**](#) - A [cloud printing](#) solution discontinued on December 31, [2020](#).
- [**Google Code**](#) - Allowed users to view source code on websites that was discontinued on March 12, [2015](#). Thousands of the Google open source products were moved to [GitHub](#).
- [**Google Code Search**](#) - A search tool that allowed developers to search for open source code.
- [**Google Deskbar**](#) and [**Google Desktop**](#) - Small software utility that adds a Google search to the Microsoft Windows [Taskbar](#) allowing users to search without even opening a browser.

- **Google Dictionary** - An online dictionary search service that was discontinued as it became integrated into the Google search.
- **Google Directory** - Browse the open directory of web pages modified to list the directory listings by Google's PageRank technology.
- **Google Express** - A delivery service available in most states that was discontinued in 2019.
- **Google Fast Flip** - An online news aggregator from Google that was discontinued in September 2011.
- **Google Hangouts** - Communication platform for messaging, SMS, video chat, and VoIP. To be shut down in November 2022.
- **Google Helpouts** - Originally launched in November 2013, Google Helpouts was a service that allowed users to share their knowledge and experience with other users with live help and video. The service officially closed on April 20, 2015.
- **Google Labs** - A section of Google that once displayed upcoming features. This section was later discontinued.
- **Google Market** - The original location to find apps for Android. Google Market was rebranded into Google Play in 2012.
- **Google Moderator** - A tool from Google that allowed anyone to collect the best input from an audience of any size. The service was discontinued on June 30, 2015.
- **Google Play** - A service that allows users to search and download apps, books, movies, and music for Android devices. The service was shut down in 2020 and moved to YouTube Music.
- **Google Reader** - An RSS/Atom reader that was discontinued on July 1, 2013.
- **Google Sets** - Type in a few keywords that are similar to pull up a listing of more words that relate to the words you typed.
- **Google SketchUp** - A tool for creating and sharing 3-D models that is now owned by Trimble on June 1, 2012.
- **Google Talk** - Instant Messenger program that used XMPP. In May 2013, Google announced plans to drop XMPP support for its own proprietary standard used with Google Hangouts.
- **Google Tango** - Augmented reality computing platform that was discontinued on December 15, 2017.
- **Google Toolbar** - For early Microsoft Windows Internet Explorer and Firefox users. Google Toolbar add-on enables users using these browsers to access Google search and other Google features any time the browser is open.
- **Google URL Shortener** - Service used shorten long URLs. Transitioned to FDL (Firebase Dynamic Links).
- **Google Web Accelerator** - For broadband users, Google Web Accelerator was used to help speed up browsing.
- **iGoogle** - Personalized Google page that allowed you to add links, RSS feeds, games, and more.

- **Orkut** - A [social networking site](#) that provided a location to socialize with your friends and family, and meet new acquaintances from all around the world. Google stopped the Orkut service on September 30, [2014](#).
- **Picasa** - Was a free Microsoft Windows software program to view images, manage images, and more. The program was retired and replaced with Google Photos on March 15, [2016](#).
- **Project Ara** - An experimental smartphone that featured a modular design. The project was canceled in 2016.
- **Stadia** - Online gaming streaming service that was canceled in 2022.
- **YouTube Video Editor** - Was a free feature of YouTube that gave users the ability to edit videos. As of September 20, 2017, Google discontinued the service, but kept the ability to allow users to add enhancements to their videos.

GMAIL

What is Gmail?

Gmail (pronounced *Gee-mail*) is a free web-based email service that provides users with 15 GB of storage for messages and the ability to search for specific messages.

The Gmail program also automatically organizes successively related messages into a conversational thread. Gmail, otherwise known as Google Mail, can be accessed from a personal computer, tablet or any Android or iOS device.

According to Google co-founder and CEO Larry Page, the company was inspired to create Gmail because of a user's letter complaining about problems with existing email services, like Yahoo Mail and Microsoft Outlook.live.com (previously known as Hotmail).

Their complaints included the constant need to delete messages to stay within storage limits and the lack of search ability.

Advantages of using email

- **Cost-effective:** Email is free to use for everyone.
- **Easy access:** Email can be accessed from anywhere, anytime.
- **Flexible:** Messages can be accessed at the recipient's convenience.
- **Speed:** Email can be composed and sent quickly with minimal lag.
- **Mass delivery:** An email can be sent to multiple recipients simultaneously.
- **Message filtering:** Users can filter and categorize their emails.
- **Message storage:** Email messages can be saved for retrieval.

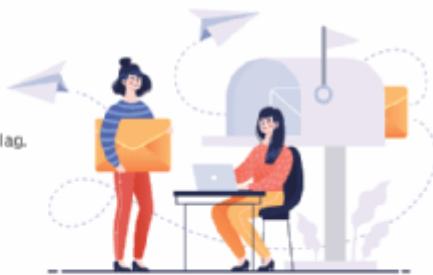


ILLUSTRATION: RACHEL HARRIS/GETTY IMAGES

IMAGE SOURCE: GETTY IMAGES Techtarget

Gmail is the email service used by more people than any other, with over 1.2 billion users worldwide.

What are Gmail's features?

Gmail's interface is minimalist and uncluttered. Gmail incorporates a search bar for users to find specific emails and messages can be filtered using tabs that automatically sort emails into categories.

Gmail also offers users the ability to chat with other Gmail users in real time, as well as make video calls. Gmail's storage capacity, at 15 GB, is considerably larger than most other free email services.

Gmail has several features not commonly found in other email services.

For example, Gmail allows users to archive messages instead of deleting them, and Gmail's search function is powerful enough to find specific messages even if a user can't remember the sender, recipient or subject line.

Gmail also offers a *Priority Inbox* feature that highlights important messages for the user and spam filtering to weed out spam and unsolicited or malicious emails.

Email spam

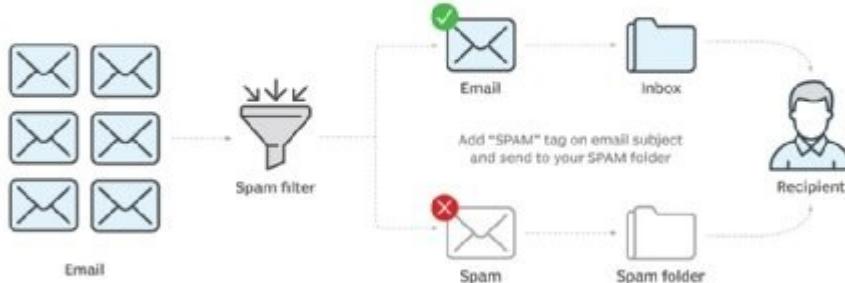


IMAGE SOURCE: GETTY IMAGES Techtarget

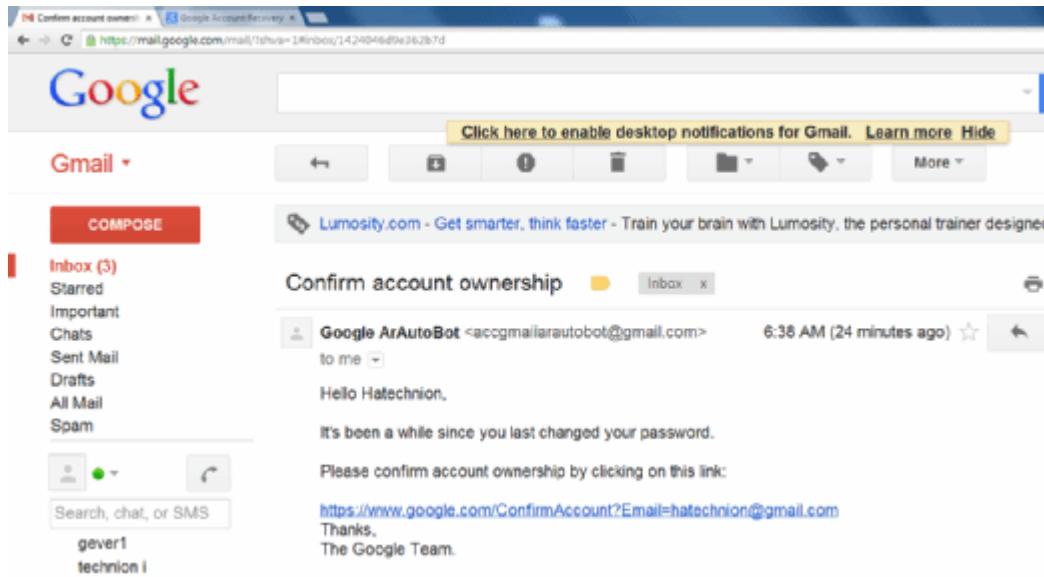
IMAGE SOURCE: GETTY IMAGES Techtarget

Gmail includes spam filtering to weed out spam and unsolicited or malicious emails.

What are Gmail's security features?

Gmail's email system uses secure sockets layer (SSL) encryption when retrieving and sending emails, which means that email messages are less likely to be intercepted by a third party.

However, users must be careful to avoid phishing scams, which are email messages that appear to be from Gmail but are actually from a third party trying to gain access to a user's account.



Gmail users should beware of suspicious emails phishing for sensitive information.

To avoid falling for a phishing scam, Gmail users should only log in to their Gmail account by going to the Gmail website and entering their username and password into the proper fields.

They should never click on a link in an email that purports to be from Gmail but goes to a different website, as these sites often have malware that can infect their PC or reveal their personal data to cybercriminals.

As an added form of protection, Gmail offers two-factor authentication, which requires users to enter not only their password but also a code that is sent to their phone when they try to log in.

This makes it more difficult for someone to gain access to a Gmail account because they would need to know the password and have access to the user's phone.

How to create a Gmail account

To use Gmail, you will need to create a Google account, which is simple and only takes a few minutes. To create a Google account, go to the Gmail website and click on the **Create an account** link.

- Enter your name, choose a username for your email account and set a password.
- You'll also need to enter a date of birth and gender.
- Once you've entered all the required information, click on the **Next Step** button.
- You'll then be asked to verify your phone number by entering a verification code that will be sent to your phone via text message or voice call.

Once you've verified your phone number, you'll be able to write a new email.

Using Gmail also grants you access to Google's other free-to-use productivity tools, such as the following:

- **Google Chrome.** A fast, free web browser powered by Google.

- **Google Calendar.** A calendar application that can be used to schedule events and track appointments.
- **Google Docs.** A word processing application that allows users to create and edit documents online.
- **Google Sheets.** A spreadsheet application that lets users create and edit spreadsheets online.
- **Google Slides.** A presentation application that allows users to create and edit presentations online.
- **Google Hangouts.** A messaging application that lets Gmail users chat with each other in real time.
- **Google Meet.** A video conferencing application that lets Gmail users chat with each other via video call.
- **Google Drive.** A cloud storage service that gives users access to their files from any device with an internet connection.



Google Drive supported files.

Additional apps include Google Play, Google News, Google Meet, Google Chat, Google Contact, Google Translate and Google Photos.

Access these applications by clicking on the **Google apps** icon in the upper right-hand corner of Gmail just to the left of your account profile picture. These should not be confused with Google Workspace (formerly G Suite), however, which is a suite of paid services that delivers productivity applications and collaboration tools plus cloud storage to businesses.

MICROSOFT WORD AND EXCEL

Introduction

Microsoft Word 2013 is a word-processing program that is used to create professional-looking documents such as reports, resumes, letters, memos, and newsletters. It includes many powerful tools that can be used to easily create and edit documents, and collaborate with others. This handout provides an overview of the Word 2013 user interface and covers how to perform basic tasks such as starting and exiting the program; creating, saving, opening, closing, editing, formatting, and printing documents; applying styles; and getting help.

Starting Word

You can start Word 2013 from the Start menu (in Windows 7) or by double-clicking an existing Word file. When you start the program without opening a specific file, the *Start* screen appears, prompting you to open an existing document or create a new document.

To start Word 2013 from the Start menu:

1. Click the **Start** button, click **All Programs**, click **Microsoft Office 2013**, and then click **Word 2013**. The *Start* screen appears (see Figure 1).
2. In the right pane, click **Blank document**. A new, blank document opens in the program window.

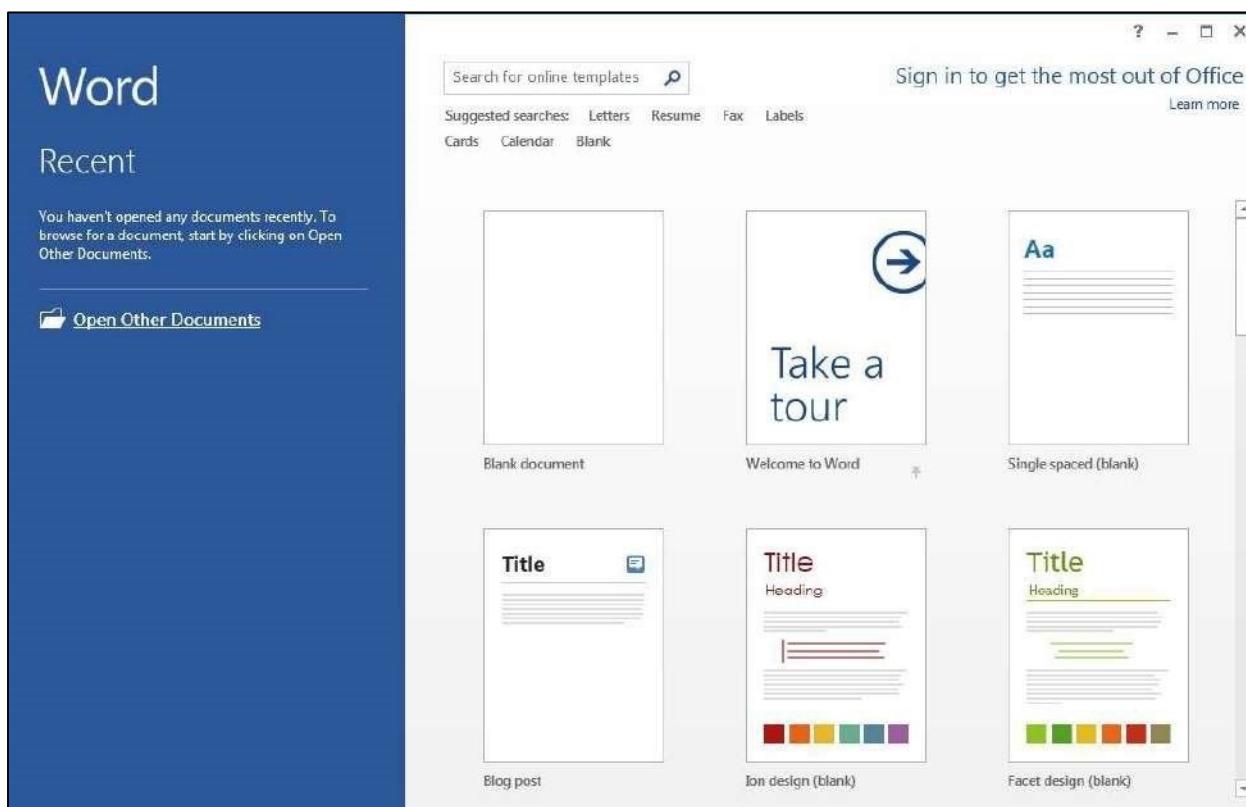


Figure 1 – Word 2013 Start Screen

Overview of the User Interface

All the Microsoft Office 2013 programs share a common user interface so you can apply basic techniques that you learn in one program to other programs. The Word 2013 program window is easy to navigate and simple to use (see Figure 2 and Table 1).

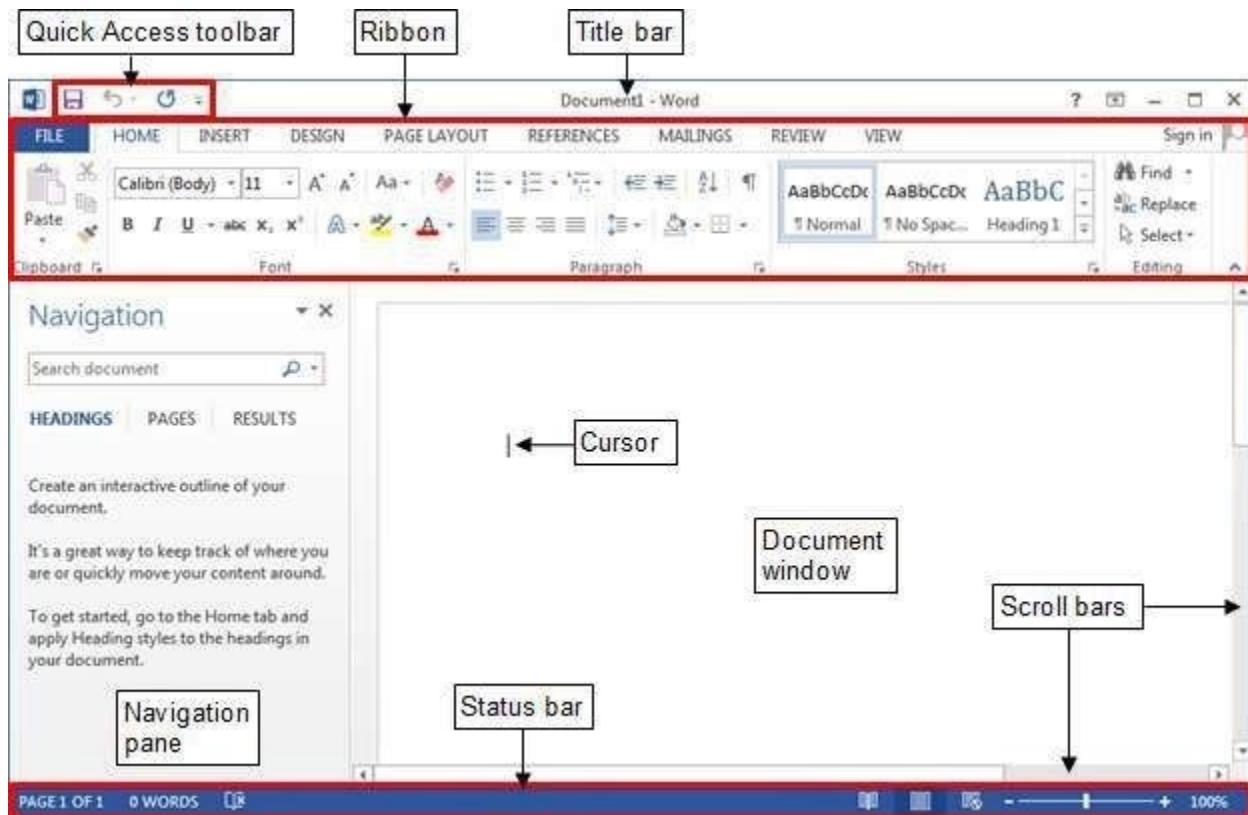


Figure 2 – Word 2013 Program Window

Table 1 – Word 2013 Program Window Elements

Name	Description
Title bar	Appears at the top of the program window and displays the name of the document and the program. The buttons on the right side of the Title bar are used to get help; change the display of the Ribbon; and minimize, restore, maximize, and close the program window.
Quick Access toolbar	Appears on the left side of the Title bar and contains frequently used commands that are independent of the tab displayed on the Ribbon.
Ribbon	Extends across the top of the program window, directly below the Title bar, and consists of a set of tabs, each of which contains groups of related commands.
Navigation pane	Appears on the left side of the program window and enables you to navigate long documents, search for specific text, and reorganize content.
Document window	Appears below the Ribbon and displays the contents of the document.

Cursor	A blinking vertical line that indicates where text or objects will be inserted.
Scroll bars	Appear along the right side and bottom of the document window and enable you to scroll through the document.
Status bar	Appears at the bottom of the program window and displays information about the document (number of pages, number of words, etc.). The tools on the right side of the Status bar can be used to display the document in a variety of views and to change the zoom level.

Ribbon

The *Ribbon* is designed to help you quickly find the commands that you need to complete a task. It consists of a set of task-specific tabs (see Figure 3 and Table 2). The standard tabs are visible at all times. Other tabs, known as *contextual tabs*, appear only when you create or select certain types of objects (such as images or tables). These tabs are indicated by colored headers and contain commands that are specific to working with the selected object. Clicking a tab displays a set of related commands that are organized into logical groups. Commands generally take the form of buttons and lists; some appear in galleries. Pointing to an option in most lists or galleries displays a live preview of that effect on the selected text or object. You can apply the previewed formatting by clicking the selected option, or you can cancel previewing without making any changes by pressing the *Esc* key. Some commands include an integrated or separate arrow. Clicking the arrow displays a menu of options available for the command. If a command on the Ribbon appears dimmed, it is unavailable. Pointing to a command on the Ribbon displays its name, description, and keyboard shortcut (if it has one) in a ScreenTip.

A *dialog box launcher*  appears in the lower-right corner of most groups on the Ribbon (see Figure 3). Clicking it opens a related dialog box or task pane that offers additional options or more precise control than the commands available on the Ribbon.

You can collapse the Ribbon by clicking the *Collapse the Ribbon* button  on the right side of the Ribbon (see Figure 3) or by double-clicking the current tab. When the Ribbon is collapsed, only the tab names are visible. You can expand the Ribbon by double-clicking any tab.

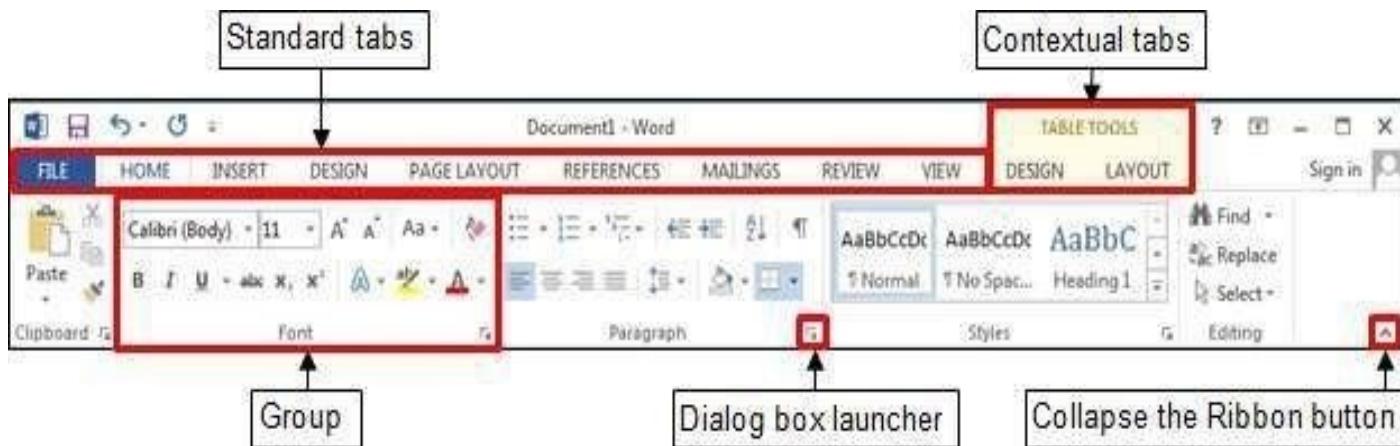


Figure 3 – Ribbon

Table 2 – Ribbon Tabs

Name	Description
File	Displays the Backstage view which contains commands related to managing files and customizing the program.
Home	Contains the most frequently used commands. The Home tab is active by default.
Insert	Contains commands related to all the items that you can insert into a document.
Design	Contains commands related to changing the overall appearance of a document.
Page Layout	Contains commands related to changing the layout of a document.
References	Contains commands related to reference information you can add to a document.
Mailings	Contains commands related to creating mass mailings.
Review	Contains commands related to proofreading a document, adding comments, tracking and resolving document changes, and protecting a document.
View	Contains commands related to changing the view and other aspects of the display.

Quick Access Toolbar

The **Quick Access** toolbar provides one-click access to commonly used commands and options. By default, it is located on the left side of the Title bar and displays the Save, Undo, and Redo buttons (see Figure 4). You can change the location of the Quick Access toolbar as well as customize it to include commands that you use frequently.

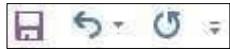


Figure 4 – Quick Access Toolbar

To add a command to the Quick Access toolbar:

1. On the **Ribbon**, right-click the command that you want to add, and then click **Add to Quick Access Toolbar** on the shortcut menu.

To remove a command from the Quick Access toolbar:

1. On the **Quick Access** toolbar, right-click the command that you want to remove, and then click **Remove from Quick Access Toolbar** on the shortcut menu.

NOTE: Clicking the arrow on the right side of the **Quick Access** toolbar displays a menu which includes additional commands and options that can be used to customize the toolbar. A check mark next to an item indicates that the item is selected (see Figure 5). **Toolbar Menu**



Figure 5 – Customize Quick Access

Mini Toolbar

The *Mini* toolbar provides quick access to frequently used commands and appears whenever you select text or right-click an object (see Figure 6).

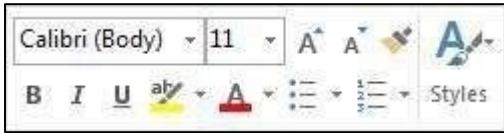


Figure 6 – Mini Toolbar

Shortcut Menus

Word 2013 includes many shortcut menus that appear when you right-click an item. Shortcut menus are context-sensitive, meaning they list commands that pertain only to the item that you right-clicked (see Figure 7).



Figure 7 – Ribbon Shortcut Menu

Navigation Pane

The *Navigation* pane offers a quick look at the structure of a document and provides an easy way to navigate long documents, search for specific text, and reorganize content. It includes a Search box and three tabs.

- The *Headings* tab displays a list of all the headings in a document. Click a heading in the pane to go to the corresponding heading in the document. Click the arrow next to a heading to collapse or expand it. Drag a heading up or down to move the heading and its content to a new location. Right-click

a heading to perform additional actions (such as promote or demote a heading, add a new heading or subheading, or delete a heading).

- The **Pages** tab displays thumbnails of all the pages in a document. Click a thumbnail in the pane to go to the corresponding page in the document.
- The **Results** tab displays a list of search results. Click a result to go to the corresponding location in the document.

To open the Navigation pane:

1. On the **View** tab, in the **Show** group, select the **Navigation Pane** check box (see Figure 8). The **Navigation** pane opens on the left side of the program window (see Figure 9).

NOTE: You can close the **Navigation** pane by clicking the **Close** button  in the upper-right corner of the pane.

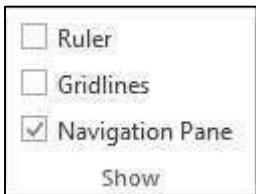


Figure 8 – Show Group on the View Tab

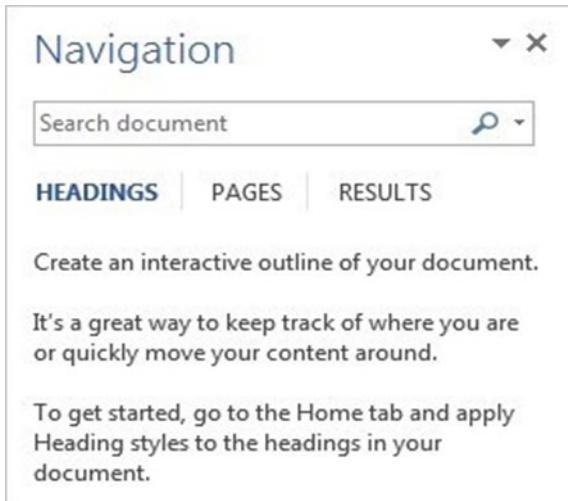


Figure 9 – Navigation Pane

To search for text using the Navigation pane:

1. In the **Search** box, type the text that you want to find, and then press the **Enter** key. The search results are displayed as follows:

- On the **Headings** tab, headings that contain a match are highlighted.
- On the **Pages** tab, only pages that contain a match are displayed.
- On the **Results** tab, all the matches are displayed in a list that includes the surrounding text for each match.

NOTE: You can review the results within the **Navigation** pane by using the scroll bar that appears on the right side of the pane when you point to it. You can also use the **Previous** button or **Next** button at the top of the pane to browse through all the headings, pages, or results.

Backstage View

The **File** tab (the first tab on the Ribbon) is used to display the **Backstage view** which contains all the commands related to managing files and customizing the program. It provides an easy way to create, open, save, print, share, export, and close files; view and update file properties; set permissions; set program options; and more. Commands available in the Backstage view are organized into pages which you can display by clicking the page tabs in the left pane.

To display the Backstage view:

1. Click the **File** tab on the **Ribbon** (see Figure 10).



Figure 10 – File Tab

To exit the Backstage view:

1. Click the **Back** button in the upper-left corner of the **Backstage view** (see Figure 11). Or, press the **Esc** key.

A screenshot of the Microsoft Word Backstage view, specifically the Info page. On the left is a vertical menu with options: Info (selected), New, Open, Save, Save As, Print, Share, Export, Close, Account, and Options. The 'Info' option is highlighted with a red box. The main area shows the document title 'Document1 - Word'. There are three sections: 'Protect Document' (with a lock icon), 'Inspect Document' (with a checkmark icon), and 'Versions' (with a document icon). To the right is a 'Properties' panel with details like Size, Pages, Words, Total Editing Time, Title, Tags, and Comments. Below that are 'Related Dates' (Last Modified, Created, Last Printed) and 'Related People' (Author, Last Modified By, Show All Properties).

Properties	
Size	Not saved yet
Pages	1
Words	0
Total Editing Time	1 Minute
Title	Add a title
Tags	Add a tag
Comments	Add comments

Related Dates	
Last Modified	Today, 11:08 AM
Created	
Last Printed	

Related People	
Author	Trainer
Last Modified By	Not saved yet
Show All Properties	

Figure 11 - Info Page of the Backstage View

Creating Documents

When you start Word 2013 and click **Blank document** on the *Start* screen, a new document opens in the program window, ready for you to enter your content. You can also create a new document while Word 2013 is running. Each new document displays a default name (such as *Document1*, *Document2*, and so on) on the Title bar until you save it with a more meaningful name. The cursor, a blinking vertical line in the upper-left corner of the page, shows where the next character you type will appear. When the cursor reaches the right margin, the word you are typing automatically moves to the next line. Pressing the *Enter* key starts a new paragraph.

To create a new document:

1. Click the **File** tab, and then click **New**. The **New** page of the **Backstage** view opens, displaying thumbnails of the available templates (see Figure 12).
2. In the right pane, click **Blank document**. A new, blank document opens in a new window.

NOTE: You can also create a new document by pressing **Ctrl+N**.

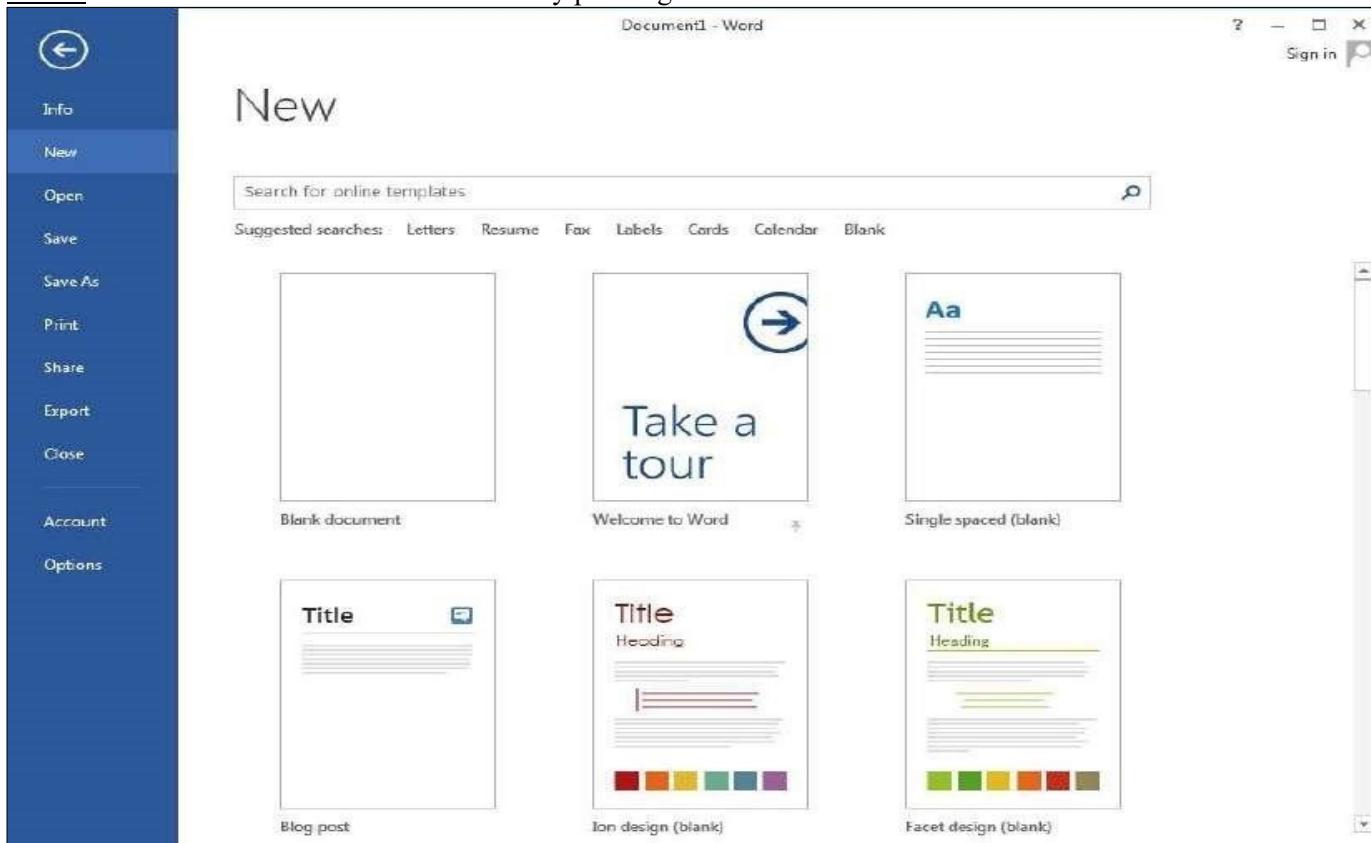


Figure 12 – New Page of the Backstage View

Saving Documents

After creating a document, you can save it on your computer. Use the *Save As* command when you save a document for the first time or if you want to save a copy of a document in a different location, with a different file name, or in a different file format. Use the *Save* command to save changes to an existing document.

NOTE: Word 2013's file format is called Word Document and is the same as Word 2007 and 2010. This format has the .docx file extension and is not backward compatible with Word versions prior to 2007. You can use Word 2013 to save a document in the Word 97-2003 Document format with the .doc file extension to make it compatible with earlier versions of Word, but you will not have access to all of Word 2013's features.

To save a document for the first time:

1. Click the **File** tab, and then click **Save As**. The **Save As** page of the **Backstage** view opens.
2. Click **Computer** in the center pane, and then click the **Browse** button or a recent folder in the right pane (see Figure 13).

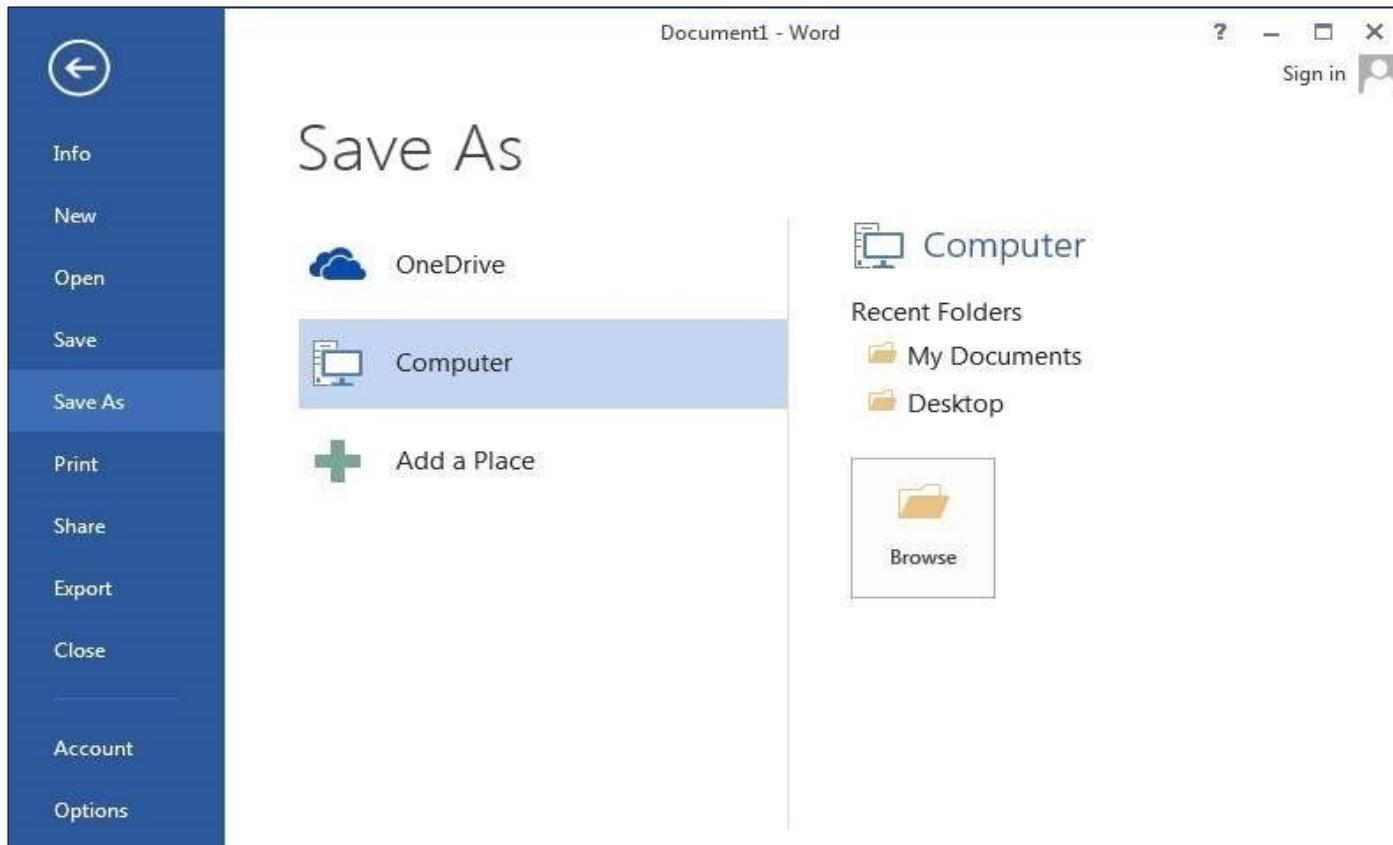


Figure 13 – Save As Page of the Backstage View

3. In the **Save As** dialog box, select a location to save the file, type a name in the **File name** box, and then click the **Save** button (see Figure 14).

NOTE: By default, Word 2013 documents are saved in the **Word Document** format. To save a document in a different format, click the **Save as type** arrow and select the desired file format from the list.

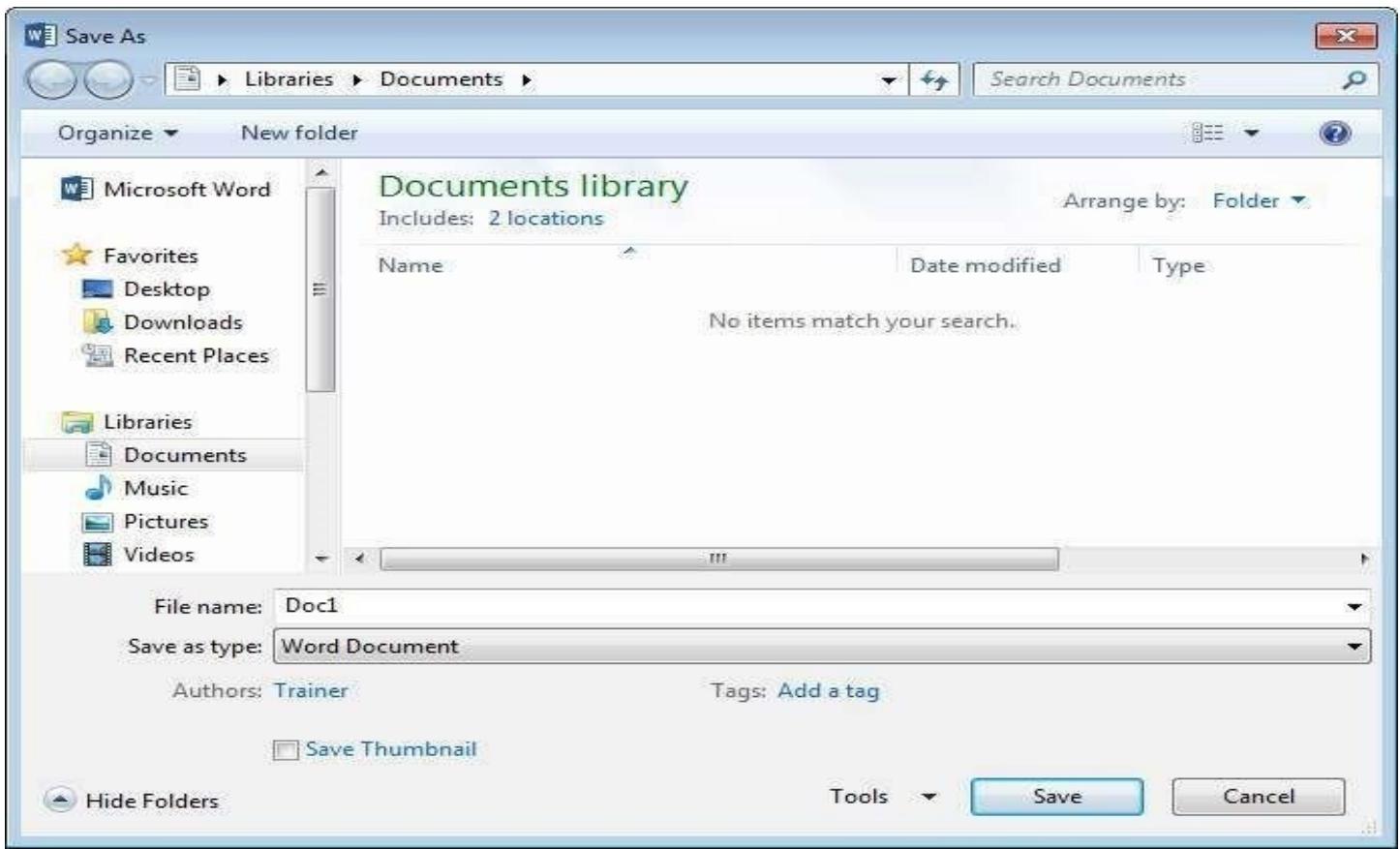


Figure 14 – Save as Dialog Box

To save changes to a document:

1. Do one of the following:

- Click the **File** tab, and then click **Save**.
- On the **Quick Access** toolbar, click the **Save** button .
- Press **Ctrl+S**.

Closing Documents

When you finish working on a document, you can close it, but keep the program window open to work on more documents. If the document contains any unsaved changes, you will be prompted to save the changes before closing it.

To close a document without exiting Word:

1. Click the **File** tab, and then click **Close**. Or, press **Ctrl+W**.

Opening Documents

You can locate and open an existing document from the Start screen when Word 2013 starts or from the Open page of the Backstage view. The Start screen and the Open page also display a list of recently used documents.

which you can quickly open by clicking them. Each document opens in its own window, making it easier to work on two documents at once.

To open a document:

1. Click the **File** tab, and then click **Open**. Or, press **Ctrl+O**. The **Open** page of the **Backstage** view opens, displaying a list of recently used documents in the right pane.
2. If the document you want is in the **Recent Documents** list, click its name to open it. Otherwise, proceed to step 3.
3. Click **Computer** in the center pane, and then click the **Browse** button or a recent folder in the right pane (see Figure 15).

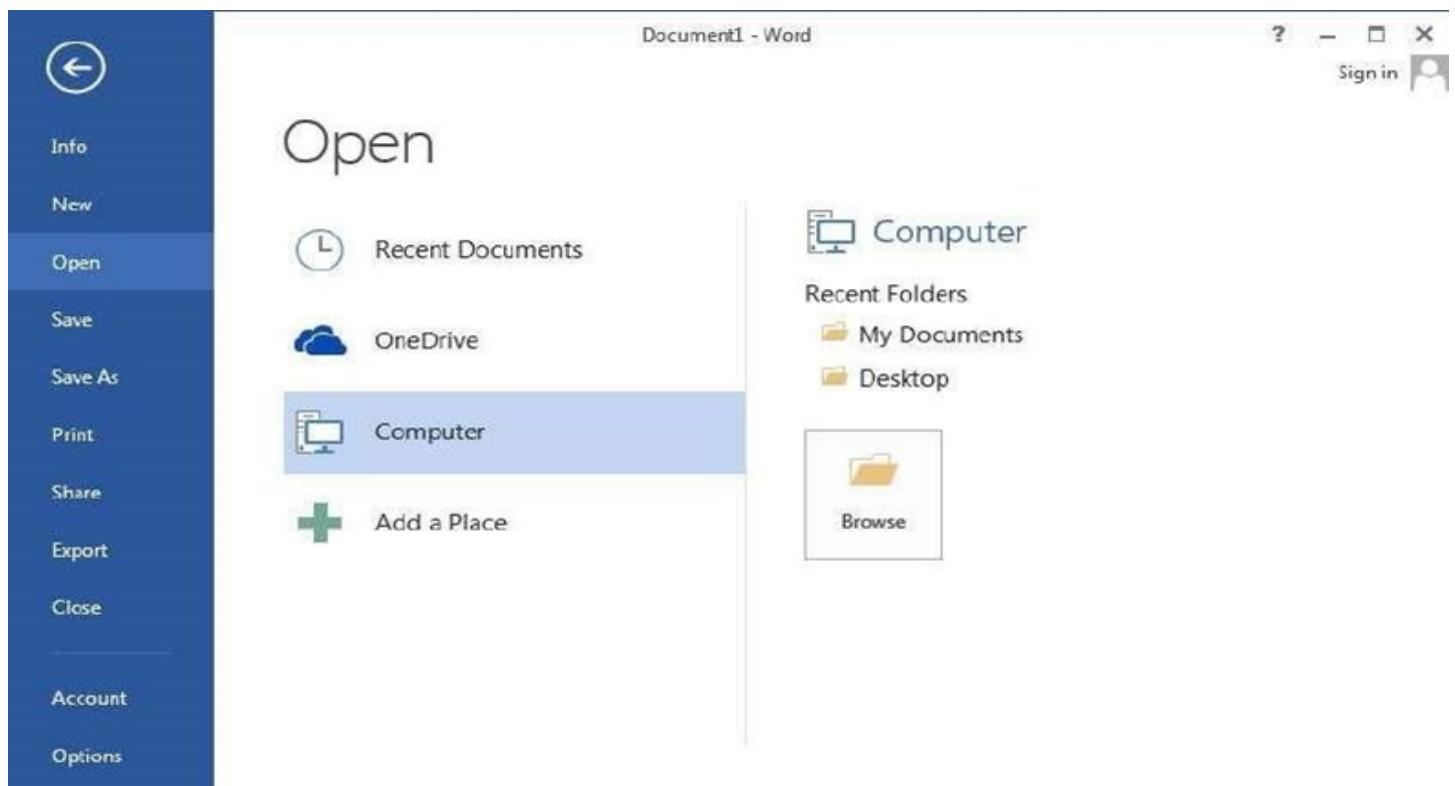


Figure 15 – Open Page of the Backstage View

4. In the **Open** dialog box, locate and select the file that you want to open, and then click the **Open** button (see Figure 16).

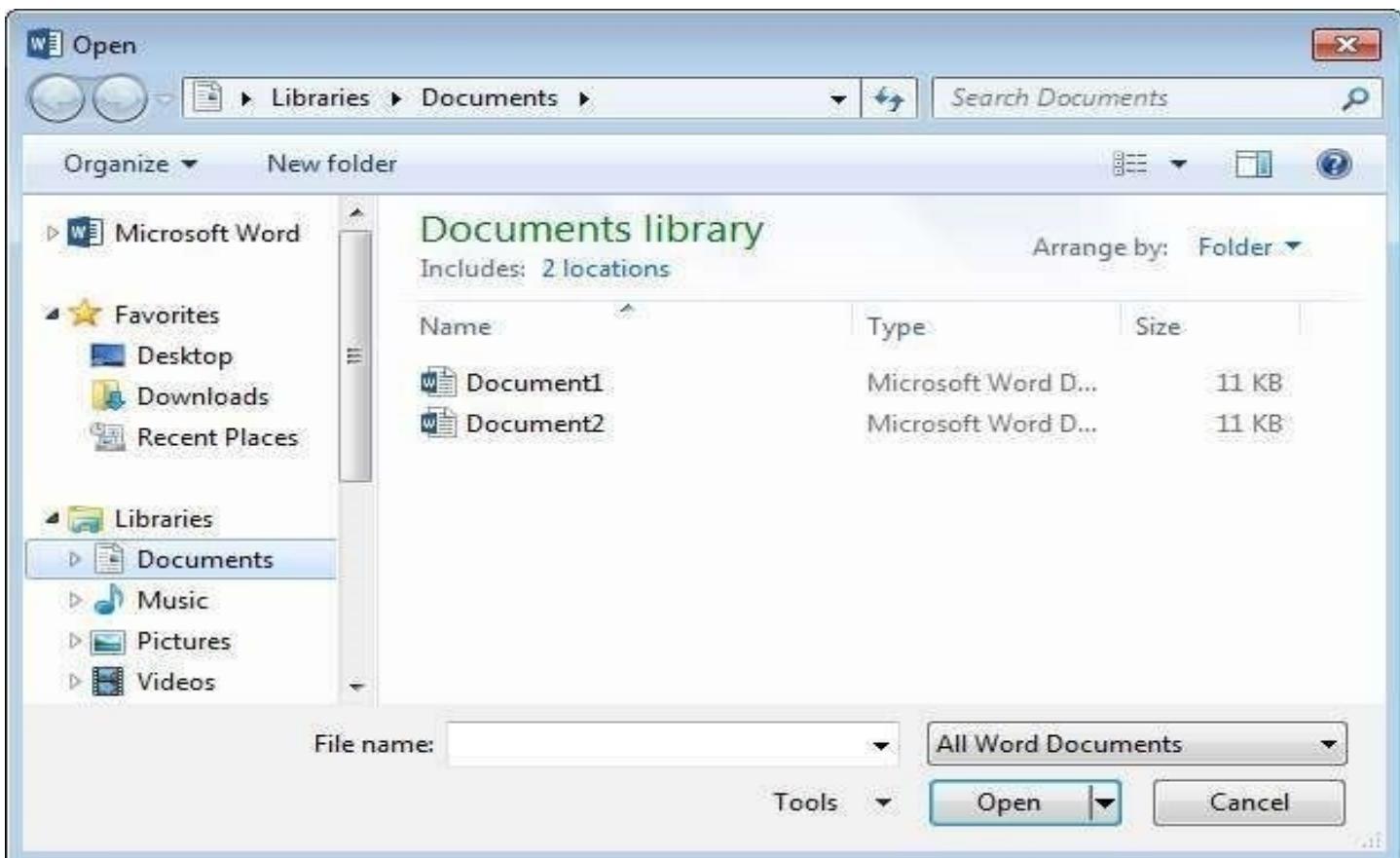


Figure 16 – Open Dialog Box

NOTE: When you open a document created with earlier versions of Word in Word 2013, the document opens in compatibility mode (indicated on the Title bar) with some of the new features of Word 2013 disabled. You can easily convert the document to the Word 2013 file format by clicking the *Convert* button on the *Info* page of the Backstage view (see Figure 17).

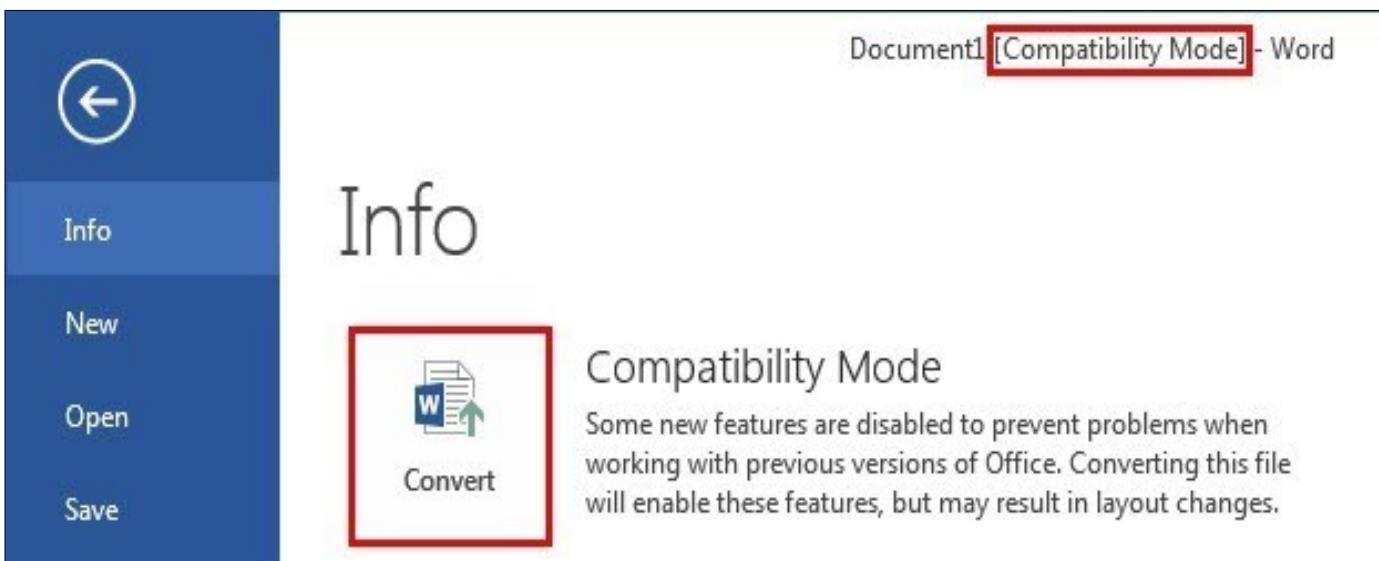


Figure 17 – Convert Button on the Info Page of the Backstage View

NOTE: When you close a document, Word 2013 automatically bookmarks the location you were last working on. When you reopen the document, you can pick up where you left off by clicking the *Resume Reading* callout that appears on the right side of the program window (see Figure 18). The callout changes to a bookmark icon after a few seconds (see Figure 19). You can point to the bookmark icon or click it to redisplay the message. Scrolling the document makes the callout disappear.



Figure 18 – Resume Reading Callout



Figure 19 – Bookmark Icon

Editing Documents

Most documents require some editing. After creating a document, you may want to add or remove text, or move text from one place to another. This section covers how to perform basic tasks such as selecting, deleting, copying, and moving text; and undoing and redoing changes.

Selecting Text

Before you can edit text, you must first select the text that you want to modify. You can use the mouse, the keyboard, or the selection area (an invisible area in the document's left margin) to make a selection. Selected text appears highlighted on the screen.

To select text:

1. Do the following:

- To select a word, double-click anywhere in the word.
- To select a sentence, hold down the **Ctrl** key and click anywhere in the sentence.
- To select a line, click in the selection area to the left of the line.
- To select a paragraph, triple-click anywhere in the paragraph. Or, double-click in the selection area to the left of the paragraph.
- To select the entire document, triple-click in the selection area. Or, press **Ctrl+A**.
- To select adjacent words, lines, or paragraphs, drag the mouse pointer over the text. Or, click at the beginning of the text, and then hold down the **Shift** key and click at the end of the text.
- To select non-adjacent words, lines, or paragraphs, make the first selection, and then hold down the **Ctrl** key and make the second selection. NOTE: To deselect selected text, click anywhere in the document.

Deleting Text

You can delete text one character at a time by positioning the cursor, and then pressing the *Backspace* key to delete the character to the left of the cursor or the *Delete* key to delete the character to the right of the cursor. You can also select and delete a word, sentence, paragraph, or block of text.

To delete text:

1. Select the text that you want to delete, and then press the **Delete** key.

Moving and Copying Text

When editing a document, you may want to duplicate text in another location, or you may want to remove (cut) text from its original location and place it in a new location.

NOTE: Cut or copied text is stored on the **Clipboard**, a temporary storage area. You can access it by clicking the dialog box launcher  in the **Clipboard** group on the **Home** tab of the **Ribbon** (see Figure 20).

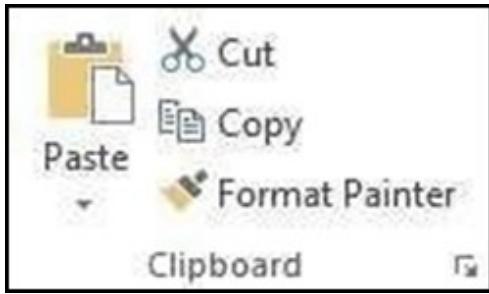


Figure 20 – Clipboard Group on the Home Tab

To move or copy text:

1. Select the text that you want to move or copy.
2. On the **Home** tab, in the **Clipboard** group, do one of the following:
 - To move text, click the **Cut**  button. Or, press **Ctrl+X**.
 - To copy text, click the **Copy** button . Or, press **Ctrl+C**.
3. Click in the document where you want to paste the cut or copied text.
4. On the **Home** tab, in the **Clipboard** group, click the **Paste** button . Or, press **Ctrl+V**.

NOTE: Clicking the arrow on the **Paste** button displays additional paste options.

Undoing and Redoing Changes

Whenever you make a mistake, you can easily reverse it with the **Undo** command. After you have undone one or more actions, the **Redo** command becomes available and allows you to restore the undone actions.

To undo an action:

1. On the **Quick Access** toolbar, click the **Undo** button . Or, press **Ctrl+Z**.

To redo an action:

1. On the **Quick Access** toolbar, click the **Redo** button . Or, press **Ctrl+Y**.

Formatting Documents

Word 2013 includes a number of features that can be used to easily format a document. Formatting enhances the appearance of a document and makes it look professional.

Formatting Text

Text formatting includes font, font size, font color, and font style and effect. The *Font* group on the *Home* tab of the *Ribbon* contains the most commonly used text formatting commands (see Figure 21). You can also format text using the *Font* dialog box which can be opened by clicking  in the dialog box launcher

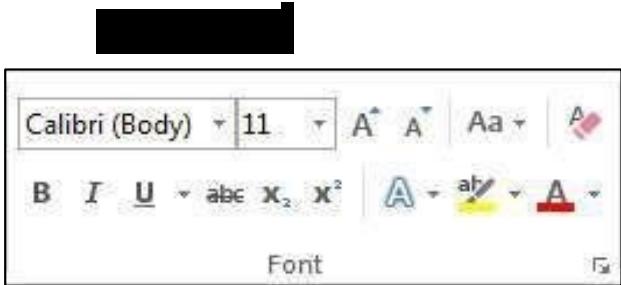


Figure 21 – Font Group on the Home Tab

Changing the Font and Font Size

A font defines the overall appearance or style of text lettering. Font size controls the height of the font. The default font in new Word 2013 documents is Calibri; the default font size is 11 points.

To change the font:

1. Select the text that you want to format.
2. On the **Home** tab, in the **Font** group, click the **Font** arrow and select the desired font from the list (see Figure 22).

To change the font size:

1. Select the text that you want to format.
2. On the **Home** tab, in the **Font** group, click the **Font Size** arrow and select the desired font size from the list (see Figure 23). If a font size you want is not listed in the **Font Size** list, click in the **Font Size** box, type the desired number, and then press the **Enter** key. NOTE: You can also change the font size by clicking the **Increase Font Size** button  or **Decrease Font Size** button  in the **Font** group on the **Home** tab of the **Ribbon**.



Figure 22 – Font List

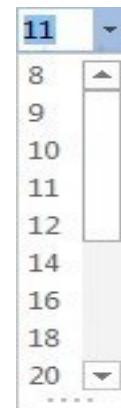


Figure 23 – Font Size List

Changing the Font Color and Highlighting Text

You can emphasize important text by changing the font color or applying highlighting.

To change the font color:

1. Select the text that you want to format.
2. On the **Home** tab, in the **Font** group, click the **Font Color** button to apply the most recently used color, or click the **Font Color** arrow and select a different color from the color palette (see Figure 24).

To highlight text:

1. Select the text that you want to highlight.
2. On the **Home** tab, in the **Font** group, click the **Text Highlight Color** button to apply the most recently used color, or click the **Text Highlight Color** arrow and select a different color from the color palette (see Figure 25).

NOTE: You can remove a highlight from selected text by clicking the **Text Highlight Color** arrow, and then clicking **No Color** on the palette.



Figure 24 – Font Color Palette

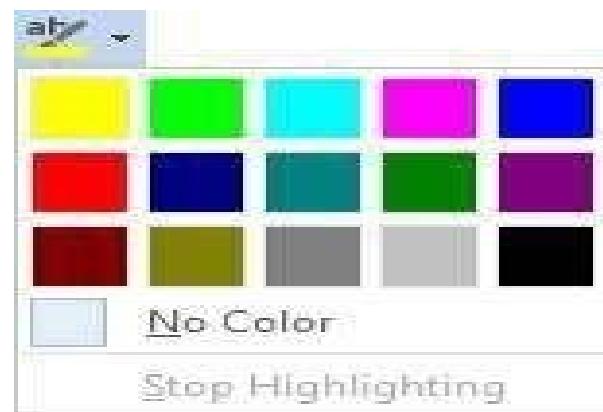


Figure 25 – Text Highlight Color Palette

Applying Font Styles and Effects

You can apply one or more font styles and effects to text. Font styles are attributes such as bold and italic; effects are special enhancements such as strikethrough and shadow (see Table 3).

Table 3 – Font Style and Effect Buttons

Name	Description
 Bold	Makes the selected text bold (<i>example</i>).
 Italic	Italicizes the selected text (<i>example</i>).
 Underline	Draws a line under the selected text (<i>example</i>). Click the arrow on the button to select the type of underline.
 Strikethrough	Draws a line through the middle of the selected text (<i>example</i>).
 Subscript	Creates small letters below the text baseline (<i>example</i>).
 Superscript	Creates small letters above the line of text (<i>example</i>).
 Text Effects and Typo graphy	Applies a visual effect (such as a shadow, glow, or reflection) to the selected text.
 Change Case	Changes the selected text to uppercase, lowercase, or other common capitalizations.

To apply a font style or effect:

1. Select the text that you want to format.
2. On the **Home** tab, in the **Font** group, click the button for the desired font style or effect. If the button has an arrow, click the arrow to see more options.

NOTE: The **Bold**, **Italic**, **Underline**, **Strikethrough**, **Subscript**, and **Superscript** buttons are toggles. If you select text to which one of these formats has been applied, and then click the corresponding button, that format is removed.

Clearing Formatting

You can remove all formatting from selected text, leaving only the plain text.

To clear formatting:

1. Select the text that has the formatting you want to clear.
2. On the **Home** tab, in the **Font** group, click the **Clear All Formatting** button .

Copying Formatting

You can copy the formatting of specific text and apply it to other text in the document. This can save you time and effort when multiple formats have been applied to text and you want to format additional text with all the same formats.

To copy formatting:

1. Select the text that has the formatting you want to copy.
2. On the **Home** tab, in the **Clipboard** group, click the **Format Painter** button . The mouse pointer changes to a paintbrush with an I-beam .
3. Select the text to which you want to apply the copied formatting.

NOTE: If you want to apply the copied formatting to more than one area, double-click the **Format Painter** button instead of single-clicking it. This keeps the **Format Painter** active until you press the **Esc** key.

Formatting Paragraphs

Paragraph formatting refers to the layout of a paragraph on the page. You can change the look of a paragraph by changing its alignment, line spacing, and indentation, as well as the space before and after it. The *Paragraph* group on the *Home* tab of the *Ribbon* contains the most commonly used paragraph formatting commands (see Figure 26). You can also format paragraphs using the

Paragraph dialog box which can be opened by clicking the dialog box launcher  in the *Paragraph* group.

NOTE: To display or hide formatting marks such as spaces, tabs, and paragraph marks, click the **Show/Hide** button  in the **Paragraph** group on the **Home** tab of the **Ribbon**.

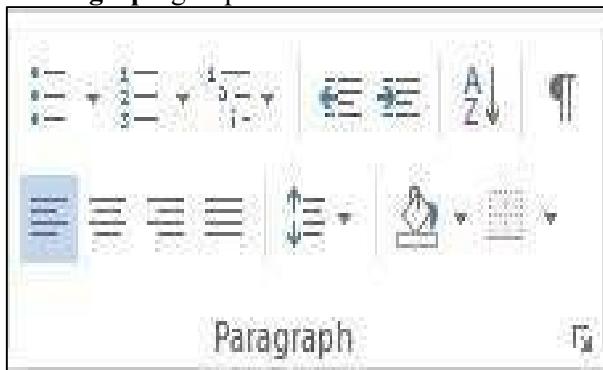


Figure 26 – Paragraph Group on the Home Tab

Changing Paragraph Alignment

Paragraph alignment refers to the position of each line of text in a paragraph between the left and right margins. The *Paragraph* group on the *Home* tab of the *Ribbon* includes four alignment buttons that can be used to quickly change the alignment of a paragraph (see Table 4).

Table 4 – Alignment Buttons

Name	Description
 Align Left	Aligns the text at the left margin, producing a ragged right edge. This is the default alignment.

 Center	Centers the text between the left and right margins, producing ragged left and right edges.
 Align Right	Aligns the text at the right margin, producing a ragged left edge.
 Justify	Aligns the text at both the left and right margins, producing even left and right edges. To accomplish this, Word adjusts the spacing between words, expanding or shrinking the spaces as needed.

To change the alignment of a paragraph:

1. Select the paragraph that you want to align.
2. On the **Home** tab, in the **Paragraph** group, click the desired alignment button.

Changing Line and Paragraph Spacing

Line spacing determines the amount of space between the lines of text in a paragraph. Paragraph spacing determines the amount of space above and below a paragraph. In Word 2013, the default spacing is 1.08 lines and 8 points after each paragraph.

To change the line spacing within a paragraph:

1. Select the paragraph that you want to format.
2. On the **Home** tab, in the **Paragraph** group, click the **Line and Paragraph Spacing** button and select the desired line spacing (see Figure 27).

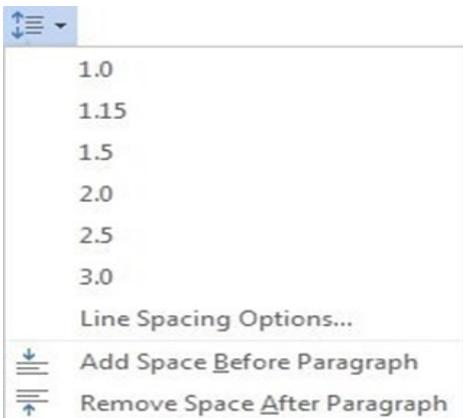


Figure 27 – Line and Paragraph Spacing Menu

To change the spacing before or after a paragraph:

1. Select the paragraph that you want to format.
2. On the **Page Layout** tab, in the **Paragraph** group, enter the desired value in the **Spacing Before** or **Spacing After** box (see Figure 28).

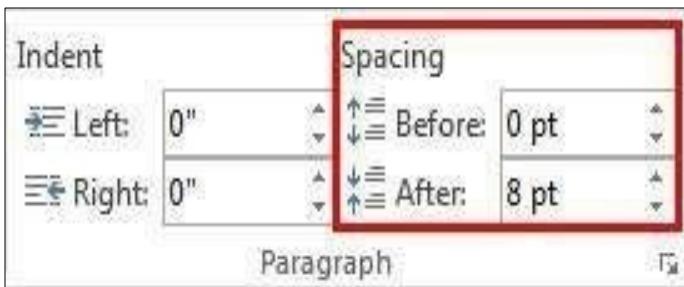


Figure 28 – Paragraph Group on the Page Layout Tab

Changing Paragraph Indentation

Indenting a paragraph refers to moving it away from the left, the right, or both margins. You can indent an entire paragraph to make it stand out from the surrounding text. You can also indent only the first line of a paragraph (which is called a *first line indent*), or indent all lines except the first line (which is called a *hanging indent*).

To change the indentation of a paragraph:

1. Select the paragraph that you want to indent.
2. On the **Home** tab, in the **Paragraph** group, click the **Increase Indent** button or **Decrease Indent** button to move the paragraph right or left in half-inch increments.

To indent a paragraph using the horizontal ruler:

1. On the **View** tab, in the **Show** group, select the **Ruler** check box to display the rulers.
2. Select the paragraph that you want to indent.
3. On the horizontal ruler, do the following (see Figure 29):
 - To change the left indent of the entire paragraph, drag the **Left Indent** marker to the position where you want the text to start.
 - To change the right indent of the entire paragraph, drag the **Right Indent** marker to the position where you want the text to end.
 - To create a first line indent, drag the **First Line Indent** marker to the position where you want the first line to start.
 - To create a hanging indent, drag the **Hanging Indent** marker to the position where you want all lines except the first line to start.

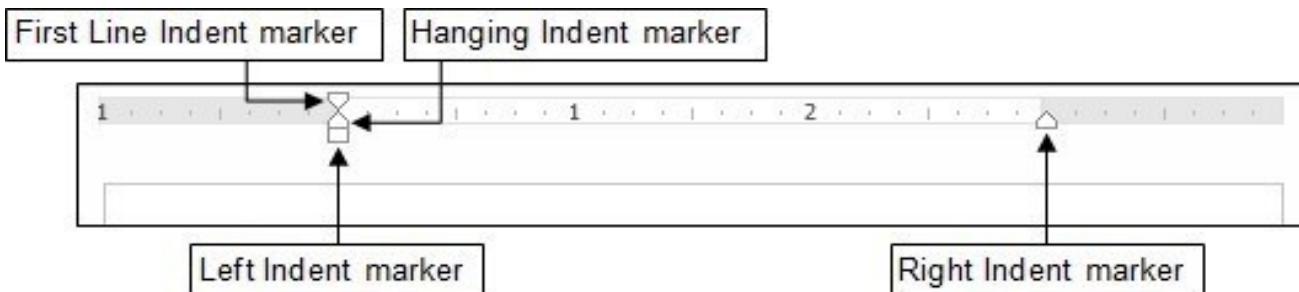


Figure 29 – Horizontal Ruler with Indent Markers

NOTE: You can specify an exact measurement for the left or right indent by entering the desired value in the **Indent Left** or **Indent Right** box in the **Paragraph** group on the **Page Layout** tab of the **Ribbon** (see Figure 30).

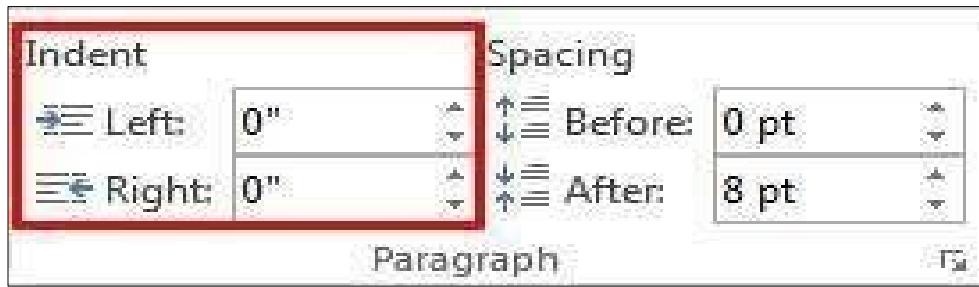


Figure 30 – Paragraph Group on the Page Layout Tab

Setting Tab Stops

Tab stops can be used to align lines of text in different locations across the page (see Table 5). By default, Word 2013 sets left-aligned tab stops every half inch from the left margin. You can also set custom tab stops exactly where you need them. The easiest way to set tab stops is to use the horizontal ruler.

Table 5 – Tab Stops

Name	Description
Left Tab	Aligns the left end of the text with the tab stop.
Center Tab	Aligns the center of the text with the tab stop.
Right Tab	Aligns the right end of the text with the tab stop.
Decimal Tab	Aligns the decimal point in the text (usually a numeric value) with the tab stop.
Bar Tab	Draws a vertical line at the position of the tab stop.

To set a custom tab stop:

1. On the **View** tab, in the **Show** group, select the **Ruler** check box to display the rulers.
2. Click the tab selector on the left side of the horizontal ruler until it displays the desired tab stop (see Figure 31).
3. Click the bottom edge of the horizontal ruler where you want to set the tab stop. A tab stop marker appears on the ruler.
4. Press the **Tab** key to move to the tab stop.



Figure 31 – Tab Selector and Tab Stop Marker

NOTE: You can change the position of a custom tab stop by dragging it left or right along the horizontal ruler.

You can remove a custom tab stop by dragging it off the horizontal ruler.

Adding Borders and Shading

You can set apart text from the rest of the document by adding borders and shading. You can add borders to any side of the text or all sides to make a box.

To add borders:

1. Select the text to which you want to add borders.
2. On the **Home** tab, in the **Paragraph** group, click the **Borders** button to apply the most recently used border, or click the **Borders** arrow and select a different border from the menu (see Figure 32).

NOTE: You can remove all borders from selected text by clicking the **Borders** arrow, and then clicking **No Border** on the menu.

To add shading:

1. Select the text to which you want to add shading.
2. On the **Home** tab, in the **Paragraph** group, click the **Shading** button to apply the most recently used color, or click the **Shading** arrow and select a different color from the color palette (see Figure 33).

NOTE: You can remove shading from selected text by clicking the **Shading** arrow, and then clicking **No Color** on the palette.



Figure 33 – Shading Palette

Figure 32 – Borders Menu

Creating Bulleted and Numbered Lists

Bulleted and numbered lists make documents easier to read and understand. When you want to emphasize items in a list in no particular order, create a bulleted list. When you want to present a sequence of information or list items by order of importance, create a numbered list. You can add bullets or numbers to existing lines of text, or Word can automatically create bulleted or numbered lists as you type. You can also create a list that has multiple levels.

NOTE: If you move an item within a numbered list, Word will renumber the list to keep the items in the correct order.

To create a bulleted or numbered list:

1. Click in the document where you want to add the list.
2. On the **Home** tab, in the **Paragraph** group, click the **Bullets** button  to start a bulleted list or **Numbering** button  to start a numbered list.
3. Type the text for the first list item.
4. Press the **Enter** key to add the next list item.
5. To end the list, press the **Enter** key twice.

NOTE: You can change the bullet or number style by clicking the **Bullets** or **Numbering** arrow and selecting the desired option from the menu (see Figure 34 and Figure 35).

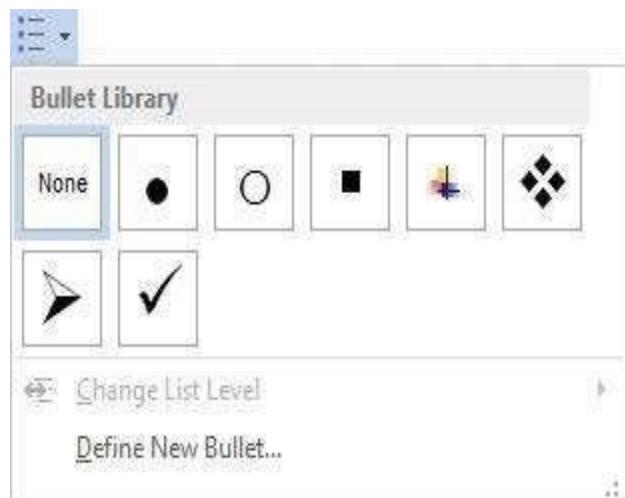


Figure 34 – Bullets Menu

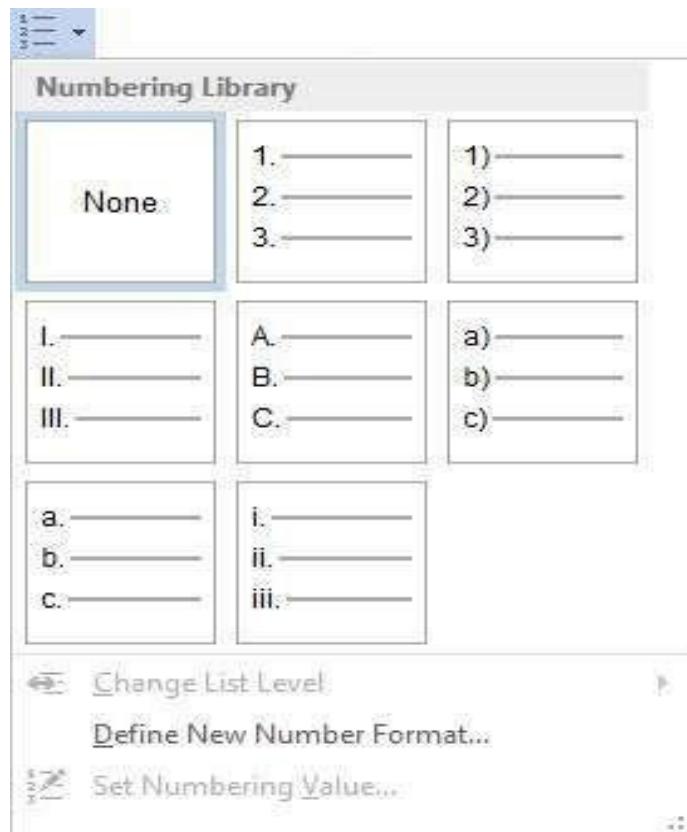


Figure 35 – Numbering Menu

To create a multilevel list:

1. Click in the document where you want to add the list.
2. On the **Home** tab, in the **Paragraph** group, click the **Multilevel List** button and select the desired style from the menu (see Figure 36).
3. Type the text for the first list item.
4. Press the **Enter** key to add the next list item.
5. Continue creating the list of items that are all at the same level.
6. To change the list level, do one of the following:
 - Press the **Tab** key to demote the list level.
 - Press **Shift+Tab** to promote the list level.
7. To end the list, position the insertion point at the end of the last list item, press the **Enter** key, and then press the **Delete** key.

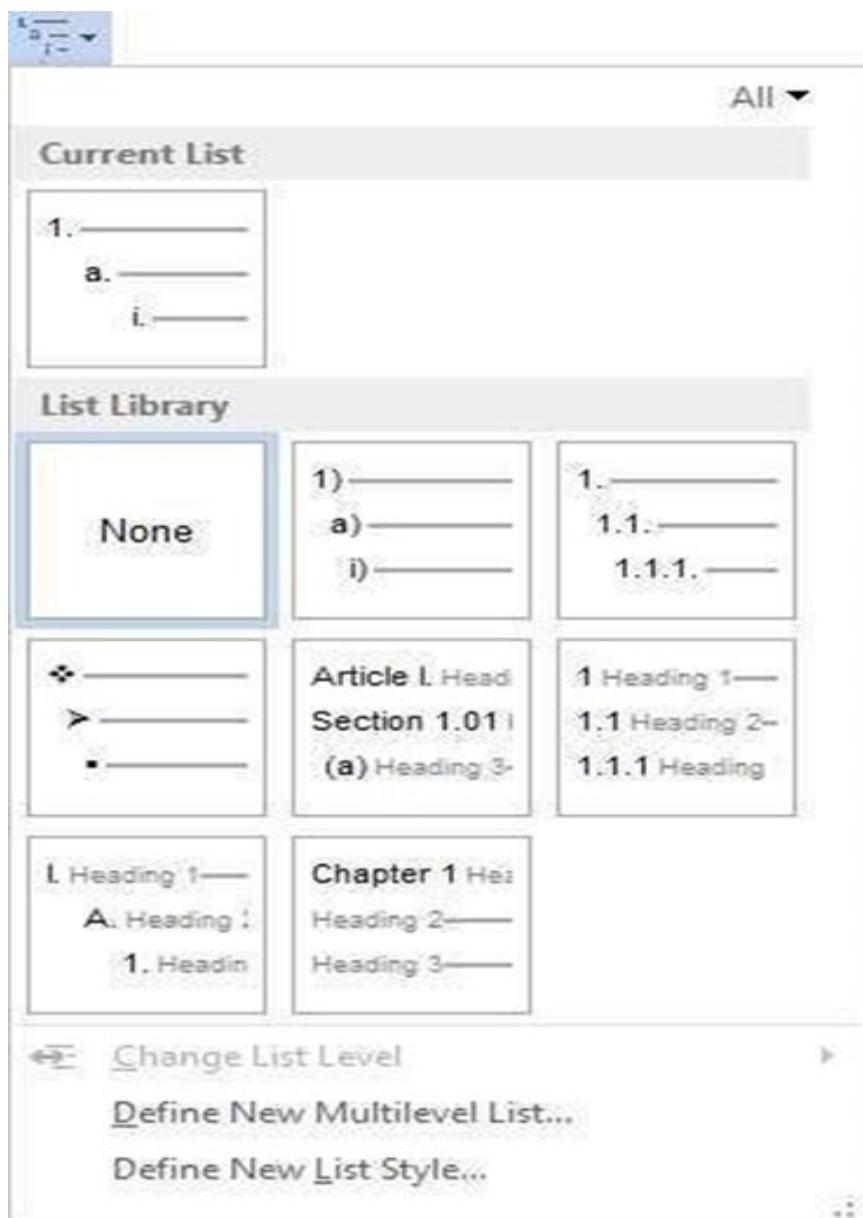


Figure 36 – Multilevel List Menu

To add bullets or numbers to existing text:

1. Select the text to which you want to add bullets or numbers.
2. On the **Home** tab, in the **Paragraph** group, click the **Bullets** button to add bullets or **Numbering** button to add numbers.

NOTE: If the numbering sequence is incorrect, right-click the list item, and then click **Restart at 1** or **Continue Numbering** on the shortcut menu.

To remove bullets or numbers from a list:

1. Select the list from which you want to remove bullets or numbers.
2. On the **Home** tab, in the **Paragraph** group, click the **Bullets** button to remove bullets or **Numbering** button to remove numbers.

Applying Styles

A *style* is a set of formatting characteristics (such as font, font size, font color, and paragraph alignment and spacing) that you can use to quickly format a document. In addition to saving you time, styles can help you keep formatting consistent throughout a document. Word 2013 includes several predefined styles that can be used to format headings, body text, lists, etc. If you do not like the appearance of a built-in style, you can modify it or create a custom style to suit your needs.

To apply a style using the Styles gallery:

1. Select the text to which you want to apply a style.
2. On the **Home** tab, in the **Styles** group, select the desired style from the **Styles** gallery (see Figure 37).

NOTE: To display the entire **Styles** gallery, click the **More** button  in the lower-right corner of the gallery to expand it.



Figure 37 – Styles Group on the Home Tab

To apply a style using the Styles pane:

1. On the **Home** tab, in the **Styles** group, click the dialog box launcher . The **Styles** pane opens on the right side of the program window (see Figure 38).
2. Select the text to which you want to apply a style.
3. In the **Styles** pane, click the desired style.

NOTE: You can close the **Styles** pane by clicking the **Close** button  in the upper-right corner of the pane.

To modify an existing style:

1. In the **Styles** pane, right-click the style, and then click **Modify** on the shortcut menu.
2. In the **Modify Style** dialog box, make the desired changes, and then click the **OK** button.

NOTE: When you modify a style, all text formatted with that particular style will be updated automatically.
To create a new style:

1. In the **Styles** pane, click the **New Style** button 
2. In the **Create New Style from Formatting** dialog box, type a name for the new style in the **Name** box, select the desired options, and then click the **OK** button.

NOTE: If you want to use formatted text as the basis of a new style, select the text before you click the **New Style** button. The dialog box will open with all the attributes of the selected text already specified, so you will only need to type a new name for the style.

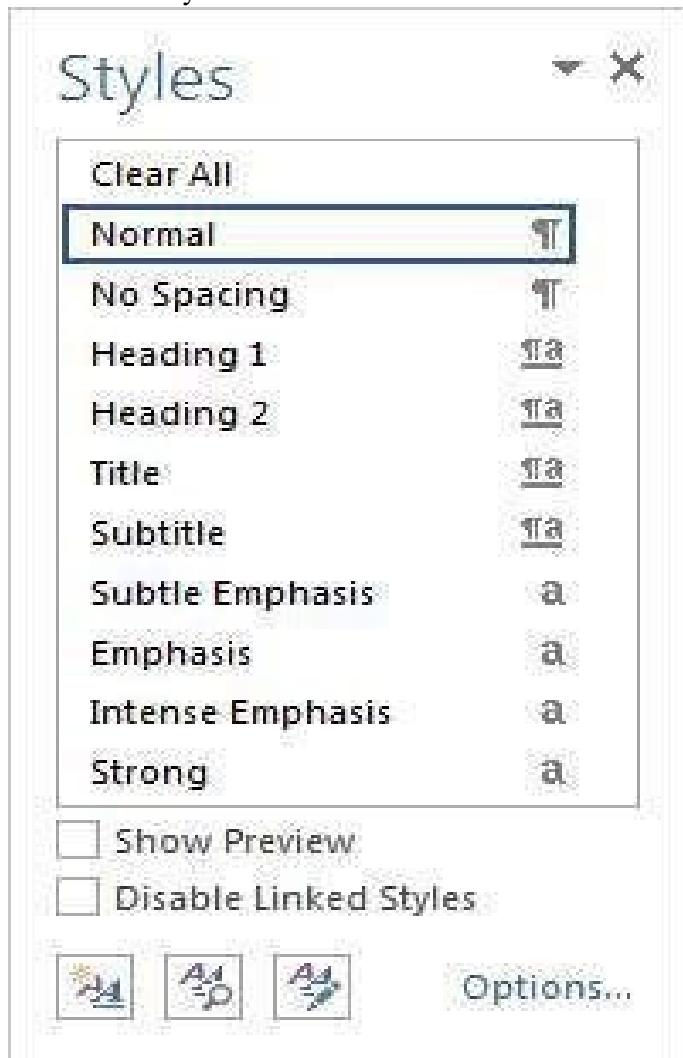


Figure 38 – Styles Pane

Formatting Headings

Headings are used to organize information into a logical structure. The best way to format headings in a Word document is to apply one of the built-in heading styles (*Heading 1* through *Heading 9*). The lower the heading number, the higher the ranking of that heading.

To format a heading:

1. Select the heading that you want format.
2. On the **Home** tab, in the **Styles** group, select the desired heading style from the **Styles** gallery.
Or, click the desired heading style in the **Styles** pane.

NOTE: When you point to a heading, a small arrow appears to the left of the heading. Click the arrow to collapse or expand the body text and subheadings below the heading (see Figure 39).

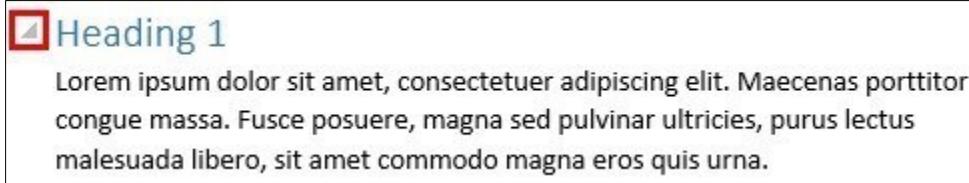


Figure 39 – Heading with Arrow

Previewing and Printing Documents

Before printing a document, you can preview it to see how each page will look when printed. When you are ready to print the document, you can quickly print one copy of the entire document using the current printer, or you can change the default print settings before printing it. The Print page of the Backstage view allows you to preview a document, set print options, and print the document, all from one location (see Figure 40).

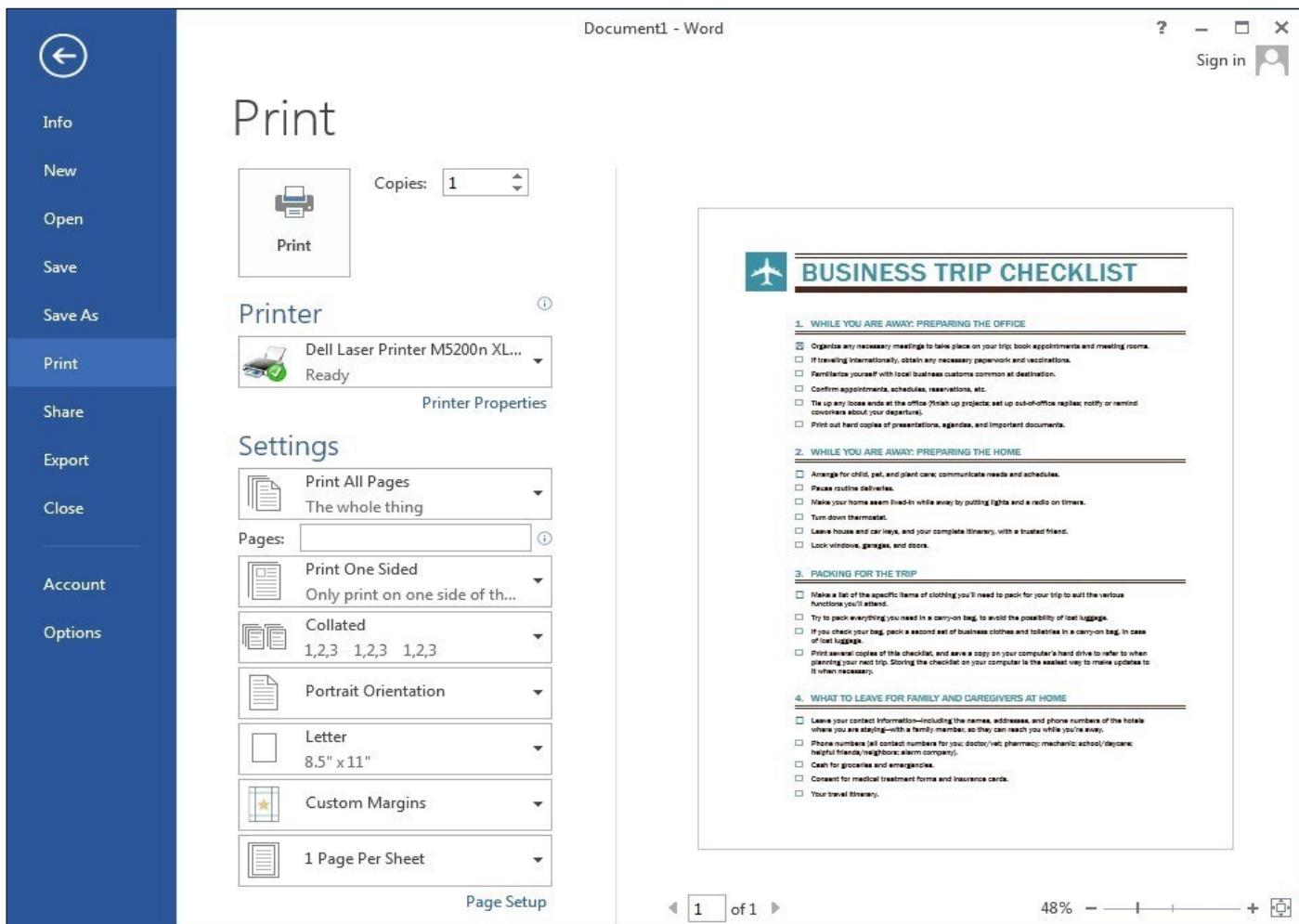


Figure 40 – Print Page of the Backstage View

To preview and print a document:

1. Click the **File** tab, and then click **Print**. Or, press **Ctrl+P**. The **Print** page of the **Backstage** view opens, displaying print settings in the center pane and a preview of the document in the right pane (see Figure 40).
2. To preview the document, in the right pane, do the following:
 - To switch pages, click the **Next Page** button  or **Previous Page** button  , or enter a specific page number in the **Current Page** box 
 - To adjust the zoom, click the **Zoom In** button  or **Zoom Out** button  , or drag the **Zoom** slider. To return to full page view, click the **Zoom to Page** button .
3. To change the print settings, in the center pane, do the following:
 - To change the printer, in the **Printer** section, click the button displaying the name of the default printer and select the desired printer from the list.
 - To print multiple copies, enter the number of copies you want to print in the **Copies** box.
 - To change other settings (such as page range, collation, orientation, paper size, margins, or pages per sheet), in the **Settings** section, select the desired options.
4. To print the document, click the **Print** button.

Getting Help

You can use the Word Help system to get assistance on any topic or task. While some information is installed with Word 2013 on your computer, most of the information resides online and is more up-to-date. You need an Internet connection to access resources from Office.com.

To get help:

1. Click the **Microsoft Word Help** button  on the right side of the **Title** bar. The **Word Help** window opens, displaying general help topics (see Figure 41).
NOTE: Clicking the **Help** button  in the upper-right corner of a dialog box displays help topics related to that dialog box in the **Word Help** window.
2. Click any link to display the corresponding information.
3. To navigate between help topics, click the **Back** button  , **Forward** button  , or **Home** button  on the toolbar.

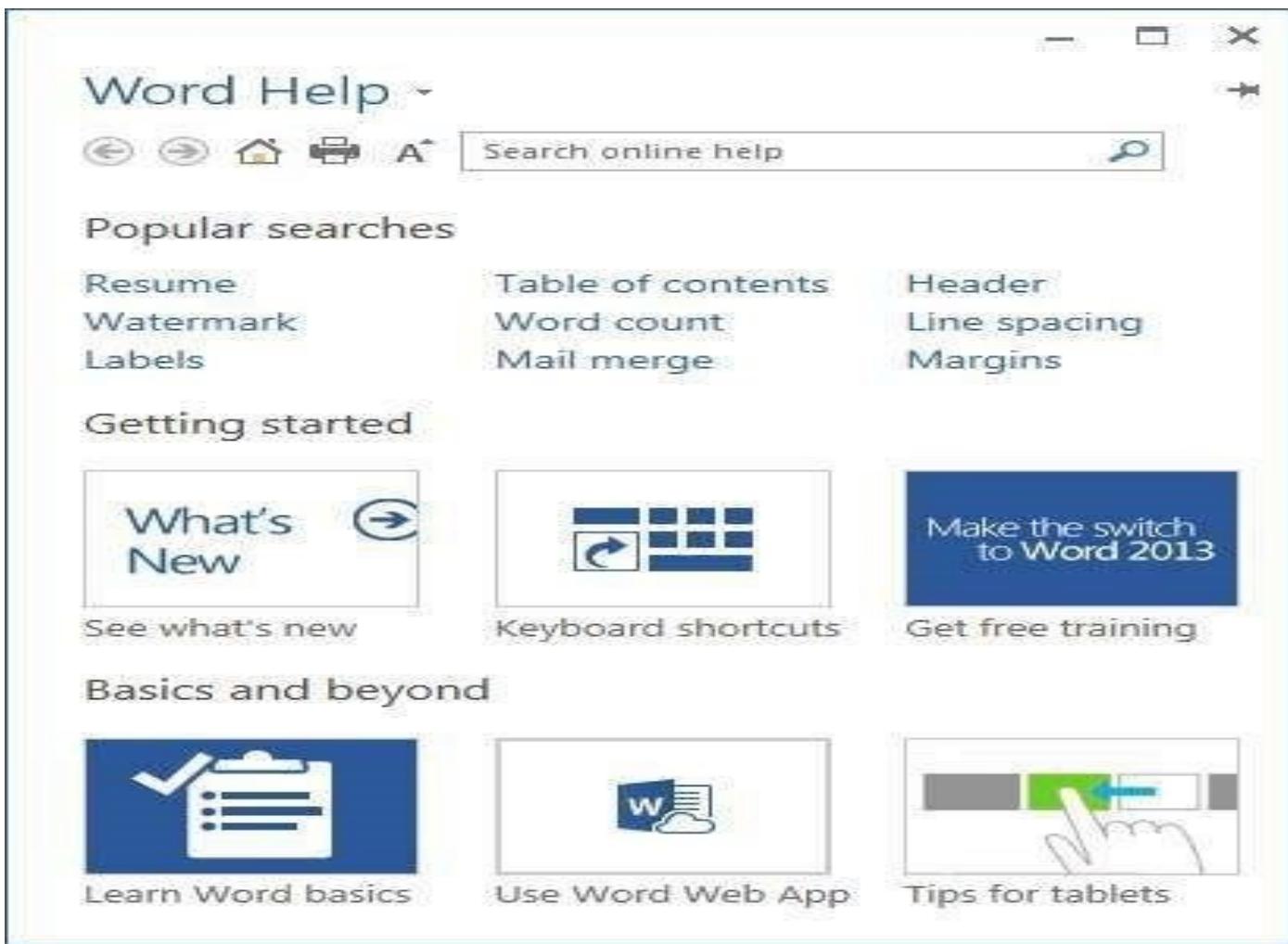


Figure 41 – Word Help Window

4. To print a help topic, click the **Print** button  on the toolbar.
5. To search for a specific topic, type one or more keywords in the **Search** box, and then press the **Enter** key to display the search results.
6. To switch between online and offline help, click the **Change Help Collection** arrow  next to **Word Help** at the top of the window, and then click **Word Help from Office.com** or **Word Help from your computer** on the menu.
7. To close the **Word Help** window, click the **Close** button  in the upper-right corner of the window.

Exiting Word

When you finish using Word 2013, you should exit the program to free up system resources.

To exit Word 2013:

1. Click the **Close** button  in the upper-right corner of the program window.

Introduction

Microsoft Excel 2013 is a spreadsheet program that is used to manage, analyze, and present data. It includes many powerful tools that can be used to organize and manipulate large amounts of data, perform complex calculations, create professional-looking charts, enhance the appearance of worksheets, and more. This handout provides an overview of the Excel 2013 user interface and covers how to perform basic tasks such as starting and exiting the program; creating, saving, opening, and closing workbooks; selecting cells; entering and editing data; formatting text and numbers; positioning cell contents; applying cell styles; and getting help.

Starting Excel

You can start Excel 2013 from the Start menu (in Windows 7) or by double-clicking an existing Excel file. When you start the program without opening a specific file, the *Start* screen appears, prompting you to open an existing workbook or create a new workbook.

To start Excel 2013 from the Start menu:

1. Click the **Start** button, click **All Programs**, click **Microsoft Office 2013**, and then click **Excel 2013**. The **Start** screen appears (see Figure 1).
2. In the right pane, click **Blank workbook**. A new, blank workbook opens in the program window.

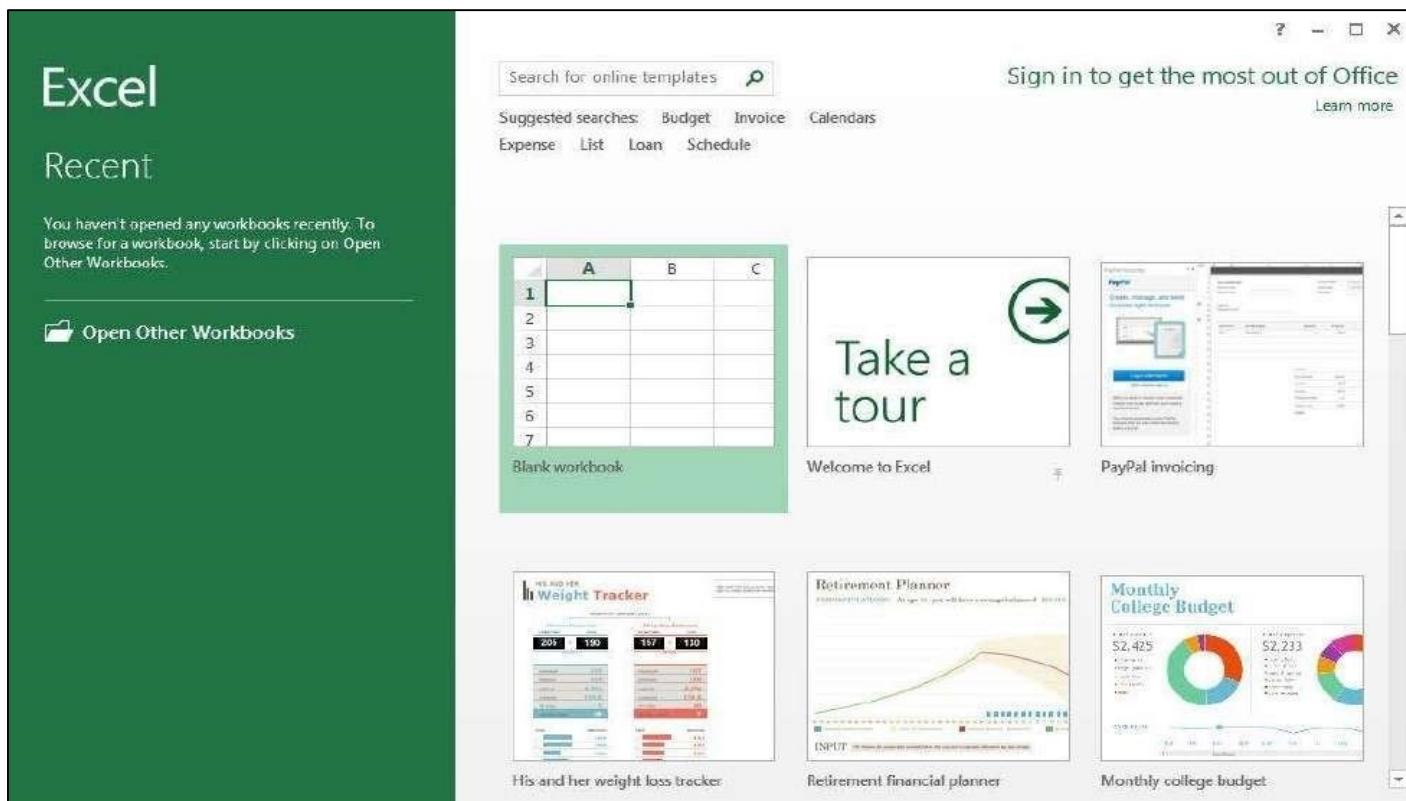


Figure 1 – Excel 2013 Start Screen

Overview of the User Interface

All the Microsoft Office 2013 programs share a common user interface so you can apply basic techniques that you learn in one program to other programs. The Excel 2013 program window is easy to navigate and simple to use (see Figure 2 and Table 1).

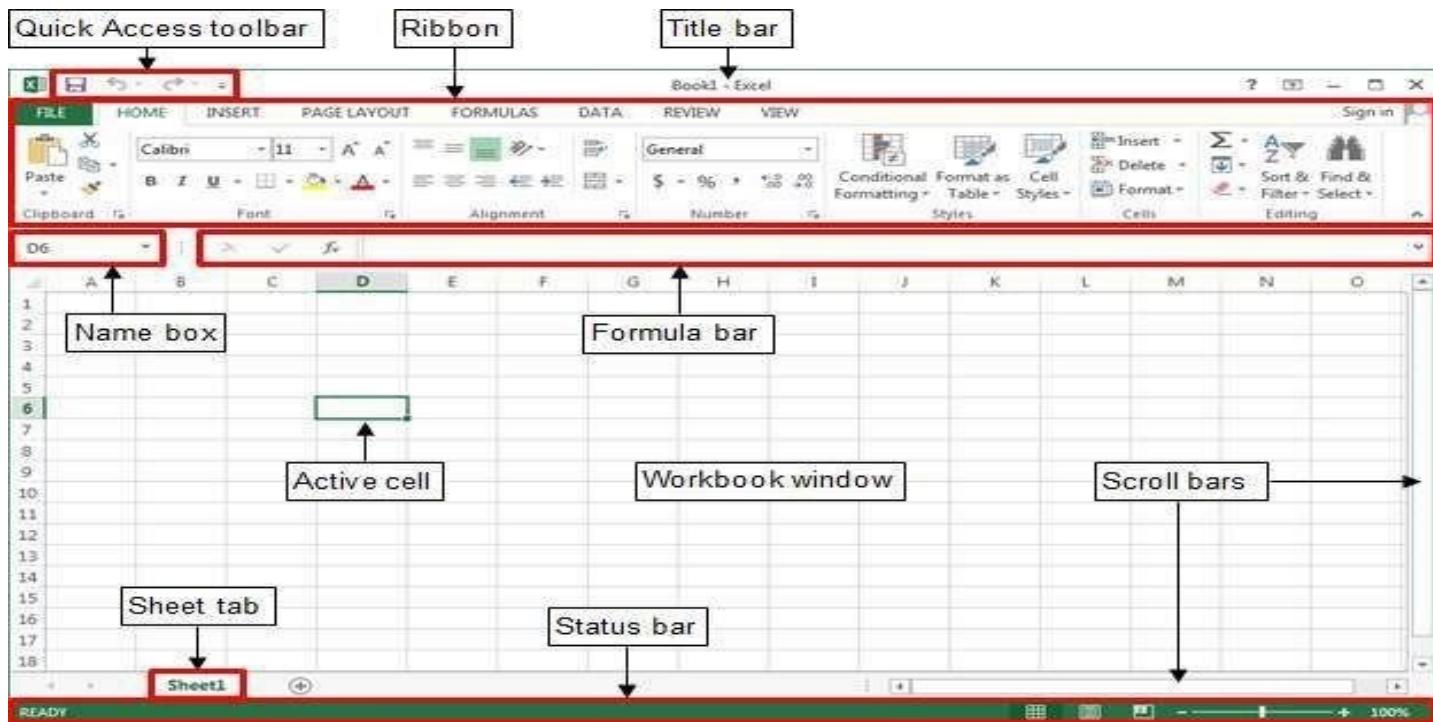


Figure 2 – Excel 2013 Program Window

Table 1 – Excel 2013 Program Window Elements

Name	Description
Title bar	Appears at the top of the program window and displays the name of the workbook and the program. The buttons on the right side of the Title bar are used to get help; change the display of the Ribbon; and minimize, restore, maximize, and close the program window.
Quick Access toolbar	Appears on the left side of the Title bar and contains frequently used commands that are independent of the tab displayed on the Ribbon.
Ribbon	Extends across the top of the program window, directly below the Title bar, and consists of a set of tabs, each of which contains groups of related commands.
Formula bar	Appears below the Ribbon and displays the data or formula stored in the active cell. It can also be used to enter or edit cell contents.
Name box	Appears on the left side of the Formula bar and displays the active cell address or the name of the selected cell, range, or object.
Workbook window	Appears below the Formula bar and displays a portion of the active worksheet.

Sheet tab	Each worksheet has a tab that appears below the workbook window and displays the name of the worksheet.
Scroll bars	Appear along the right side and bottom of the workbook window and enable you to scroll through the worksheet.
Status bar	Appears at the bottom of the program window and displays the status of Excel (such as <i>Ready</i>). The tools on the right side of the Status bar can be used to display the worksheet in a variety of views and to change the zoom level.

Ribbon

The *Ribbon* is designed to help you quickly find the commands that you need to complete a task. It consists of a set of task-specific tabs (see Figure 3 and Table 2). The standard tabs are visible at all times. Other tabs, known as *contextual tabs*, appear only when you create or select certain types of objects (such as images or charts). These tabs are indicated by colored headers and contain commands that are specific to working with the selected object. Clicking a tab displays a set of related commands that are organized into logical groups. Commands generally take the form of buttons and lists; some appear in galleries. Pointing to an option in most lists or galleries displays a live preview of that effect on the selected text or object. You can apply the previewed formatting by clicking the selected option, or you can cancel previewing without making any changes by pressing the *Esc* key. Some commands include an integrated or separate arrow. Clicking the arrow displays a menu of options available for the command. If a command on the Ribbon appears dimmed, it is unavailable. Pointing to a command on the Ribbon displays its name, description, and keyboard shortcut (if it has one) in a ScreenTip.

A *dialog box launcher*  appears in the lower-right corner of most groups on the Ribbon (see Figure 3). Clicking it opens a related dialog box or task pane that offers additional options or more precise control than the commands available on the Ribbon.

You can collapse the Ribbon by clicking the *Collapse the Ribbon* button  on the right side of the Ribbon (see Figure 3) or by double-clicking the current tab. When the Ribbon is collapsed, only the tab names are visible. You can expand the Ribbon by double-clicking any tab.

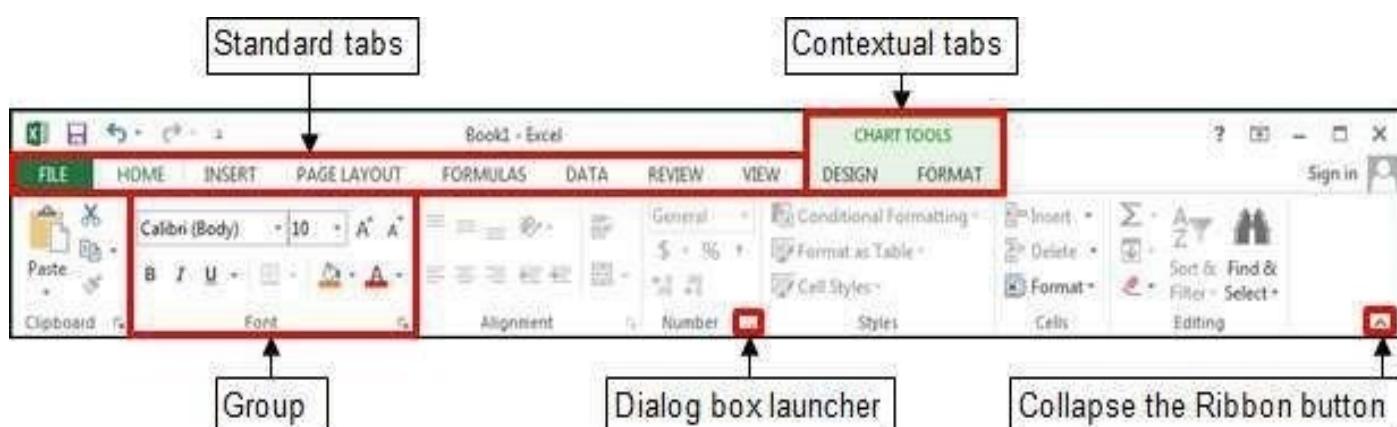


Figure 3 – Ribbon

Table 2 – Ribbon Tabs

Name	Description
File	Displays the Backstage view which contains commands related to managing files and customizing the program.
Home	Contains the most frequently used commands. The Home tab is active by default.
Insert	Contains commands related to all the items that you can insert into a worksheet.
Page Layout	Contains commands that affect the overall appearance and layout of a worksheet.
Formulas	Contains commands used to insert formulas, define names, and audit formulas.
Data	Contains commands used to manage data and import or connect to external data.
Review	Contains commands used to check spelling, track changes, add comments, and protect worksheets.
View	Contains commands related to changing the view and other aspects of the display.

Quick Access Toolbar

The *Quick Access* toolbar provides one-click access to commonly used commands and options. By default, it is located on the left side of the Title bar and displays the Save, Undo, and Redo buttons (see Figure 4). You can change the location of the Quick Access toolbar as well as customize it to include commands that you use frequently.



Figure 4 – Quick Access Toolbar

To add a command to the Quick Access toolbar:

1. On the **Ribbon**, right-click the command that you want to add, and then click **Add to Quick Access Toolbar** on the shortcut menu.

To remove a command from the Quick Access toolbar:

1. On the **Quick Access** toolbar, right-click the command that you want to remove, and then click **Remove from Quick Access Toolbar** on the shortcut menu.

NOTE: Clicking the arrow on the right side of the **Quick Access** toolbar displays a menu which includes additional commands and options that can be used to customize the toolbar. A check mark next to an item indicates that the item is selected (see Figure 5).

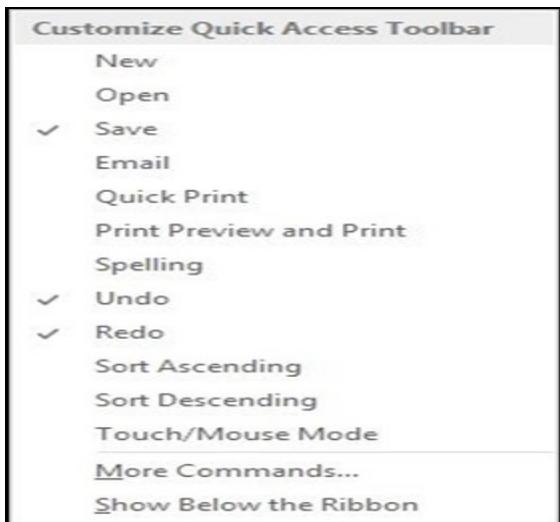


Figure 5 – Customize Quick Access Toolbar Menu

Mini Toolbar

The *Mini* toolbar provides quick access to frequently used commands and appears whenever you right-click a cell or an object (see Figure 6).

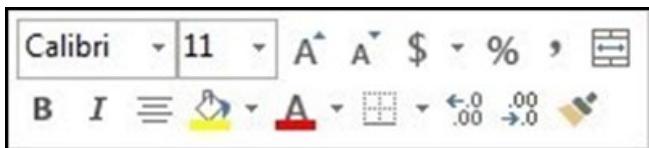


Figure 6 – Mini Toolbar

Shortcut Menus

Excel 2013 includes many shortcut menus that appear when you right-click an item. Shortcut menus are context-sensitive, meaning they list commands that pertain only to the item that you right-clicked (see Figure 7).

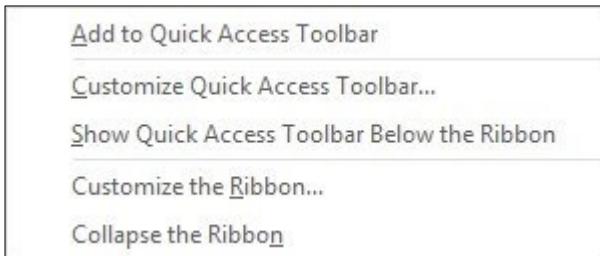


Figure 7 – Ribbon Shortcut Menu

Backstage View

The *File* tab (the first tab on the Ribbon) is used to display the *Backstage* view which contains all the commands related to managing files and customizing the program. It provides an easy way to create, open, save, print, share, export, and close files; view and update file properties; set permissions; set program options; and more. Commands available in the Backstage view are organized into pages which you can display by clicking the page tabs in the left pane.

To display the Backstage view:

1. Click the **File** tab on the **Ribbon** (see Figure 8).



Figure 8 – File Tab

To exit the Backstage view:

1. Click the **Back** button in the upper-left corner of the **Backstage** view (see Figure 9). Or, press the **Esc** key.

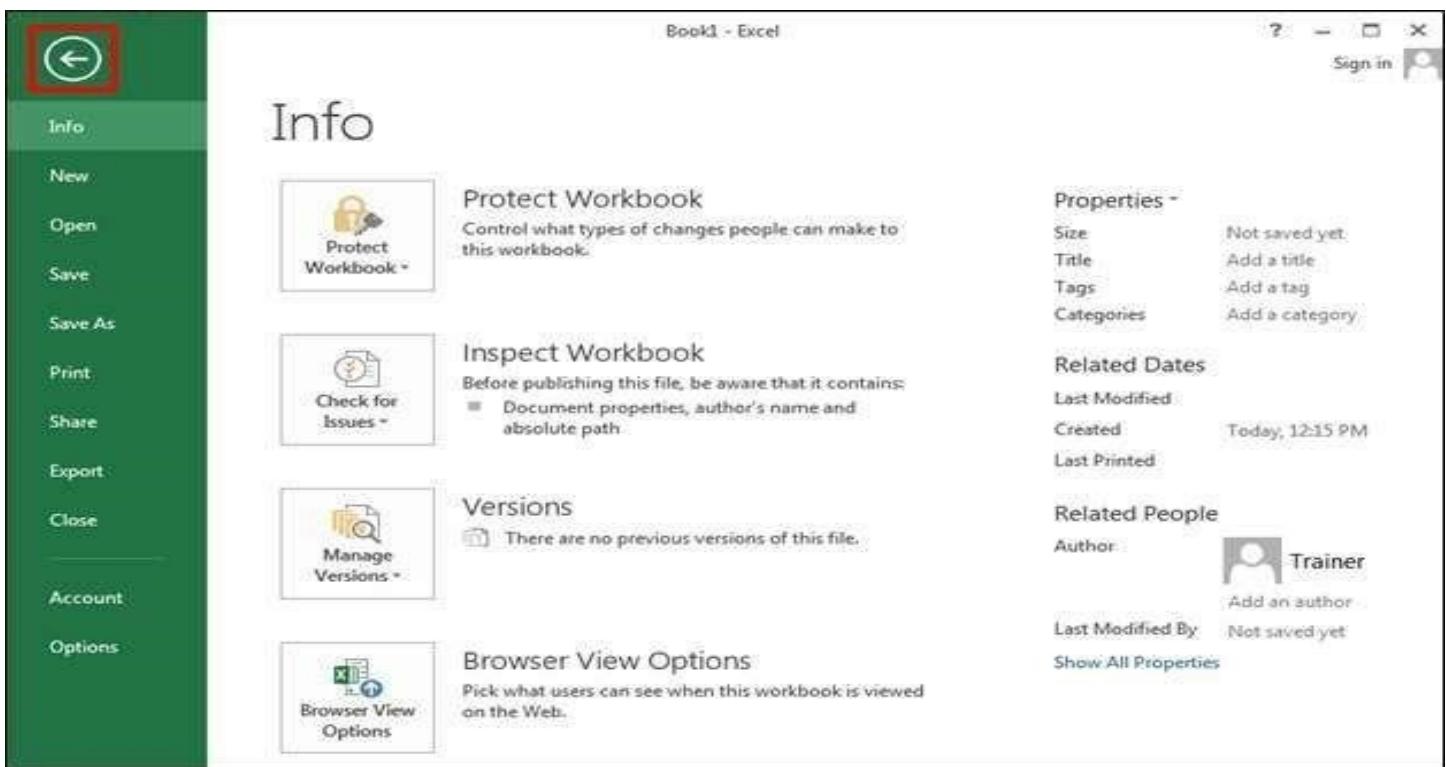


Figure 9 – Info Page of the Backstage View

Formula Bar

The *Formula* bar displays the contents of the active cell and can be used to enter or edit cell contents. The Formula bar contains three buttons (see Figure 10). The Insert Function button is always available, but the other two buttons are active only while you are entering or editing data in a cell. Clicking the *Cancel* button cancels the changes you make in the cell, which is the same as pressing the *Esc* key. Clicking the *Enter* button completes the changes you make in the cell, which is the same as pressing the *Enter* key. Clicking the *Insert Function* button opens a dialog box that helps you construct formulas.

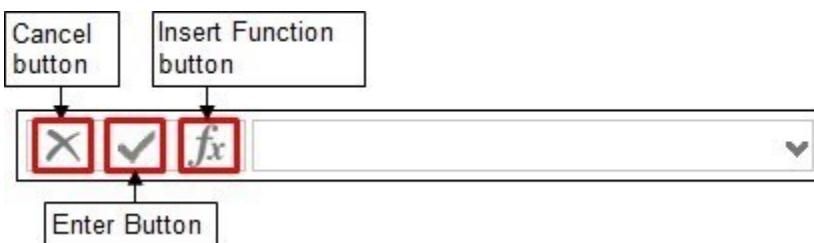


Figure 10 – Formula Bar

Overview of Workbooks

An Excel file is called a *workbook*. Each new workbook contains one blank *worksheet* (see Figure 11). You can add additional worksheets or delete existing worksheets as needed. By default, a new workbook is named *Book1* and the worksheet it contains is named *Sheet1*. Each worksheet consists of 1,048,576 rows (numbered 1 through 1,048,576) and 16,384 columns (labeled A through XFD). The box formed by the intersection of a row and a column is called a *cell*. Cells are used to store data. Each cell is identified by its address which consists of its column letter and row number (e.g., cell A1 is the cell in the first column and first row). A group of cells is called a *range*. A range is identified by the addresses of the cells in the upper-left and lower-right corners of the selected block of cells, separated by a colon (e.g., A1:C10). Only one cell can be active at a time. The *active cell* has a green border around it and its address appears in the Name box on the left side of the Formula bar. The row and column headers of the active cell appear in a different color to make it easier to identify. A worksheet also has an invisible *draw layer* which holds charts, images, and diagrams.

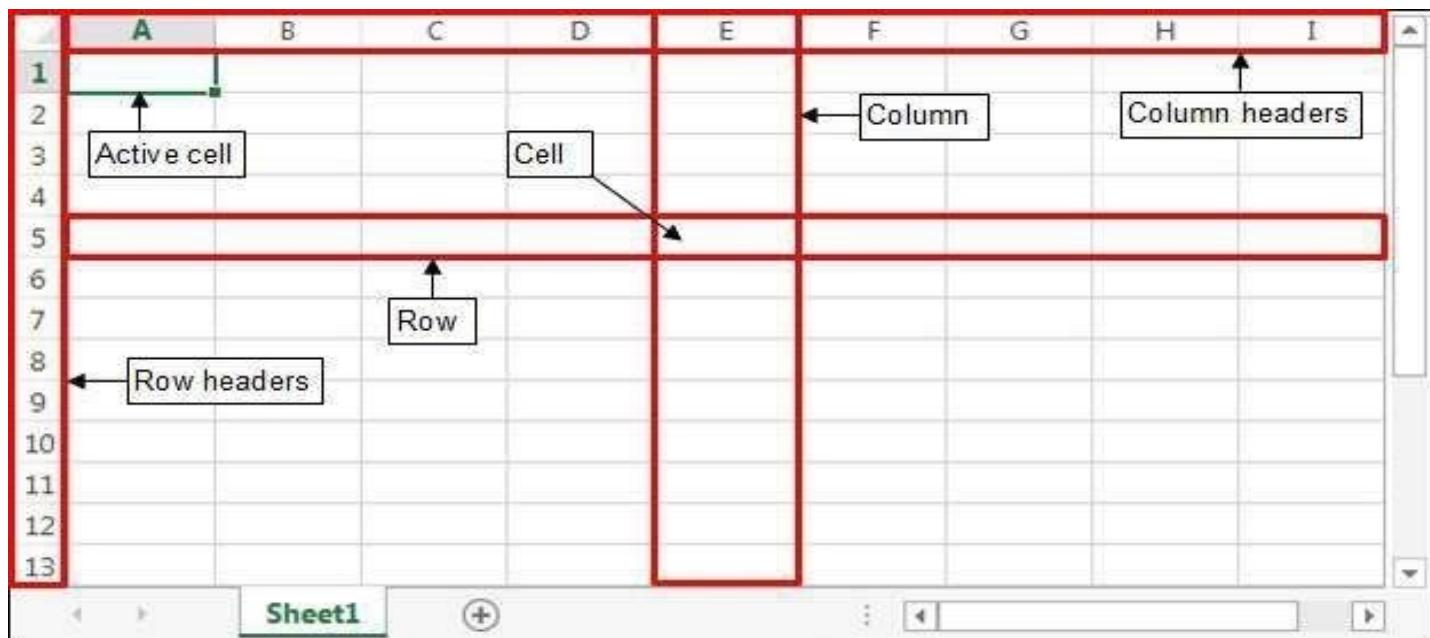


Figure 11 – Worksheet

Creating Workbooks

When you start Excel 2013 and click *Blank workbook* on the *Start* screen, a new workbook opens in the program window, ready for you to enter your data. You can also create a new workbook while Excel 2013 is running. Each new workbook displays a default name (such as *Book1*, *Book2*, and so on) on the Title bar until you save it with a more meaningful name.

To create a new workbook:

1. Click the **File** tab, and then click **New**. The **New** page of the **Backstage** view opens, displaying thumbnails of the available templates (see Figure 12).
2. In the right pane, click **Blank workbook**. A new, blank workbook opens in a new window.

NOTE: You can also create a new workbook by pressing **Ctrl+N**.

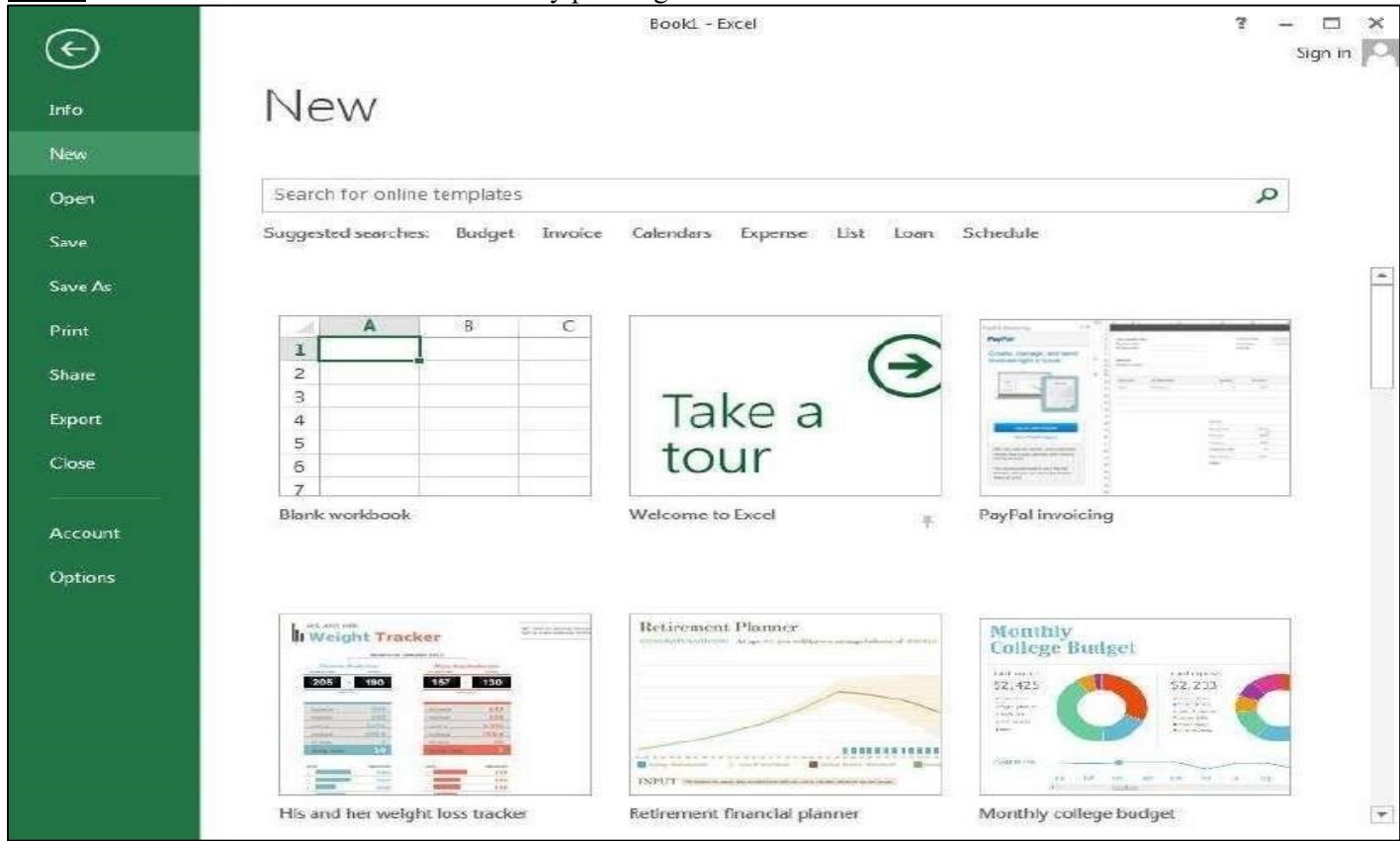


Figure 12 – New Page of the Backstage View

Saving Workbooks

After creating a workbook, you can save it on your computer. Use the *Save As* command when you save a workbook for the first time or if you want to save a copy of a workbook in a different location, with a different file name, or in a different file format. Use the *Save* command to save changes to an existing workbook.

NOTE: Excel 2013's file format is called *Excel Workbook* and is the same as Excel 2007 and 2010. This format has the *.xlsx* file extension and is not backward compatible with Excel versions prior to 2007. You can use Excel 2013 to save a workbook in the *Excel 97-2003 Workbook* format with the *.xls* file extension to make it compatible with earlier versions of Excel, but you will not have access to all of Excel 2013's features.

To save a workbook for the first time:

1. Click the **File** tab, and then click **Save As**. The **Save As** page of the **Backstage** view opens (see Figure 13).
2. Click **Computer** in the center pane, and then click the **Browse** button or a recent folder in the right pane.



Figure 13 – Save As Page of the Backstage View

3. In the **Save As** dialog box, select a location to save the file, type a name in the **File name** box, and then click the **Save** button (see Figure 14).

NOTE: By default, Excel 2013 workbooks are saved in the **Excel Workbook** format. To save a document in a different format, click the **Save as type** arrow and select the desired file format from the list.

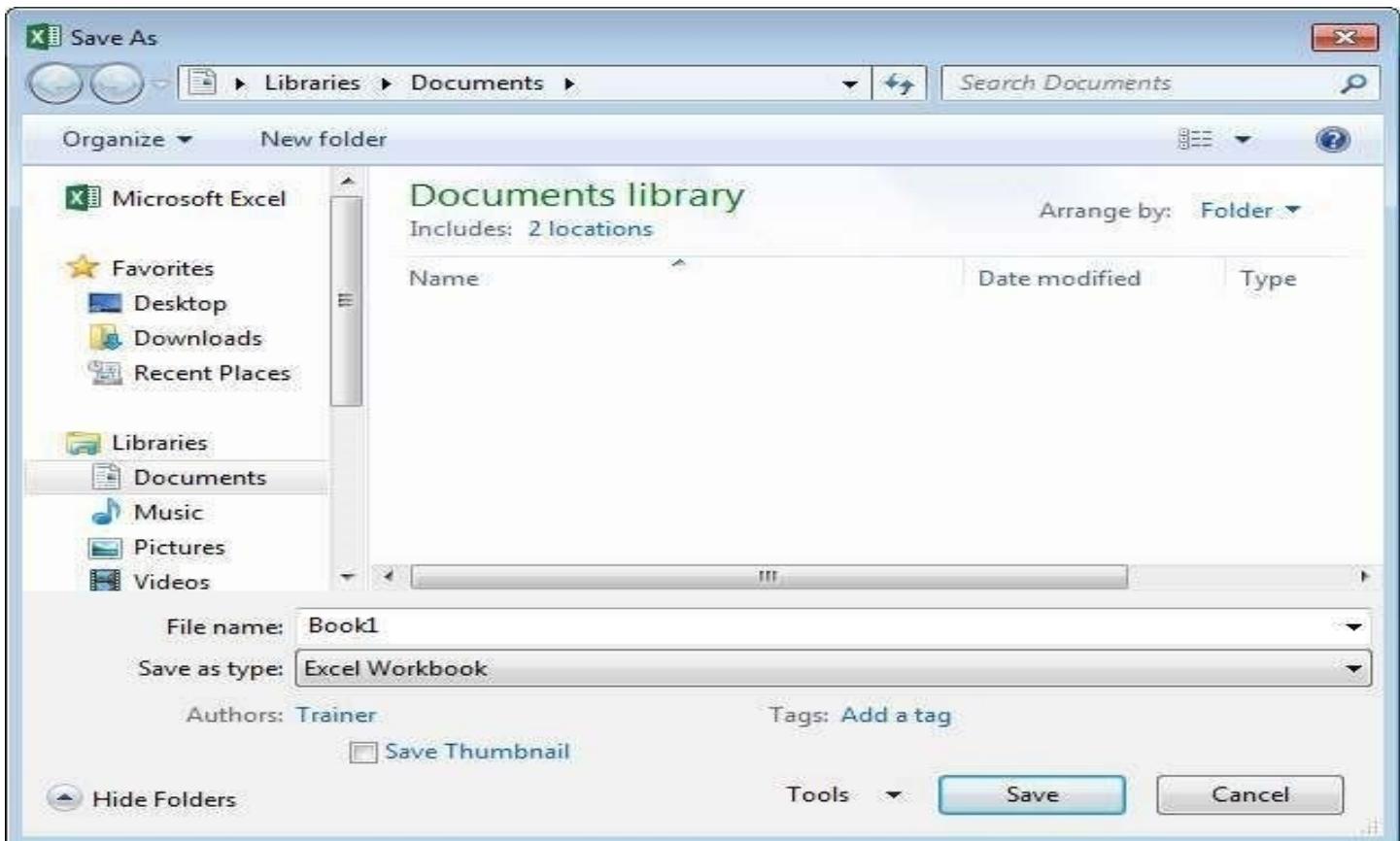


Figure 14 – Save as Dialog Box

To save changes to a workbook:

1. Do one of the following:

- Click the **File** tab, and then click **Save**.
- On the **Quick Access** toolbar, click the **Save** button .
- Press **Ctrl+S**.

Closing Workbooks

When you finish working on a workbook, you can close it, but keep the program window open to work on more workbooks. If the workbook contains any unsaved changes, you will be prompted to save the changes before closing it.

To close a workbook without exiting Excel:

1. Click the **File** tab, and then click **Close**. Or, press **Ctrl+W**.

Opening Workbooks

You can locate and open an existing workbook from the Start screen when Excel 2013 starts or from the Open page of the Backstage view. The Start screen and the Open page also display a list of recently used workbooks which you can quickly open by clicking them. Each workbook opens in its own window, making it easier to work on two workbooks at once.

To open a workbook:

1. Click the **File** tab, and then click **Open**. Or, press **Ctrl+O**. The **Open** page of the **Backstage** view opens, displaying a list of recently used workbooks in the right pane.
2. If the workbook you want is in the **Recent Workbooks** list, click its name to open it. Otherwise, proceed to step 3.
3. Click **Computer** in the center pane, and then click the **Browse** button or a recent folder in the right pane (see Figure 15).

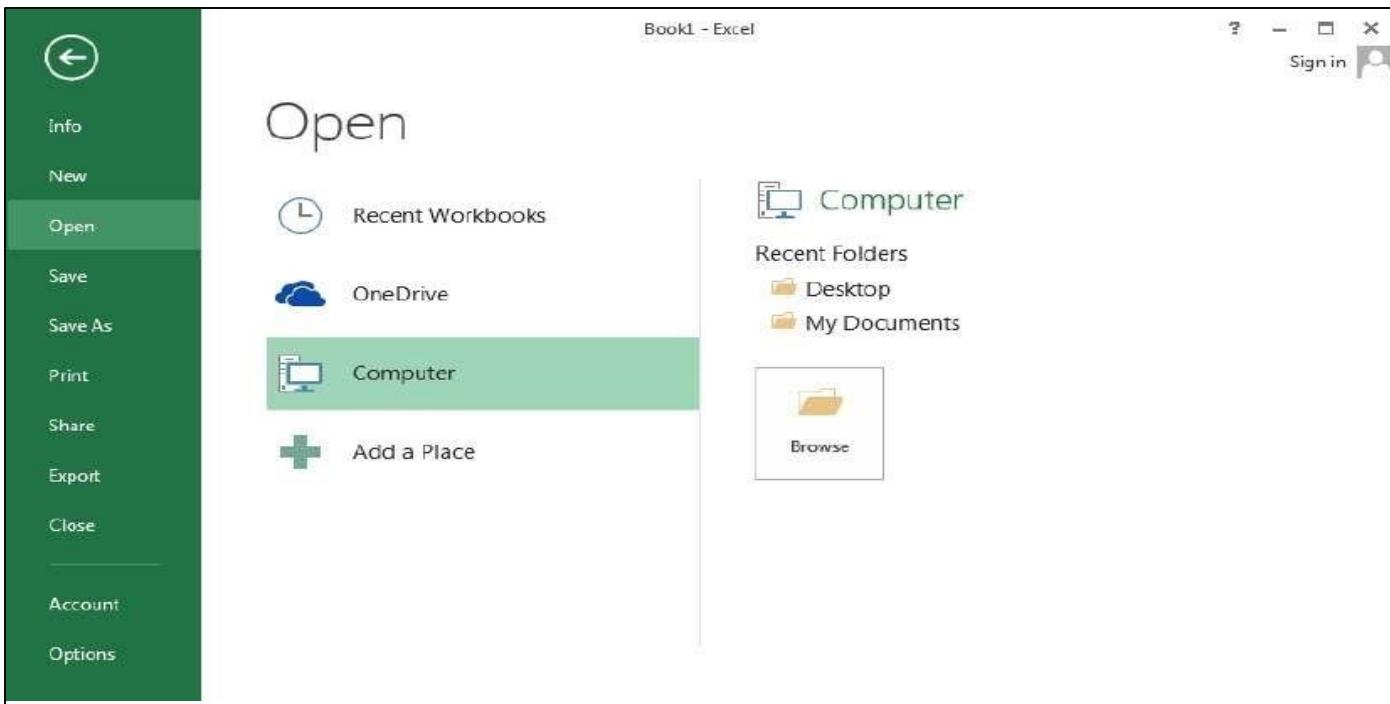


Figure 15 – Open Page of the Backstage View

- In the **Open** dialog box, locate and select the file that you want to open, and then click the **Open** button (see Figure 16).

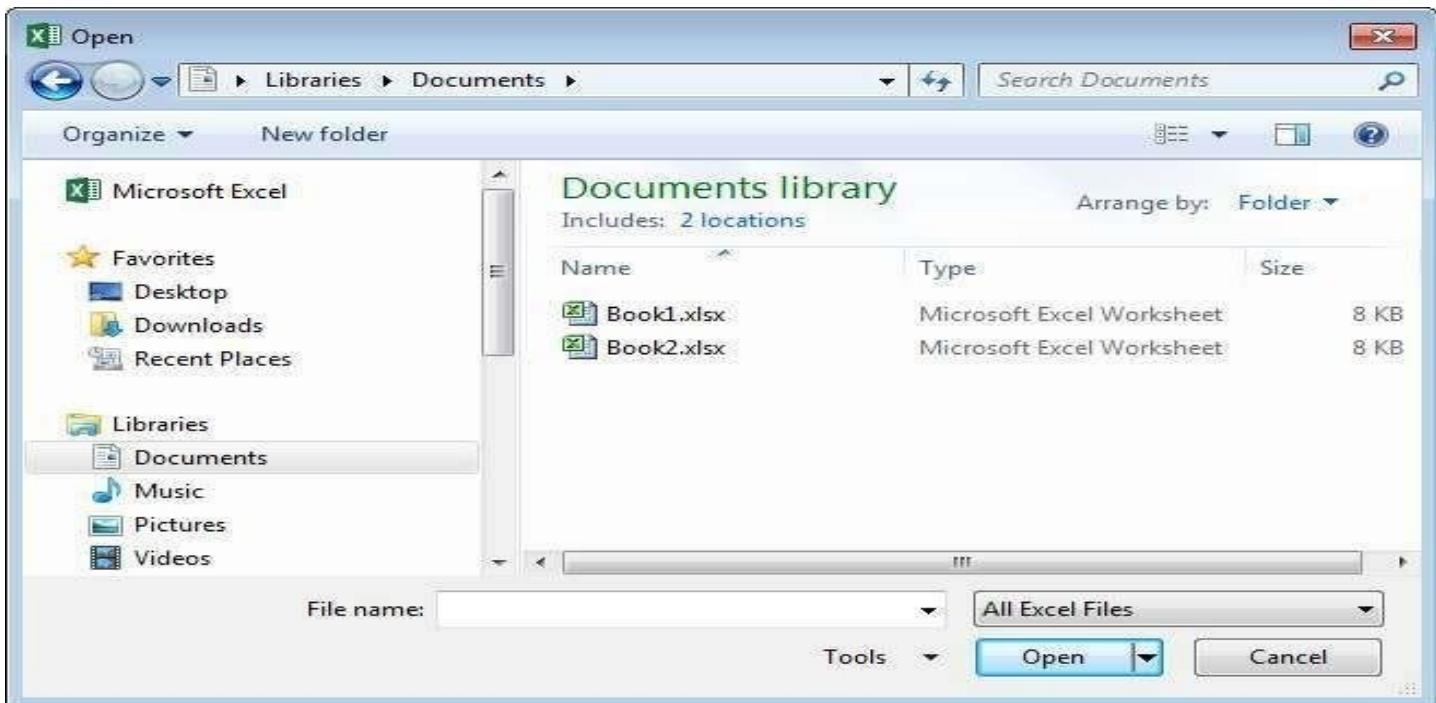


Figure 16 – Open Dialog Box

NOTE: When you open a workbook created with earlier versions of Excel in Excel 2013, the workbook opens in compatibility mode (indicated on the Title bar) with some of the new features of Excel 2013 disabled. You can easily convert the workbook to the Excel 2013 file format by clicking the *Convert* button on the *Info* page of the *Backstage* view (see Figure 17).



Figure 17 – Convert Button on the Info Page of the Backstage View

Moving Around and Making Selections

This section covers how to perform basic tasks such as moving around worksheets and selecting cells, rows, and columns.

Moving Around Worksheets

There are various ways to navigate through a worksheet. Using the mouse and the scroll bars, you can scroll through the worksheet in any direction. Using the navigational keys on the keyboard, you can move from cell to cell, move up or down one page at a time, or move to the first or last used cell in the worksheet (see Table 3). You can also navigate to a specific cell in the worksheet by entering its address in the Name box.

NOTE: Scrolling with the mouse does not change the location of the active cell. To change the active cell, you must click a new cell after scrolling.

Table 3 – Navigation Keyboard Shortcuts

Key	Action
Down arrow or Enter	Moves the active cell one cell down.
Up arrow or Shift+Enter	Moves the active cell one cell up.
Right arrow or Tab	Moves the active cell one cell to the right.
Left arrow or Shift+Tab	Moves the active cell one cell to the left.
Page Down	Moves the active cell down one page.
Page Up	Moves the active cell up one page.
Alt+Page Down	Moves the active cell right one page.
Alt+Page Up	Moves the active cell left one page.
Ctrl+Home	Moves the active cell to cell A1.
Ctrl+End	Moves the active cell to the last used cell in the worksheet.

Selecting Cells, Rows, and Columns

In order to work with a cell, you must first select it. When you want to work with more than one cell at a time, you can quickly select ranges, rows, columns, or the entire worksheet.

To select a single cell:

1. Click the desired cell (see Figure 18).

	A	B	C
1			
2		B2	
3			

Figure 18 – Active Cell

To select a range of cells:

1. Click the first cell that you want to include in the range, hold down the **Shift** key, and then click the last cell in the range (see Figure 19). Or, drag from the first cell in the range to the last cell.

NOTE: When a range is selected, every cell in the range is highlighted, except for the active cell. You can deselect a range by pressing any arrow key or by clicking any cell in the worksheet.

To select nonadjacent cells or ranges:

1. Select the first cell or range, hold down the **Ctrl** key, and then select the other cells or ranges (see Figure 20).

	A	B	C	D
1				
2		B2	C2	
3				
4				
5				

Figure 19 – Selected Range

	A	B	C	D
1				
2		B2		
3				
4			C4	D5
5				

Figure 20 – Selected Nonadjacent Ranges

To select a single row or column:

1. Click the header of the row or column that you want to select (see Figure 21 and Figure 22).

NOTE: When a row or column is selected, every cell in the row or column is highlighted, except for the active cell. You can deselect a row or column by pressing any arrow key or by clicking any cell in the worksheet.

	A	B	C	D
1				
2				
3				
4				
5				

Figure 21 – Selected Row

	A	B	C	D
1				
2				
3				
4				
5				

Figure 22 – Selected Column

To select multiple adjacent rows or columns:

1. Click the header of the first row or column that you want to select, hold down the **Shift** key, and then click the header of the last row or column. Or, drag across the headers of the rows or columns that you want to select.

To select multiple nonadjacent rows or columns:

1. Hold down the **Ctrl** key, and then click the headers of the rows or columns that you want to select.

To select all cells in a worksheet:

1. Click the **Select All** button in the upper-left corner of the worksheet (see Figure 23). Or, press **Ctrl+A**.

	A	B	C	D
1				
2				
3				
4				
5				

Figure 23 – Select All Button

Editing Worksheets

After creating a workbook, you can start adding data to a worksheet. If you need to make changes, you can easily edit the data to correct errors, update information, or remove information you no longer need.

Entering Data

You can add data by entering it directly in a cell or by using the Formula bar. A cell can contain a maximum of 32,767 characters and can hold any of three basic types of data: text, numbers, or formulas.

NOTE: If you make a mistake while entering data, simply press the **Backspace** key to delete all or a portion of your entry and enter the correct data.

Entering Text

You can enter text in a worksheet to serve as labels for values, headings for columns, or instructions about the worksheet. Text is defined as any combination of letters and numbers. Text automatically aligns to the left in a cell. If you enter text that is longer than its column's current width, the excess characters appear in the next cell to the right, as long as that cell is empty (see Figure 24). If the adjacent cell is not empty, the long text entry appears truncated (see Figure 25). The characters are not actually deleted and will appear if the width of the column is adjusted to accommodate the long text entry.

A	B	C	D
1 Cell content that appears to overflow			

Figure 24 – Overflowing Text Entry

A	B	C	D
1	Cell conte	1	

Figure 25 – Truncated Text Entry

To enter text:

1. Select the cell in which you want to enter text.
2. Type the desired text, and then press the **Enter** key.

	A
	Line 1
	Line 2
1	Line 3

Figure 26 – Cell with Line Breaks

NOTE: To enter a line break in a cell, press **Alt+Enter** (see Figure 26).

Entering Numbers

Numeric entries contain only numbers and are automatically aligned to the right in a cell. Numbers can exist as independent values, or they can be used in formulas to calculate other values. You can enter whole numbers (such as 5 or 1,000), decimals (such as 0.25 or 5.15), negative numbers (such as -10 or -5.5), percentages (such as 20% or 1.5%), and currency values (such as \$0.25 or \$20.99).

NOTE: A number that does not fit within a column is displayed as a series of pound signs #####). To accommodate the number, increase the column width.

To enter a number:

1. Select the cell in which you want to enter the number.
2. Type the desired number, and then press the **Enter** key.

Entering Dates and Times

Excel treats dates and times as special types of numeric values.

To enter a date:

1. Select the cell in which you want to enter the date.
2. Type the month, day, and year, with each number separated by a forward slash (/) or a hyphen (-), and then press the **Enter** key.

To enter a time:

1. Select the cell in which you want to enter the time.
2. Type the hour, a colon (:), and the minutes, press the **Spacebar**, type **a** for A.M. or **p** for P.M., and then press the **Enter** key.

Editing Data

If a cell contains a long entry and you only want to change a few characters, it is faster to edit the data than to retype the entire entry. You can edit the contents of a cell directly in the cell or by using the Formula bar.

To edit data:

1. Double-click the cell that contains the data you want to edit. The cursor (a blinking vertical line) appears in the cell in the location that you double-clicked.
2. To insert characters, click where you want to make changes, and then type the new characters.

NOTE: You can also move the cursor by pressing the **Home**, **End**, or arrow keys.

3. To delete characters, click where you want to make changes, and then press the **Backspace** or **Delete** key.

NOTE: Pressing the **Backspace** key deletes the character to the left of the cursor; pressing the **Delete** key deletes the character to the right of the cursor.

4. When you are finished, press the **Enter** key.

NOTE: If you are editing data and decide not to keep your edits, press the **Esc** key to return the cell to its previous state.

Replacing Data

You can replace the entire contents of a cell with new data. Any formatting applied to the cell remains in place and is applied to the new data.

To replace data:

1. Select the cell that contains the data you want to replace.
2. Type the new data, and then press the **Enter** key.

Deleting Data

You can delete the entire contents of a cell if the data is no longer needed. Deleting data does not remove any formatting applied to the cell.

To delete data:

1. Select the cell that contains the data you want to delete, and then press the **Delete** key.

Moving and Copying Cells

When editing a worksheet, you may want to duplicate a cell in another location or remove (cut) a cell from its original location and place it in a new location. A copied cell can be pasted multiple times; a cut cell can be pasted only once.

NOTE: Cut or copied data is stored on the **Clipboard**, a temporary storage area. You can access it by clicking the dialog box launcher  in the **Clipboard** group on the **Home** tab of the **Ribbon** (see Figure 27).

To move or copy a cell:

1. Select the cell that you want to move or copy.

2. On the **Home** tab, in the **Clipboard** group, do one of the following:
 - To move the cell, click the **Cut**  button. Or, press **Ctrl+X**.
 - To copy the cell, click the **Copy**  button. Or, press **Ctrl+C**.
3. Select the cell where you want to paste the cut or copied cell.
4. On the **Home** tab, in the **Clipboard** group, click the **Paste** button . Or, press **Ctrl+V**.

NOTE: When you cut or copy cells, a *marquee* (scrolling dotted line) appears around the cells. You can remove the marquee by pressing the **Esc** key (see Figure 28).



Figure 27 – Clipboard Group on the Home Tab

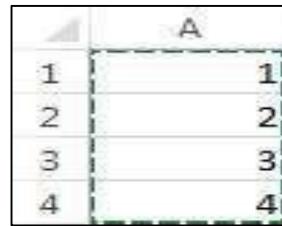


Figure 28 – Cells with Marquee

Using Paste Special

The *Paste Special* command is a very useful editing feature. It allows you to control which aspect of the copied cell to paste into the target cell. For example, you can choose to paste only the copied cell's formula, only the result of the formula, only the cell's formatting, etc. You must copy to use the Paste Special command; when you cut, the Paste Special command is not available.

To use the Paste Special command:

1. Select the cell that contains the value, formula, or formatting you want to copy.
2. On the **Home** tab, in the **Clipboard** group, click the **Copy** button .
3. Select the cell where you want to paste the value, formula, or formatting.
4. On the **Home** tab, in the **Clipboard** group, click the **Paste** arrow and select the desired option from the menu (see Figure 29).

NOTE: Pointing to a command on the **Paste** menu displays its name in a ScreenTip. You can access more options by clicking **Paste Special** at the bottom of the menu.

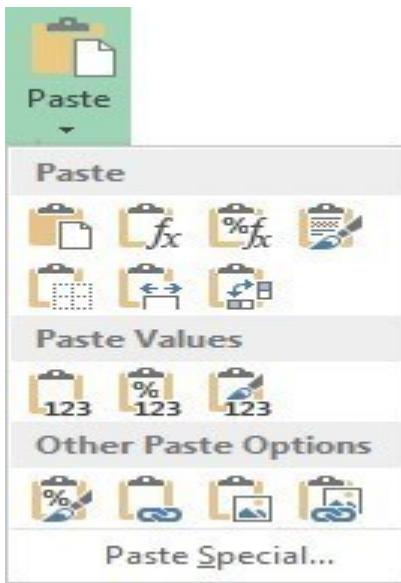


Figure 29 – Paste Menu

Clearing Cells

You can clear a cell to remove its contents, formats, or comments. When clearing a cell, you must specify whether to remove one, two, or all three of these elements from the cell.

To clear a cell:

1. Select the cell that you want to clear.
2. On the **Home** tab, in the **Editing** group, click the **Clear** button and select the desired option from the menu (see Figure 30).

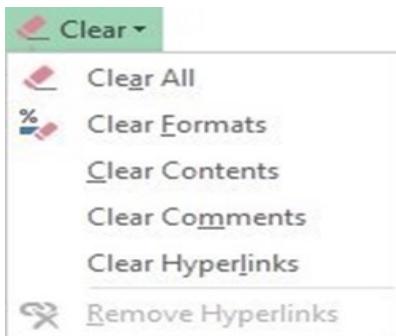


Figure 30 – Clear Menu

Undoing and Redoing Changes

Whenever you make a mistake, you can easily reverse it with the *Undo* command. After you have undone one or more actions, the *Redo* command becomes available and allows you to restore the undone actions.

To undo an action:

1. On the **Quick Access** toolbar, click the **Undo** button . Or, press **Ctrl+Z**.

To redo an action:

1. On the **Quick Access** toolbar, click the **Redo** button . Or, press **Ctrl+Y**.

Formatting Worksheets

Excel 2013 includes a number of features that can be used to easily format a worksheet.

Formatting enhances the appearance of a worksheet and makes it look professional.

Formatting Cells and Cell Contents

You can format cells and cell contents by changing the font, font size, font style, and font color, as well as adding cell borders and changing the background color of cells. Since formatting is attached to the cell and not to the entry, you can format a cell before or after you enter the data. The *Font* group on the *Home* tab of the *Ribbon* contains the most commonly used formatting commands (see Figure 31). You can also format cells using the *Format Cells* dialog box which can be opened by clicking the dialog box launcher  in the *Font* group.

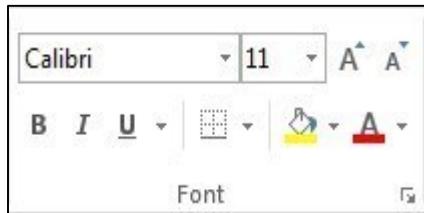


Figure 31 – Font Group on the Home Tab

Changing the Font and Font Size

A font defines the overall appearance or style of text lettering. Font size controls the height of the font. The default font in new Excel 2013 workbooks is Calibri; the default font size is 11 points.

To change the font:

1. Select the cell that you want to format.
2. On the **Home** tab, in the **Font** group, click the **Font** arrow and select the desired font from the list (see Figure 32).

To change the font size:

1. Select the cell that you want to format.
2. On the **Home** tab, in the **Font** group, click the **Font Size** arrow and select the desired font size from the list (see Figure 33). If a font size you want is not listed in the **Font Size** list, click in the **Font Size** box, type the desired number, and then press the **Enter** key.

NOTE: You can also change the font size by clicking the **Increase Font Size** button  or **Decrease Font Size** button  in the **Font** group on the **Home** tab of the **Ribbon**.



Figure 32 – Font List

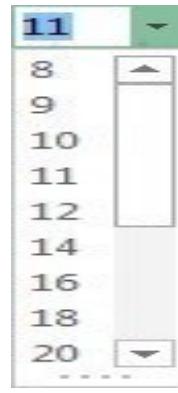


Figure 33 – Font Size List

Changing the Font Color and Fill Color

You can change the font color of cell contents or the background color of cells to emphasize important data or add visual impact to a worksheet.

To change the font color:

1. Select the cell that you want to format.
2. On the **Home** tab, in the **Font** group, click the **Font Color** button to apply the most recently used color, or click the **Font Color** arrow and select a different color from the color palette (see Figure 34).

To change the fill color:

1. Select the cell that you want to format.
2. On the **Home** tab, in the **Font** group, click the **Fill Color** button to apply the most recently used color, or click the **Fill Color** arrow and select a different color from the color palette (see Figure 35).

NOTE: You can remove the fill color from a selected cell by clicking the **Fill Color** arrow, and then clicking **No Fill** on the palette.



Figure 34 – Font Color Palette



Figure 35 – Fill Color Palette

Applying Font Styles

You can apply one or more font styles to emphasize important data in a worksheet. Font styles are attributes such as bold, italic, and underline. Bolding makes the characters darker. Italicizing slants the characters to the right. Underlining adds a line below the cell contents, not the cell itself.

To bold or italicize data:

1. Select the cell that you want to format.
2. On the **Home** tab, in the **Font** group, click the **Bold** button  or **Italic** button .

To underline data:

1. Select the cell that you want to format.
2. On the **Home** tab, in the **Font** group, do one of the following (see Figure 36):
 - To apply a single underline, click the **Underline** button.
 - To apply a double underline, click the **Underline** arrow, and then click **Double Underline** on the menu.

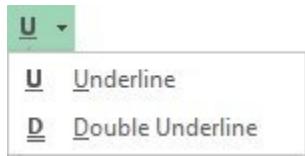


Figure 36 – Underline Menu

NOTE: The **Bold**, **Italic**, and **Underline** buttons are toggles. If you select a cell to which one of these formats has been applied, and then click the corresponding button, that format is removed.

Adding Cell Borders

You can add borders to any or all sides of a single cell or range. Excel 2013 includes several predefined border styles that you can use.

To add cell borders:

1. Select the cell to which you want to add borders.
2. On the **Home** tab, in the **Font** group, click the **Borders** button to apply the most recently used border, or click the **Borders** arrow and select a different border from the menu (see Figure 37).

NOTE: You can remove all borders from a selected cell by clicking the **Borders** arrow, and then clicking **No Border** on the menu.

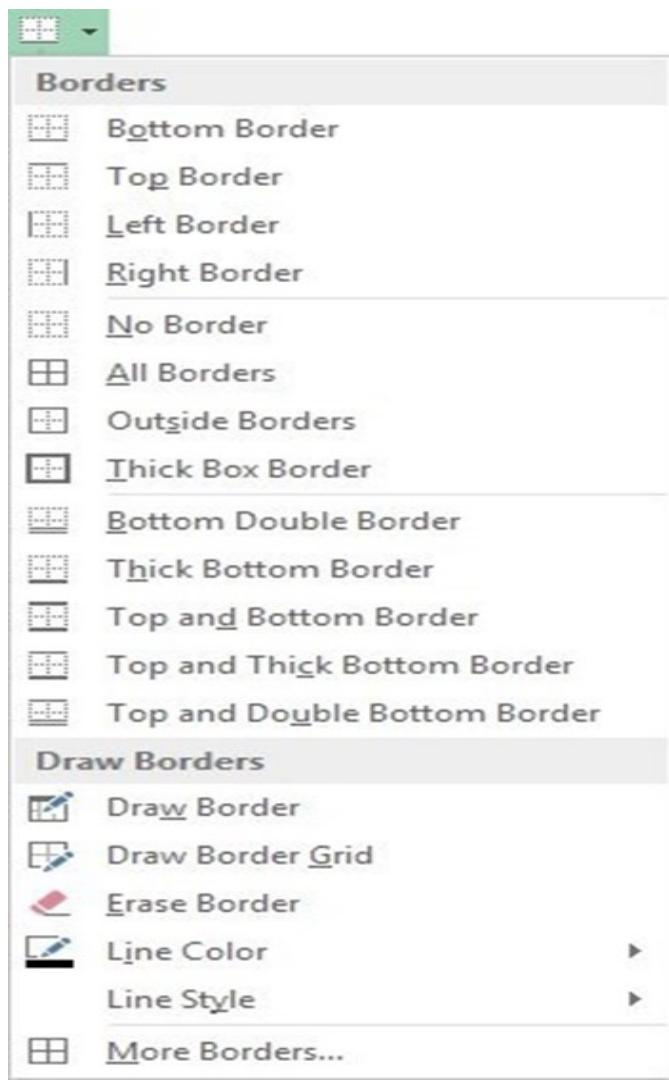


Figure 37 – Borders Menu

Formatting Numbers

You can apply number formats to cells containing numbers to better reflect the type of data they represent. For example, you can display a numeric value as a percentage, currency, date or time, etc. The *Number* group on the *Home* tab of the *Ribbon* contains the most commonly used commands for formatting numbers (see Figure 38). You can also format numbers using the *Number* tab of the *Format Cells* dialog box which can be opened by clicking the dialog box launcher in the *Number* group.

NOTE: Formatting does not change the actual value stored in a cell. The actual value is used in calculations and is displayed in the Formula bar when the cell is selected.

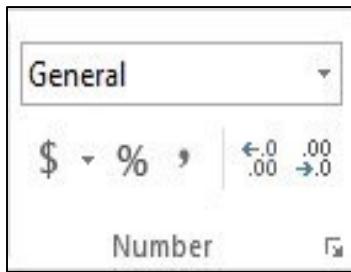


Figure 38 – Number Group on the Home Tab

To format numbers:

1. Select the cell that you want to format.
2. On the **Home** tab, in the **Number** group, do one of the following (see Figure 38):
 - Click the **Accounting Number**

Format button  to display the number with a dollar sign, comma separators, and two decimal places.

NOTE: You can select a different currency symbol by clicking the **Accounting Number Format** arrow and selecting the desired symbol from the menu.

- Click the **Percent Style** button  to convert the number to a percentage and display it with a percent sign and no decimal places.
- Click the **Comma Style** button  to display the number with comma separators and two decimal places.

NOTE: You can access additional number formats by clicking the **Number Format** arrow and selecting the desired option from the menu (see Figure 39).



Figure 39 – Number Format Menu

To change the number of decimal places:

1. Select the cell that you want to format.
2. On the **Home** tab, in the **Number** group, do one of the following (see Figure 38):

- Click the **Increase Decimal**  button to increase the number of decimal places.
- Click the **Decrease Decimal**  button to decrease the number of decimal places.

Positioning Cell Contents

You can change the alignment, indentation, and orientation of cell contents, wrap the contents within a cell, and merge cells. The *Alignment* group on the *Home* tab of the *Ribbon* contains the most commonly used commands for positioning cell contents (see Figure 40). You can also position cell contents using the *Alignment* tab of the *Format Cells* dialog box which can be

opened by clicking the dialog box launcher  in the *Alignment* group.



Figure 40 – Alignment Group on the Home Tab

Aligning Data

By default, Excel 2013 aligns numbers to the right and text to the left, and all cells use bottom alignment. The *Alignment* group on the *Home* tab of the *Ribbon* includes six alignment buttons that can be used to change the horizontal and vertical alignment of cell contents.

- The **Align Left** button  aligns the cell contents with the left edge of the cell.
- The **Center** button  centers the cell contents horizontally within the cell.
- The **Align Right** button  aligns the cell contents with the right edge of the cell.
- The **Top Align** button  aligns the cell contents with the top edge of the cell.
- The **Middle Align** button  centers the cell contents vertically within the cell.
- The **Bottom Align** button  aligns the cell contents with the bottom edge of the cell.

To align data:

1. Select the cell that contains the data you want to align.
2. On the **Home** tab, in the **Alignment** group, click the desired alignment button.

Indenting Data

Indenting moves data away from the edge of the cell. This is often used to indicate a level of less importance (such as a subtopic) (see Figure 41).

	A	B	C
1	Topic		
2	Subtopic		
3	Subtopic		
4	Subtopic		
5			

Figure 41 – Indented Data

To indent data:

1. Select the cell that contains the data you want to indent.
2. On the **Home** tab, in the **Alignment** group, click the **Increase Indent** button . Each click increments the amount of indentation by one character.

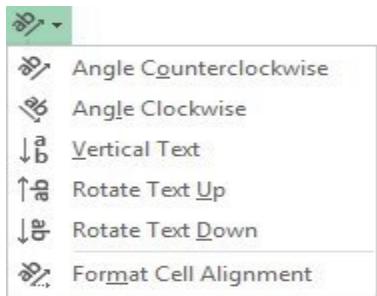
NOTE: You can decrease the indentation of data by clicking the **Decrease Indent** button  in the **Alignment** group on the **Home** tab of the **Ribbon**.

Rotating Data

You can rotate data clockwise, counterclockwise, or vertically within a cell. This is often used to label narrow columns or to add visual impact to a worksheet.

To rotate data:

1. Select the cell that contains the data you want to rotate.
2. On the **Home** tab, in the **Alignment** group, click the **Orientation** button and select the desired option from the menu (see Figure 42). The row height automatically adjusts to fit the rotated data (see Figure 43).



	A	B	C
1	January	February	March
2			
3			

Figure 43 – Rotated Data

Figure 42 – Orientation Menu

NOTE: You can restore the data to its default orientation by clicking the **Orientation** button and selecting the currently selected orientation.

Wrapping Data

Wrapping displays data on multiple lines within a cell. The number of wrapped lines depends on the width of the column and the length of the data.

To wrap data:

1. Select the cell that contains the data you want to wrap.
2. On the **Home** tab, in the **Alignment** group, click the **Wrap Text** button . The row height automatically adjusts to fit the wrapped data (see Figure 44).

NOTE: You can restore the data to its original format by clicking the **Wrap Text** button again.

	A	B	C
1	January 2014	February 2014	March 2014
2			
3			

Figure 44 – Wrapped Data

Merging Cells

Merging combines two or more adjacent cells into one larger cell. This is a great way to create labels that span several columns.

NOTE: If the cells you intend to merge have data in more than one cell, only the data in the upper-left cell remains after you merge the cells.

To merge cells:

1. Select the cells that you want to merge.
2. On the **Home** tab, in the **Alignment** group, click the **Merge & Center** button to merge the selected cells into one cell and center the data, or click the **Merge & Center** arrow and select one of the following options (see Figure 45):
 - **Merge Across:** Merges each row of the selected cells into a larger cell.
 - **Merge Cells:** Merges the selected cells into one cell.

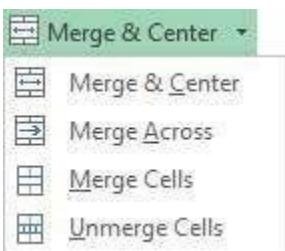


Figure 45 – Merge & Center Menu

NOTE: You can split a merged cell by clicking the **Merge & Center** arrow, and then clicking **Unmerge Cells** on the menu.

Copying Cell Formatting

You can copy the formatting of a specific cell and apply it to other cells in the worksheet. This can save you time and effort when multiple formats have been applied to a cell and you want to format additional cells with all the same formats.

To copy cell formatting:

1. Select the cell that has the formatting you want to copy.
2. On the **Home** tab, in the **Clipboard** group, click the **Format Painter** button . The mouse pointer changes to a plus sign with a paintbrush .
3. Select the cell to which you want to apply the copied formatting.

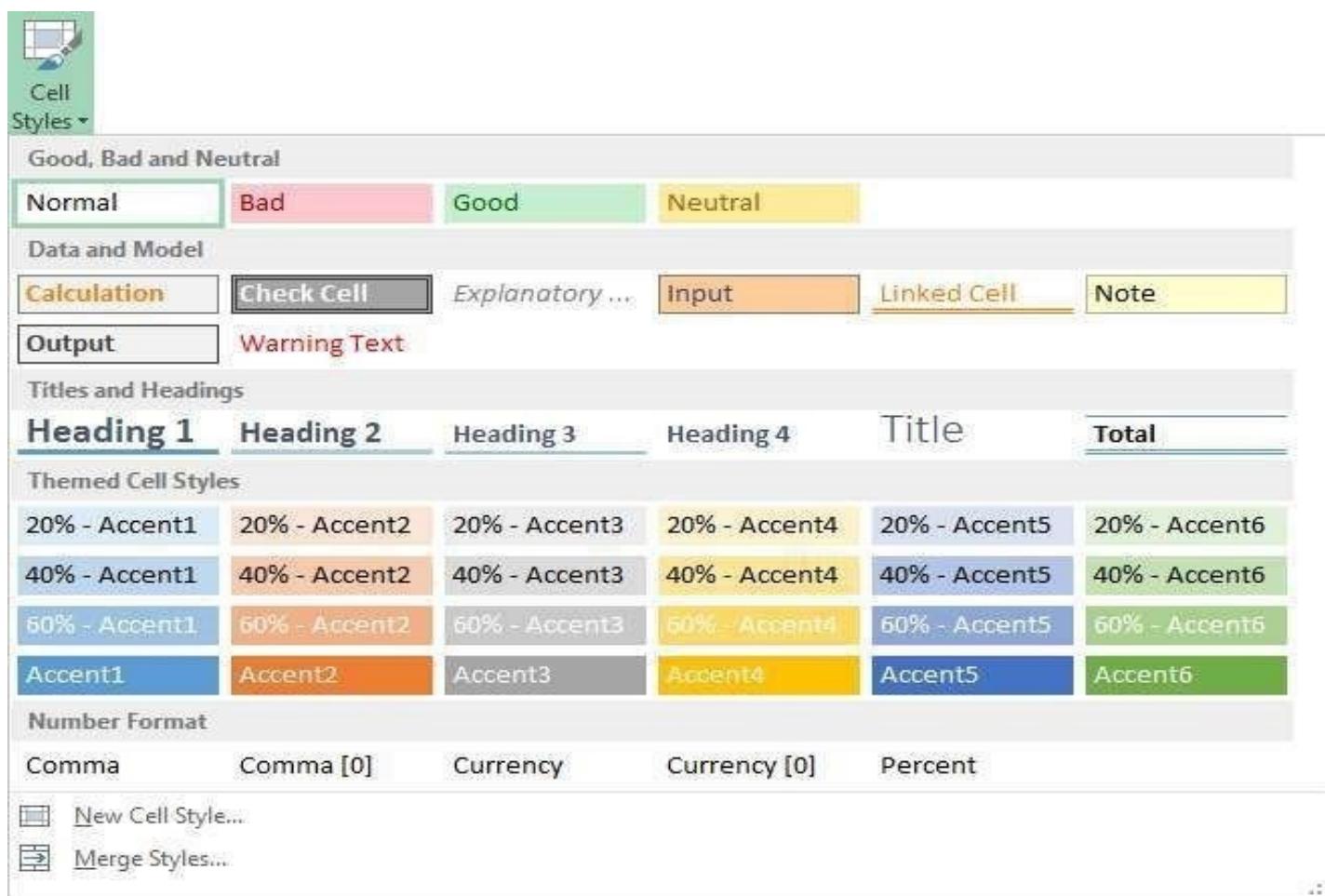
NOTE: If you want to apply the copied formatting to more than one area, double-click the **Format Painter** button instead of single-clicking it. This keeps the **Format Painter** active until you press the **Esc** key.

Applying Cell Styles

A *cell style* is a set of formatting characteristics (such as font, font size, font color, cell borders, and fill color) that you can use to quickly format the cells in a worksheet. In addition to saving you time, cell styles can help you keep formatting consistent throughout a worksheet. Excel 2013 includes several predefined styles that can be used to format headings, numbers, notes, etc.

To apply a cell style:

1. Select the cell to which you want to apply a style.
2. On the **Home** tab, in the **Styles** group, click the **Cell Styles** button and select the desired style from the gallery (see Figure 46).



The screenshot shows the **Cell Styles** ribbon tab selected. The main area displays a grid of 24 color-coded cell styles under the heading "Themed Cell Styles". The styles are arranged in a 4x6 grid. The colors range from light green (top-left) to dark red (bottom-right). Below the grid, there are sections for "Number Format" containing buttons for "Comma", "Comma [0]", "Currency", "Currency [0]", and "Percent". At the bottom left, there are two buttons: "New Cell Style..." and "Merge Styles...".

Figure 46 – Cell Styles Gallery

Getting Help

You can use the Excel Help system to get assistance on any topic or task. While some information is installed with Excel 2013 on your computer, most of the information resides online and is more up-to-date. You need an Internet connection to access resources from Office.com.

To get help:

1. Click the **Microsoft Excel Help** button  on the right side of the **Title bar**. The **Excel Help** window opens, displaying general help topics (see Figure 47).

NOTE: Clicking the **Help** button  in the upper-right corner of a dialog box displays topics related to that dialog box in the **Excel Help** window.

2. Click any link to display the corresponding information.
3. To navigate between help topics, click the **Back** button , **Forward** button , or **Home** button  on the toolbar.
4. To print a help topic, click the **Print** button 
5. To search for a specific topic, type one or more keywords in the **Search** box, and then press the **Enter** key to display the search results.
6. To switch between online and offline help, click the **Change Help Collection** arrow  next to **Excel Help** at the top of the window, and then click **Excel Help from Office.com** or **Excel Help from your computer** on the menu.
7. To close the Excel Help window, click the Close button 

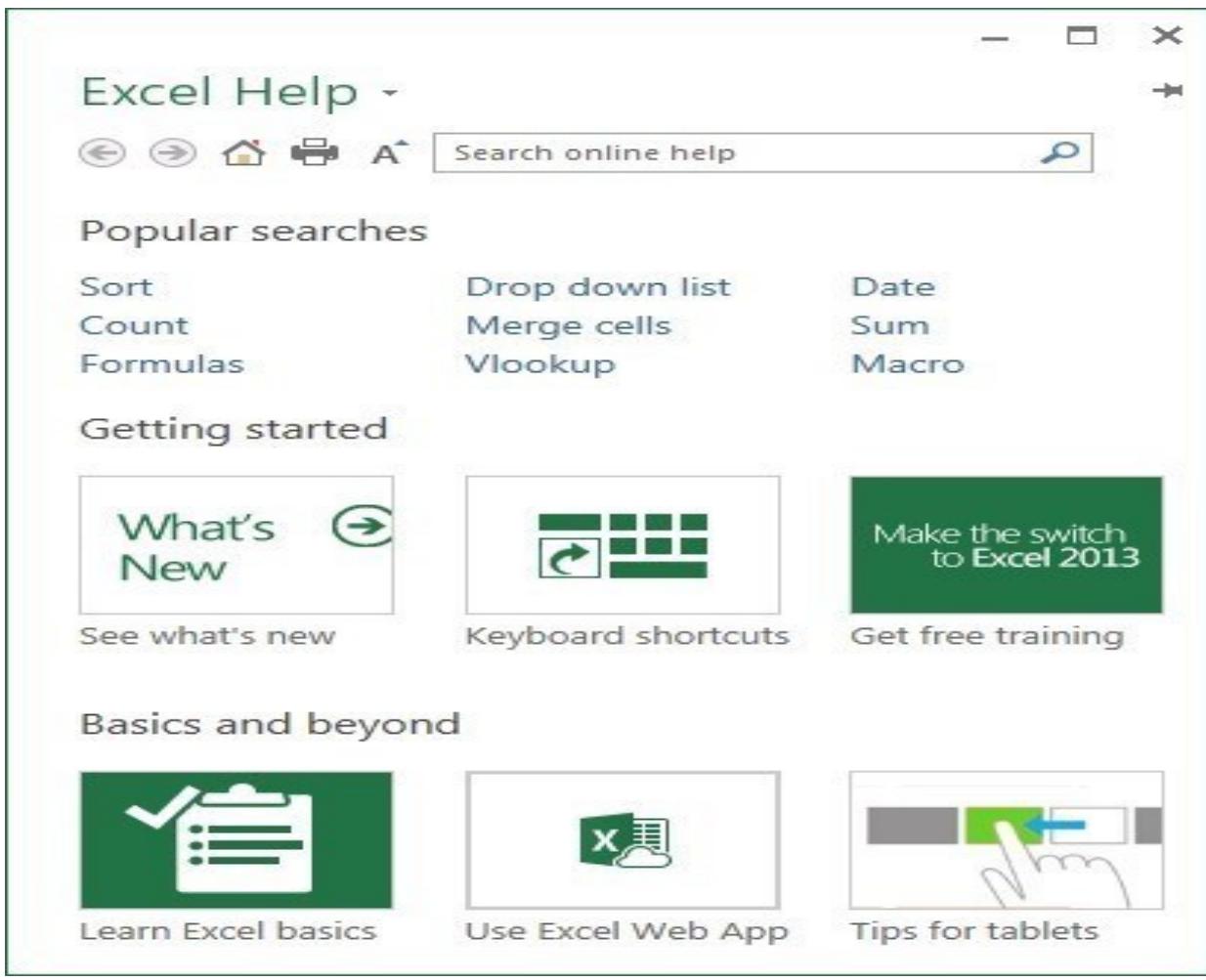


Figure 47 – Excel Help Window

Exiting Excel

When you finish using Excel 2013, you should exit the program to free up system resources. To exit Excel 2013:

1. Click the **Close** button in the upper-right corner of the program window.