Faculty of Commerce

South Valley University

Quantitative Methods Department

Introduction to Computer Science

First Year BSc. Students – English Department

Prepared By

Dr\ Saddam Hussein Ahmed

PhD- University of Lincoln- UK

INTRODUCTION

Computer science is the study of the theory, experimentation, and engineering that form the basis for the design and use of computers. It is the scientific and practical approach to computation and its applications and the systematic study of the feasibility, structure, expression, and mechanization of the methodical procedures (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information. An alternate, more succinct definition of computer science is the study of automating algorithmic processes that scale. A computer scientist specializes in the theory of computation and the design of computational systems.

Its fields can be divided into a variety of theoretical and practical disciplines. Some fields, such as computational complexity theory (which explores the fundamental properties of computational and intractable problems), are highly abstract, while fields such as computer graphics emphasize real-world visual applications. Other fields still focus on challenges in implementing computation. For example, programming language theory considers various approaches to the description of computation, while the study of computer programming itself investigates various aspects of the use of programming language and complex systems. Human–computer interaction considers the challenges in making computers and computations useful, usable and universally accessible to humans.

This course presents a condensed introductory doze for the computer science that covers some basic computer concepts, number systems, Microsoft excel, computer networks, MS-DOS system and database design principles.

The final chapter in this book is an introductory part for the artificial intelligence and its applications in business .

Saddam Hussein Ahmed

Associate Professor,

PhD, MSc., BSc.

Table of Contents

Chapter 1	**Basic Concepts**	**5**
	Exercises	**31**
Chapter 2	**Number systems**	**33**
	Exercises	**69**
Chapter 3	**Computer networks**	**71**
	Exercises	**82**
Chapter 4	**Microsoft Excel**	**83**
	Exercises	**117**
Chapter 5	**Using MS-DOS**	**118**
	Exercises	**139**
Chapter 6	**Introduction to Database**	**140**
	Exercises	**172**
Chapter 7	**Artificial Intelligence in Business**	**174**
	Exercises	**200**
References		**202**

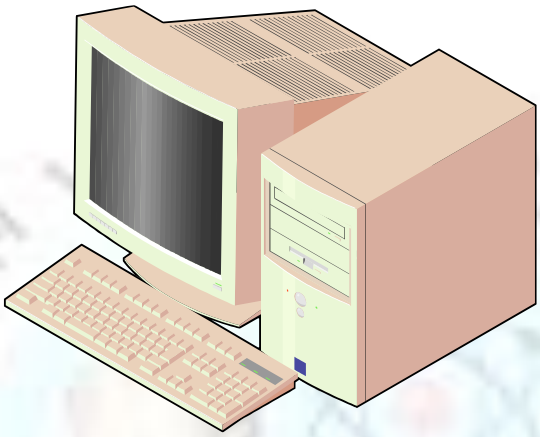
Chapter 1
Basic Concepts

This Computer Basics chapter introduces general computer use and terminology. It describes the basic hardware components of a PC and introduces basic skills for using software programs in a windows environment. This course will address hardware and peripheral components of the computer and how to use them correctly. After completing this basics part, you should be able to:

- Describe the basic components of the computer.
- Describe hardware and software.
- Identify peripheral devices.
- Identify input and output devices.
- Start the computer, run programs and shut down the computer.
- Control program windows and menus.

A computer is an electronic device that has the ability to store, retrieve, and process data, and can be programmed with instructions that it remembers. The physical parts that make up a computer (the central processing unit, input, output, and memory) are called **hardware**. Programs that tell a computer what to do are called **software**. A set of instructions that perform a particular task is called a **program**, **software program**, or **software**. **Peripherals** are any hardware device connected to a computer, any part of the computer outside the CPU and working memory. Some examples of peripherals are keyboards,

the mouse, monitors, printers, scanners, disk and tape drives, microphones, speakers, joysticks, plotters, and cameras.



A. MONITOR

The computer monitor is an output device that displays input on a screen and is very similar to a television monitor. When the computer wants to display something, it calculates how it needs to change the color and brightness of the different pixels, and changes the values in the video memory.

- Controls for the monitor are located on the monitor itself. The monitor has an ON/OFF Button/Switch (which powers only the monitor) and an indicator light (green or amber).
- A green indicator light denotes that the monitor is on.
- An amber light indicates that the computer is in “sleep” mode. Software in newer computers automatically shuts the monitor down when the computer is shut down--the monitor is put in a

"sleep" mode and the indicator light turns amber. When the monitor light is amber, if the computer is booted up, the monitor will automatically come on when you move the mouse or press any key on the keyboard.

- No indicator light indicates that the monitor is off. If you turn your monitor off with the switch, there will be no indicator light. When you boot up your computer, you will have to turn the monitor on by pressing the ON/OFF switch.

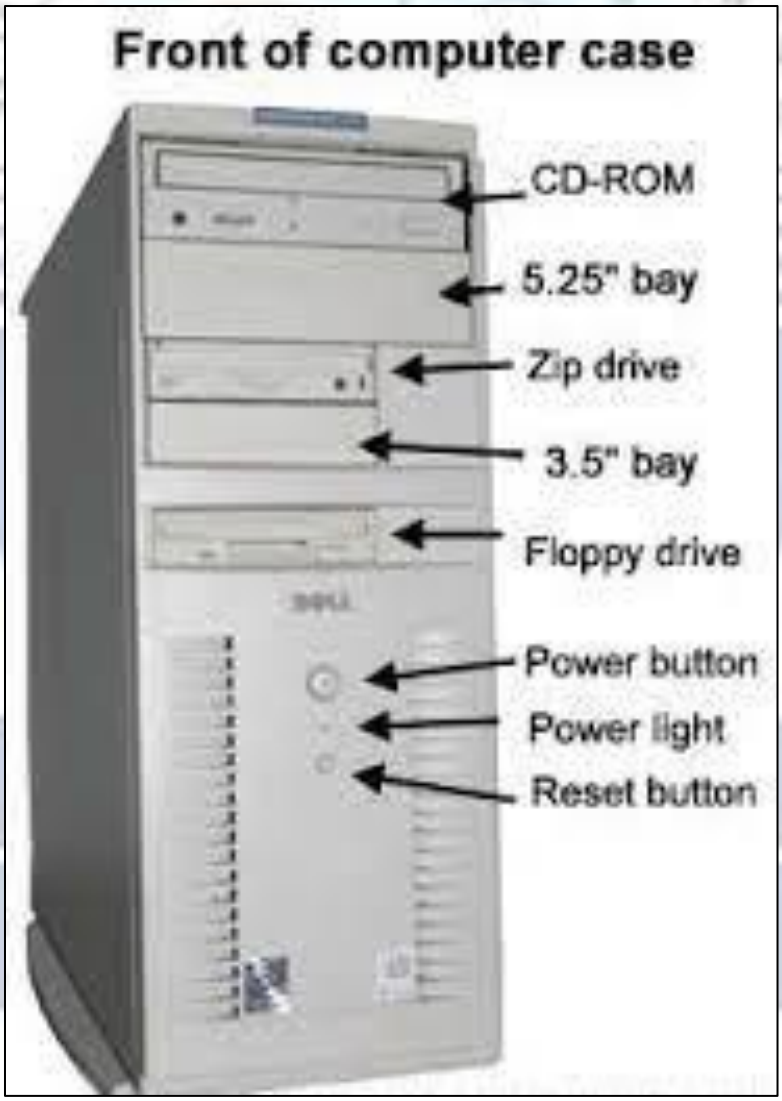
Monitor resolution is a crucial factor in determining the clarity and sharpness of a display. It is expressed by two numbers, such as 1920x1080, which indicate the number of pixels horizontally and vertically on the screen. The higher the resolution, the more pixels are used to create the image, resulting in finer details and a clearer picture. For example, a 4K resolution of 3840x2160 has four times as many pixels as a standard 1080p resolution, leading to significantly sharper images and more defined visuals.

This increase in pixel density is especially important for tasks that require high levels of detail, such as graphic design, photo editing, and watching high-definition videos. When the resolution is higher, text appears crisper, images look more lifelike, and overall visual quality is enhanced. However, higher resolution also requires more powerful

hardware to run effectively, especially in demanding applications like gaming or video editing.

B. COMPUTER

The following is a typical (legacy) front case of a computer, look at the given buttons and input drives.

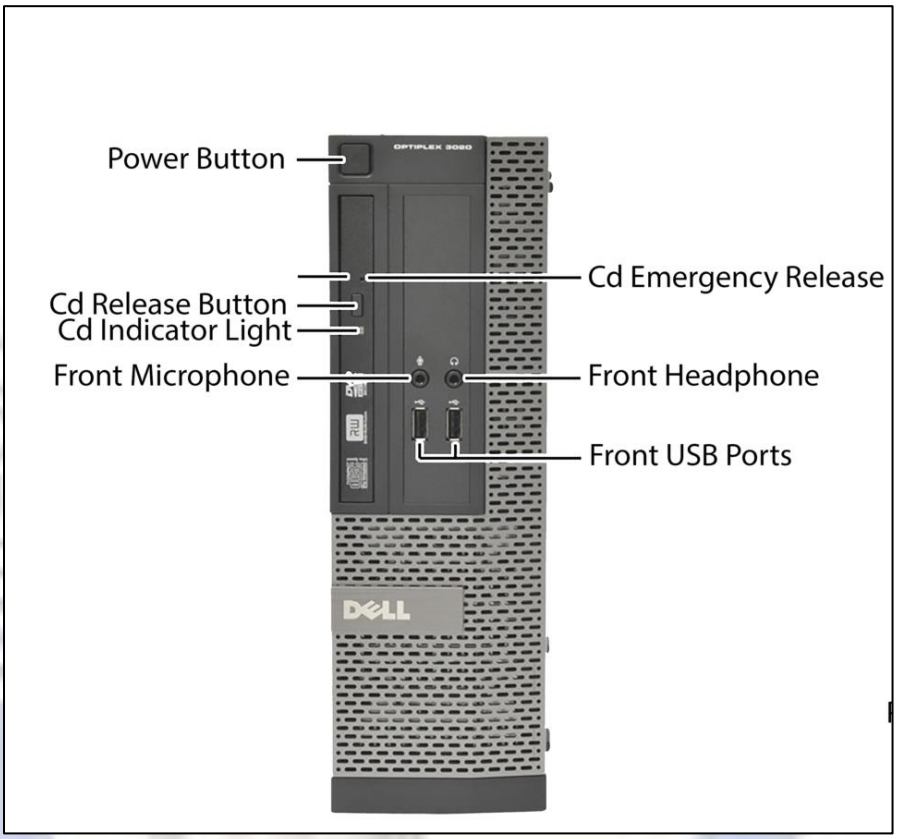


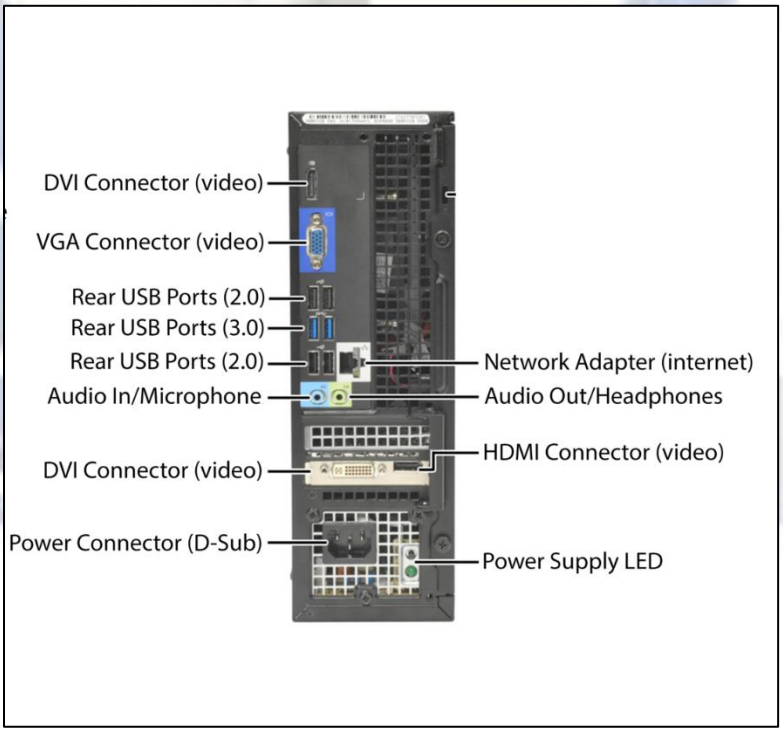
The computer is a machine that processes data according to a set of instructions that are stored internally either temporarily or

permanently. The computer has either external or internal peripherals attached to it. The picture below displays two internal devices—the floppy disk drive and CD ROM drive.

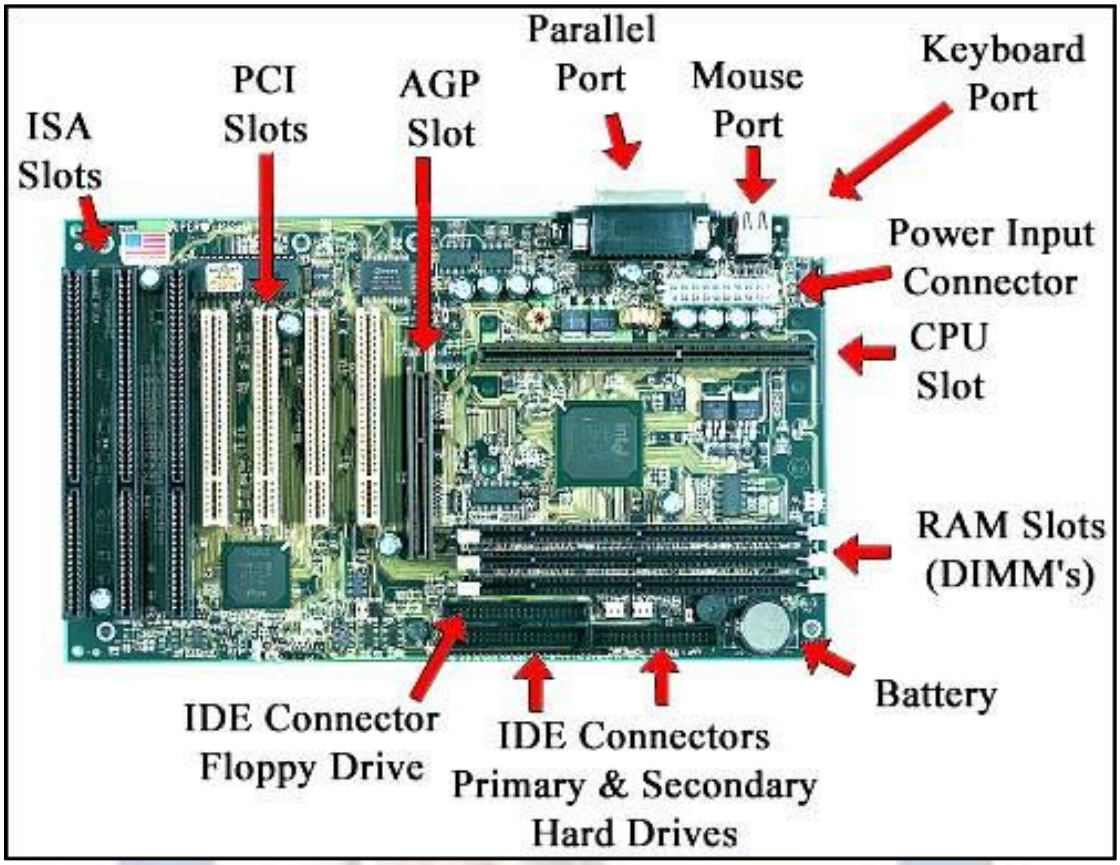
1. **POWER SWITCH** -- Turns the computer on and off. Whenever the computer is turned off, always wait at least 60 seconds before turning it back on again.
2. **POWER INDICATOR** -- Located in the center of the power switch. A green light indicates the computer is on.
3. **RESET BUTTON** -- Allows you to reboot (restart) your system without having to power down the entire computer. Rebooting the system in this manner reduces stress on the system components. This button is used **ONLY** when the computer has "frozen" and will not accept any commands.
4. **HARD DISK DRIVE ACCESS INDICATOR** -- Turns green when the computer is accessing your hard drive, either retrieving or storing information.
5. **FLOPPY DISK DRIVE** -- Storage device that holds, reads and writes to floppy disks, usually called Drive A.
6. **CD-DRIVE** -- Player or reader that reads data from a CD ROM disk.

Look at the given two images of a front and back of a modern computer case and compare with the previous .





C. INTERNAL COMPONENTS OF A COMPUTER



Motherboard

Sometimes called the system board or main board, the motherboard is the main circuit board of a PC. The motherboard is the central nervous system and circulatory system, plus much more, all rolled into one. The motherboard typically contains the processor (or CPU), BIOS (basic input/output system), memory, mass storage interfaces, serial and

parallel ports, expansion slots, and all the controllers required to communicate with standard peripheral devices, such as the display screen, mouse, keyboard and disk drive. Collectively, some of the chips which reside on the motherboard are known as the motherboard's chipset.

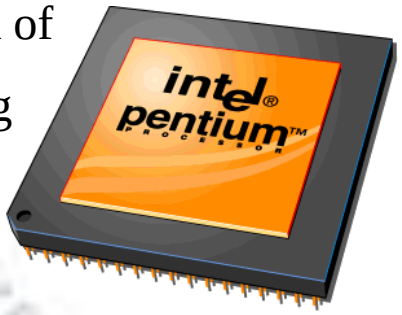
Chipset

The chipset controls the system and its capabilities. All components communicate with the processor through the chipset - it is the hub of all data transfer. The chipset uses the DMA controller and the bus controller to organize the steady flow of data that it controls. The chipset is a series of chips attached directly to the motherboard, and is usually second in size only to the processor. Chipsets are integrated (soldered onto the motherboard) and **are not upgradable** without a new motherboard.

BIOS (Basic Input Output System)

An integral part of the PC, the BIOS is the program a microprocessor uses to get the computer started after you turn it on. It also manages the data flow between the computer's operating system and attached peripheral devices.

CPU (Central Processing Unit)



The CPU is the computer's control center. Think of it as the brain that does all the thinking (computation). It reads instructions from your software and tells your computer what to do. The actual CPU is about 1.5 inches square, yet it is the most critical part of the computer.

The speed at which the CPU processes information internally is measured in Megahertz (MHz) and Gigahertz (GHz). 1 GHz is equal to 1,000 MHz. Generally, processors with higher MHz or GHz enhance your ability to run creative, entertainment, communication, and productivity applications.

- MegaHertz -- One million cycles per second — used to measure the speed of a CPU chip.

Types of CPU's

According to the recent Intel products, exists the following processor types:

Intel Core i3:

Intel Core i5:

Intel Core i7:

Intel Core i9:

Exercise

What is the difference between the previous processor types, compare in terms of number of cores and usages requirements ?

ROM (Read Only Memory)

A type of memory chip that does not lose information, even when the power is turned off. Once data is programmed into the ROM chip, its contents cannot be altered. For example, ROM BIOS chips are used to store information for starting up your computer.

RAM (Random Access Memory)

Available for storing data and programs currently being processed. RAM is erased automatically when the power is turned off. Can be accessed without touching preceding bytes.

Exercise

What are the different RAM types ?

Measuring Computer Storage

Byte -- Bytes are used to measure both computer memory (RAM) and the storage capacity of floppy disks, CD-ROM drives, and hard drives. BYTE One character. A character can be a number, letter or symbol.

Note: A **byte** consists of 8 bits.

KILOBYTE (KB) Approximately one thousand characters, or one page of double spaced text.

MEGABYTE (MB) Approximately one million characters, or one novel.

GIGABYTE (GB) Approximately one billion characters, or one thousand novels.

This can be summarized in the following table:

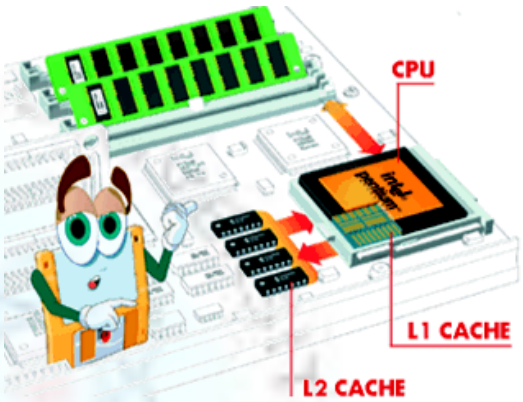
Unit Name	Symbol	Size
Bit	-	-
Byte	B	8 bits
Kilo Byte	KB	1024 byte
Mega Byte	MB	1024 KB
Giga Byte	GB	1024 MB
Tera Byte	TB	1024 GB

Cache

Cache (pronounced cash) is a block of high-speed memory where data is copied when it is retrieved from the RAM. This storage of key

instructions enables a performance improvement in the processor. Intel processors incorporate level 1 (L1) and level 2 (L2) caches.

There are two groups of extremely fast memory chips that allow the computer to operate faster:



1) Internal cache (L1) is built into the CPU, and

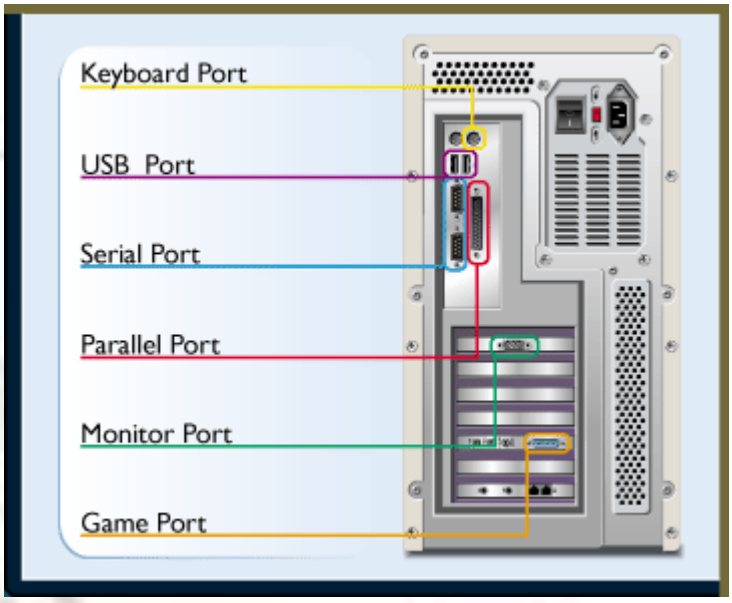
2) External cache (L2) resides on the motherboard. The L2 cache is an area of high-speed memory that improves performance by reducing the average memory access time. L2 cache is also called SRAM.

Both L1 and L2 store data recently used by the CPU. When the CPU needs data, it first checks the fastest source — L1. If the data is not there, the CPU checks the next-fastest source — L2. If the data still cannot be found, a time-consuming search of the slower RAM is required.

Exercise

Can you have a processor with 1TB cache memory ?

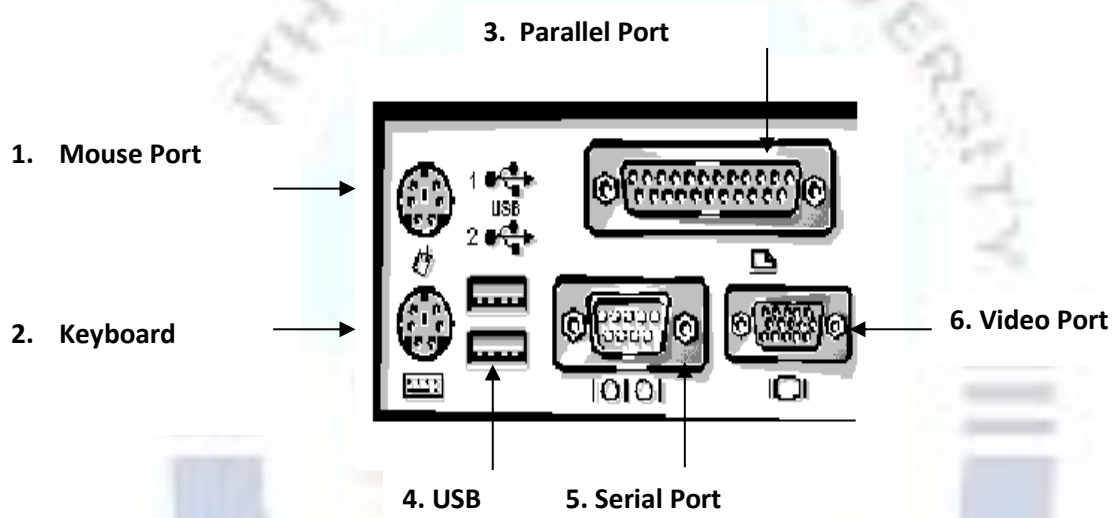
D. BACK PANEL AND CABLES



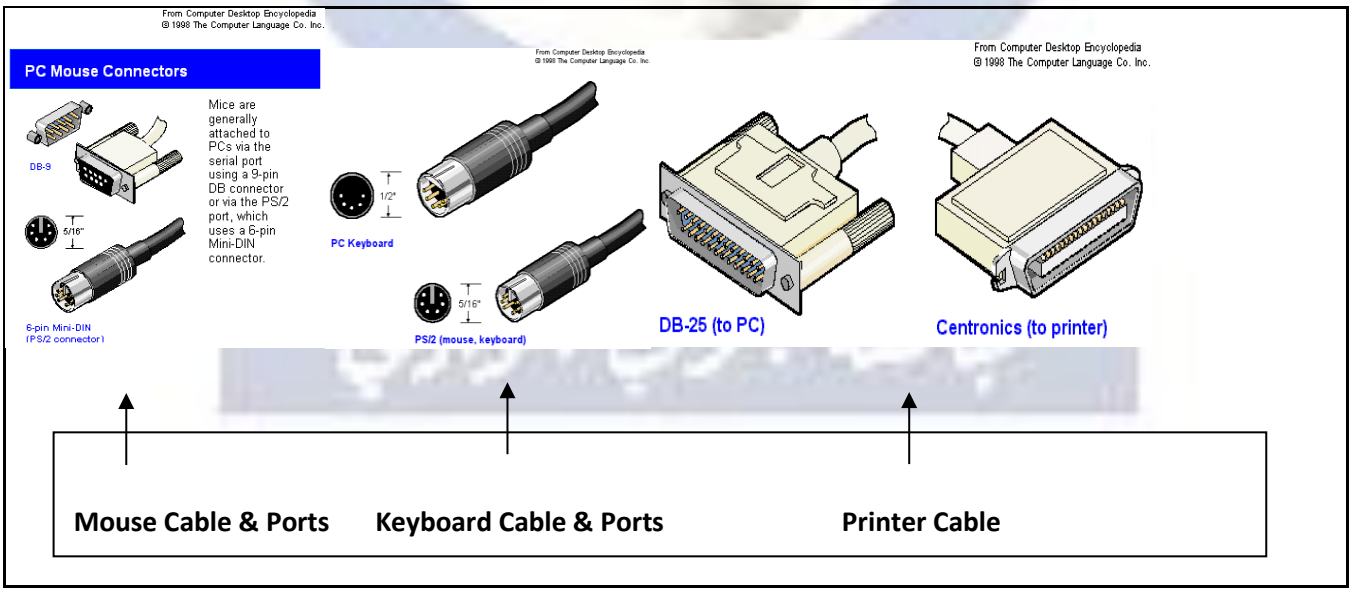
The ports that connect the peripherals to the computer are located on the back panel of the computer. Newer computers have ports that are color-coded with their appropriate cables. Speaker cables plug into headphone jacks on the back panel and are also color-coded. The back panel may have small icons on the ports showing the correct cables (example -- monitor for monitor cable). It is important that all cables are inserted completely and securely in their port (pins screwed in all the way) or the peripheral will not function properly. Once all peripherals have been connected to the computer, it may be useful to label each cable and it's appropriate port. When the computer is stored for the summer it will be very easy to reconnect cables in the fall. Two successful methods used to code cables and ports include colored dots using nail polish (red mouse cable, red dot on mouse port, pink printer cable, pink dot on printer port, etc.) and numbering cables and ports (1 & 1, 2 & 2, etc.).

When attaching or removing cables from the computer it is important to be very careful. The cables are connected with "pins" that can easily be bent or broken. Don't try to remove cables by "wiggling" from side to side. Pull cables directly out to avoid damaging the pins.

The following figure is a diagram of the ports on the back of the

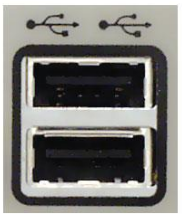


computer. Included are pictures of the cable connectors for different peripherals attached to the computer.

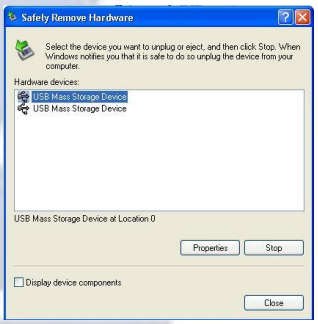


SCSI (Small Computer System Interface). A processor-independent standard for system-level interfacing between a computer and intelligent devices including hard-drives, floppy disks, CD-ROM, printer, scanners and many more.

USB (Universal Serial Bus) is a new technology theoretically capable of connecting a very large number of external devices on a computer. USB give the PC user a no-hassle way to connect a new digital joystick, a scanner, a set of digital speakers, a digital camera, or a PC telephone to their computer.



- Adds the feature of "hot-swapping" so that you don't need to shut down and restart your PC to attach or remove a peripheral. Just plug it in and go!



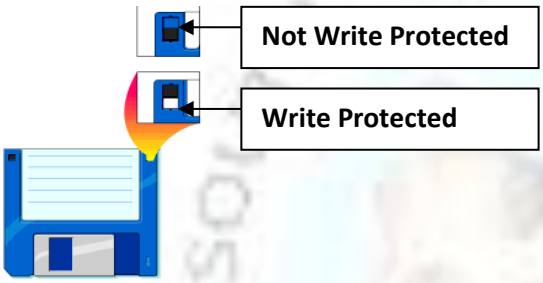
- To remove a USB device, single click the hardware button in the system tray, the “Remove Hardware” window opens. Select
  the device you wish to disconnect, click the “Stop” button then remove the device

E. STORAGE DEVICES

When working on the computer, all work is entered into the computer's memory. In order to store your work for future retrieval, you must "save" your work to a storage device before turning the computer off. When your work is saved it creates a computer "file". The most common storage devices are hard disks and floppy disks. If you only save your work on the hard disk, you run the risk of losing your data, either through viruses, which attack the hard disk, or to hard disk failure or crashes. It's very important to back up your important files onto other media, such as floppy disks.

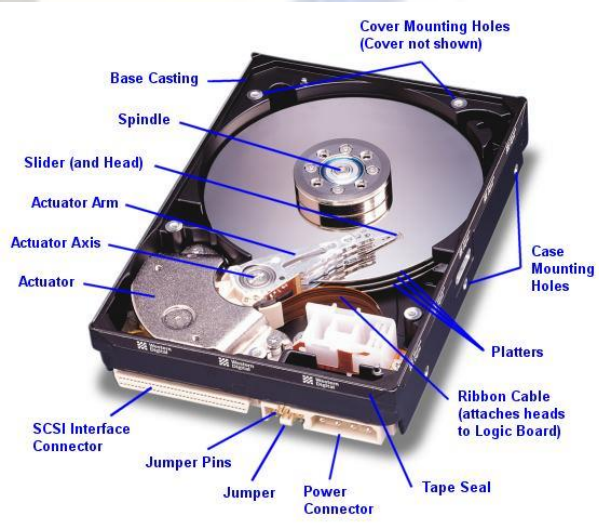
1. **Floppy Disk** (**Legacy**) A removable disk that stores information magnetically, also called a diskette. You can use a floppy disk to exchange information between computers, or to make a backup of your files. Floppy disks are 3.5 inches in diameter and they are enclosed in a rigid plastic shell. A "double-density" (DD) diskette has a storage capacity of 740 KB while a "high-density" (HD) diskette has a storage capacity of 1.44 MB. To protect your floppy disks, keep them away from heat, drinks, and magnets. Use a felt tip pen to label a disk and write on the label before you attach it to the disk.

Every disk must be formatted with the operating system used by the computer in order to allow storage of files. The operating system is the "language" of the program—the disk must be in the same language as the computer in order to communicate. Examples of operating systems are DOS, Windows, IOS, and Linux.



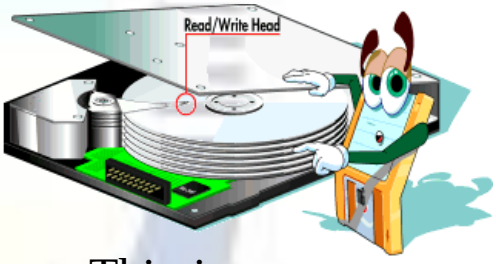
Every disk comes with a write-protect tab. The tab provides protection against erasing or replacing information on a floppy disk. You can write-protect a 3.5-inch floppy disk by moving the plastic tab up to the write-protected position (open hole). No information can be altered on the disk when it is write-protected.

2. **Hard drive**-- The primary device that a computer uses to store information. Most computers come with one or two hard drives, called drive C and drive D, located inside the computer case. The terms hard drive and hard disk are used interchangeably. Today's hard disks provide fast retrieval and can



hold several gigabytes of information as compared to megabytes on floppy disks.

The Read/Write Heads are energy converters: they transform electrical signals to magnetic signals, and magnetic signals back to electrical ones again. They are in essence tiny electromagnets that perform this conversion from electrical information to magnetic and back again. There is normally one head for each surface used on the drive.



If the heads contact the surface of the disk while it is at operational speed, the result can be loss of data, damage to the heads, damage to the surface of the disk, or all three. This is usually called a *head crash*, two of the most frightening words to any computer user. :^) The most common causes of head crashes are contamination getting stuck in the thin gap between the head and the disk, and shock applied to the hard disk while it is in operation.

Exercise

What is the difference between HDD an SSD hard drives?

CD-ROMS—Compact disks can store approximately 650-800 MB of data or 74-80 minutes of music. Most software programs today are

shipped on CD-ROMs instead of floppy disks. All computers today come with CD-ROM drives that are part of the computer's multimedia configuration. They are connected to a sound card, which provides the computer with stereo speaker capabilities, allowing for musical CD-ROMs to also be played on your computer. These drives are ***read only*** and **cannot** be used for recording data. Do you know about DVD's?

- Only retrieve data that's pre-recorded by the manufacturer. Like a musical CD-ROM, the information is pressed on one side (the side opposite the label).

- CD-ROM's are inserted into the CD-ROM drive with the label side up.
- Pressing the button opens and closes the drive.

- Handling and storage of CD-ROM's are the same as musical CD-ROM's and floppy disks.
- Avoid putting fingers on the information side. Hold the CD-ROM by the edges when handling. Protect CD-ROM's by making sure the data side does not get scratched and by providing proper storage (store them in the case they came in).

3. USB/Flash Drive - is a plug-and-play portable storage device that uses flash memory and is lightweight enough to attach

to a key chain. A keychain drive can be used in place of a floppy disk, Zip drive disk, or CD. When the user plugs the device into their USB port, the computer's operating system recognizes the device as a removable drive. Unlike most removable drives, a keychain drive does not require rebooting after it's attached, does not require batteries or an external power supply, and is not platform dependent. Several keychain drive manufacturers offer additional features such as password protection, and downloadable drivers that allow the keychain drive to be compatible with older systems that do not have USB ports. Keychain drives are available in capacities ranging from 8 MB to 2 gigabytes, depending on manufacturer, in a corresponding range of prices.

F. INPUT DEVICES

1. **Mouse** – The mouse is a pointing device attached to the computer that controls the movement of the cursor on the screen. It allows the user to execute commands using point & click and click & drag techniques. As the user moves the mouse across the pad, the cursor moves across the screen. The mouse should always be used with a mouse pad to provide a smooth surface for mouse movement and to help keep the mouse from

damage. If you "run out of room" on the pad, simply pick up the mouse and move it to the opposite edge and continue movement.

The PC mouse has two buttons (left and right) and newer mice have a scroll wheel between the two. Mouse commands are executed by "clicking". The term “click” refers to the left mouse button. The phrase to "**click**" means to select (a screen object) by moving the mouse pointer to the object's position and clicking a mouse button by pressing it down once, and them immediately releasing it.

- Executing commands (i.e. opening a folder, opening a file, opening a program) requires a **double click**, meaning that you must click the left mouse button twice in rapid succession. There is a timed rhythm to double clicking and the mouse must NOT move between clicks.

- **Shift Click** refers to clicking the mouse button while holding the Shift key down.
- **Click and Drag** is also used more generally to refer to any operation in which the left mouse button is held down while the mouse is moved. Placing the mouse arrow on an object and holding down the left mouse button while moving it, the object can by moved to a new location by “dragging”.

- Some newer mice also include a scroll wheel for scrolling through long documents.
- **Right Click** refers to clicking the right mouse button which reveals a context menu, because it changes based on the status of the item you clicked -- the type of file, for example. The context menu may display actions such as Open, New, Print, Copy, Paste, Delete, Send To, Create Shortcut and Properties (to see an item's settings, and so on) all dependent upon where you right click, on a file or on a blank space in a window.

2. **Keyboard** -- The computer receives most of its input from the user via the keyboard that is very similar to the typewriter keyboard. The keyboard is connected by a cable to the keyboard port on the back of the computer. There are extra keys on the computer's keyboard that are not found on a normal typewriter. Following is an explanation of the function of these keys.

KEYSTROKES TO KNOW

Exercise

What are the functions of the following key combinations ?

1) **Ctrl + Esc or Windows Logo Key**
2) **Ctrl + Alt + Delete**
3) **F1**
4) **F2**
5) **F3**
6) **Alt + F4**
7) **Print Screen**
8) **Alt + Print Screen**
9) **Windows Logo Key + M**

H. OUTPUT DEVICES

Output devices are computer devices that display or output information. The monitor is a common example of an output device. Other output devices are:

- Printers—take information from the CPU and transfer it to paper, provides a *hard copy*. There are a number of different printer technologies available: Dot Matrix, Ink Jet, Laser.
- Plotters—produces high-quality line drawing graphic output (used for blueprints).
- Video projector, Scan Converter or LCD overhead projector—projects the image onto a wall screen for greater view by large groups.

- Speaker(s)—provides output of sound or speech.

K. SHUTDOWN

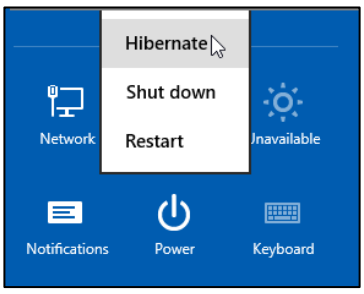
To shut down your computer, click the **Start** button, click **Shut Down**, and then click **Shut Down the Computer (Shortcut:** Press the **Windows Logo Key**, then the **U** key and then the **S** key). It is imperative that you shut down the computer properly. Failure to do so could cause damage or loss of data.

If the computer "freezes", it may be necessary to restart (also known as "reboot") the computer using alternate means. Pressing the "Control" "Alt" and "Delete" keys at the same time is an alternate way of rebooting the computer. A window will appear (see #4 under Keystrokes to Know) showing all programs currently open with the one currently in use highlighted. At the bottom of the window will be three tabs. Click on the one that says “End Task”. If you are lucky, the program will close and you can continue as normal.

However, many times, even this will not work. If using "Control" "Alt" and "Delete" will not restart your computer, you need to reboot your computer by pressing the reset button in front of your computer

Exercise

Do you know what is hibernation?



M. File System types

A file system -- sometimes written filesystem -- is a logical and physical system for organizing, managing and accessing the files and directories on a storage devices. Without a file system, the operating system (OS) would see only large chunks of data without any way to distinguish one file from the next. As data capacities increase, the efficient organization and accessibility of individual files becomes even more important in data storage.

Digital file systems are named for and modelled after the paper-based filing systems used to store and retrieve documents. Despite their shared roots, however, file systems can differ significantly between operating systems such as Microsoft Windows, macOS or Linux. On the other hand, an OS can support multiple file systems despite their differences. In some cases, a file system can also be used across multiple platforms. Some file systems are designed for specific applications, including distributed file systems, disk-based file systems and special-purpose file systems.

Exercise

There are several file systems types, could you search and list them? 

Exercises

1. What is the difference between RAM and ROM?

2. What is a cache memory?

3. What is the difference between L1 and L2 cache?

4. What are the different types of computer file systems?

5. What is the shortcut for starting the task manager?

6. Evaluate the following expressions:

a. 1 BYTE =….. BIT

b. 10 BYTE=….. BIT

c. 1024 BYTE=….. BIT

d. 1024 BYTE=….. KB

e. 2048 BYTE=…. KB

f. 3KB=… MB

g. 5 KB=….. BYTE

h. 1024 GB=…. TB

i. 1 TB=….. MB

7. CPU stands for _____

8. One of the most common brands of processors is made by___.

9. Where do you plug a flash drive into a computer?

10. When you buy a new monitor, what things should you look for?

11. State three examples of computer output devices?

12. State three examples of computer input devices?

13. Keyboard shortcut keys make tasks faster. What do these keyboard commands do? (HINT: Open Word and search under the pull-down menus)

Ctrl + X _____

Ctrl + C _____

Ctrl + V _____

Ctrl + S _____

Ctrl + A _____

Ctrl + P _____

Ctrl + Z _____

Chapter 2

Number systems

Numerical Systems for computers

Europe was using the figures and numbers and the ancient Roman Arithmetic methods which didn't know the positions of numbers .Therefore; the used the alphabetical letters to express numbers or figures. For example: the number **172** is similar to or matches **CLXXII** in the Roman Arithmetic, which means that the number **172**, is total C=**100**, L=**50**, X=**10**, **1**=I so if they needed to make an addition:

112+159, the question needs A Roman expert spending time while making additions for nearly a month, this is why the Romans had been considered the ones who could multiply : **1234 x3241** as a global expert in arithmetic, until the Arabic figures had come,(numbers from **0-9**) to express any figure, a matter which made the previous multiply process didn't need more than minutes, it had been as the sun of the Arabs that is shining on Europe, and all have learnt from the Arabs, and without the Arabic figures . This lofty edifice of arithmetic and astronomy hadn't been existed, and without them, aero planes, rockets or electronics wouldn't have been existed, too.

Long time ago, man had known the decimal system that depends on number **10**, which is used in our daily life, and which had been used by the Arabic scientists of mathematics, the reason of the spread of that system refers to the use of the individuals their hand fingers in

counting, from here, the decimal system had appeared, it is composed of the numbers from **zero** to **9** .

Although the decimal system is the common used system, we find that the computer transfers numbers from the Decimal system into the Binary system.

It is worth mentioning that there are several digital systems of computers, but we will specify in this chapter the four systems that are used in digital computers, of all their types, and they are:

- Decimal System
- Binary System
- Octal System
- Hexadecimal System

We are going to start with the numerical system, that is recognized and used in all fields, and in all parts of the world, which is known as the decimal system as a base for studying the other three systems. In this study we will rely on the following elements:

- N (Base)
- Digits (Numbers used)
- Positional Values
- System Conversions

Arithmetic Operations for Numbering Systems

Decimal Number System

Decimal System									
Base N=10									
NUMBERS USED(Digits) 0, 1, 2, 3, 4, 5, 6, 7, 8, 9									
...	3	2	1	0	.	-1	-2	-3	…	Positions
...	10^3	10^2	10^1	10^0	.	10^{-1}	10^{-2}	10^{-3}	…	Positional
...	1000	100	10	1	.	1/10	1/100	1/1000	…	Values

Example

Construct $(364)_{10}$ according to its position values:

Solution

2	1	0	Positions
10^2	10^1	10^0	Positional
100	10	1	Values

3 6 4

$4 \times 1 = 4$

$6 \times 10 = 60$

$3 \times 100 = 300$

$= \mathbf{364}$

Example

Construct $(0.625)_{10}$ according to its position values

solution

.	-1	-2	-3	Positions
.	10^{-1}	10^{-2}	10^{-3}	Positional
.	1/10	1/100	1/1000	Values

. 6 2 5

$5 \times \frac{1}{1000} = 0.005$

$2 \times \frac{1}{100} = 0.02$

$6 \times \frac{1}{10} = 0.6$

$= 0.625$

Exercise

Construct $(364.625)_{10}$ according to its position values

Binary Number System

Binary System									
Base						N=2			
NUMBERS USED(Digits)						0, 1			
…	3	2	1	0	.	-1	-2	-3	…	Positions
… …	2^3 8	2^2 4	2^1 2	2^0 1	. .	2^{-1} 1/2	2^{-2} 1/4	2^{-3} 1/8	… …	Positional Values

Example

Convert $(100100)_2$ to Decimal

5	4	3	2	1	0	Positions
2^5	2^4	2^3	2^2	2^1	2^0	Positional
32	16	8	4	2	1	Values

1 0 0 1 0 0

$0 \times 1 = 0$

$0 \times 2 = 0$

$1 \times 4 = 4$

$0 \times 8 = 0$

$0 \times 16 = 0$

$1 \times 32 = 32$

$(100100)_2 = (36)_{10}$

Example

Convert $(1101.0101)_2$ to Decimal by using equation system?

solution

$$A = \sum_{i=0}^{k} a_i N^i + \sum_{i=-1}^{m} a_i N^i$$

$$A = a_3N^3 + a_2N^2 + a_1N^1 + a_0N^0 + a_{-1}N^{-1} + a_{-2}N^{-2} + a_{-3}N^{-3} + a_{-4}N^{-4}$$

$A = 1\ (2^3) + 1\ (2^2) + 0\ (2^1) + 1\ (2^0) + 0\ (2^{-1}) + 1\ (2^{-2}) + 0$

$(2^{-3}) + 1\ (2^{-4})$

$A = 1\ (8) + 1\ (4) + 0\ (2) + 1\ (1) + 0\ (\frac{1}{2}) + 1\ (\frac{1}{2^2}) + 0\ (\frac{1}{2^3}) + 1\ (\frac{1}{2^4})$

$A = 8 + 4 + 0 + 1 + 0\ (\frac{1}{2}) + 1\ (\frac{1}{4}) + 0\ (\frac{1}{8}) + 1\ (\frac{1}{16})$

$A = 13 + 0\ (0.5) + 1\ (0.25) + 0\ (0.125) + 1\ (0.0625)$

$A = 13 + 0 + 0.25 + 0 + 0.0625$

$(1101.0101)_2 = (13.3125)_{10}$

Exercise

Convert $(0.0101)_2$ to Decimal by using two methods

Exercise

Convert $(100100.0101)_2$ to Decimal by using two methods.

Octal Number System

Octal System									
Base N=8									
NUMBERS USED(Digits) 0, 1,2,3,4,5,6,7									
…	3	2	1	0	.	-1	-2	-3	…	Positions
…	8^3	8^2	8^1	8^0	.	8^{-1}	8^{-2}	8^{-3}	…	Positional
…	512	64	8	1	.	1/8	1/64	1/512	…	Values

Example

Convert $(554)_8$ to Decimal by using two different methods?

Solution

The first method

2	1	0	Positions
8^2	8^1	8^0	Positional Values
64	8	1	
5	5	4	

$4 \times 1 = 4$

$5 \times 8 = 40$

$5 \times 64 = 320$

364=

$(554)_8 = (364)_{10}$

The second method

$$A = \sum_{i=0}^{k} a_i N^i + \sum_{i=-1}^{m} a_i N^i$$

$$A = a_3N^3 + a_2N^2 + a_1N^1 + a_0N^0 + a_{-1}N^{-1} + a_{-2}N^{-2} + a_{-3}N^{-3} + a_{-4}N^{-4}$$

$A = 5\ (8^2) + 5\ (8^1) + 4\ (8^0)$

$A = 5\ (64) + 5\ (8) + 4\ (1)$

$A = 320 + 40 + 4$

$A = 364$

$(554)_8 = (364)_{10}$

Example

Convert $(0.24)_8$ to Decimal by using two different methods?

Solution

The first method

.	-1	-2	Positions
.	8^{-1}	8^{-2}	Positional
.	1/8	1/64	Values
.	2	4	

$4 \times \frac{1}{64} = 0.0625$

$2 \times \frac{1}{8} = 0.25$

$0.3125 =$

$(0.24)_8 = (0.3125)_{10}$

The second method

$A = \sum_{i=-1}^{m} a_i N^i$

$A = a_{-1}N^{-1} + a_{-2}N^{-2}$

$A = 2\ (8^{-1}) + 4\ (8^{-2})$

$A = 2\ (\frac{1}{8}) + 4\ (\frac{1}{64})$

$A = 0.0625 + 0.25$

$(0.24)_8 = (0.3125)_{10}$

Exercise

Convert $(554.24)_8$ to Decimal by using two methods.

Exercise

Convert $(345.00)_8$ to Decimal by using two methods.

Exercise

Convert $(20.01)_8$ to Decimal by using two methods .

Exercise

Convert $(7.24)_8$ to Decimal by using two methods .

Exercise

Convert $(24.24)_8$ to Decimal by using two methods .

Hexadecimal Number System

Hexadecimal System										
Base					N=16					
NUMBERS USED(Digits)					0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F					
…	3	2	1	0	.	-1	-2	-3	..	Positions
… …	16^3 4096	16^2 256	16^1 16	16^0 1	.	16-1 1/16	16^{-2} 1/256	16^{-3} 1/4096	.. ..	Positional Values

Example

Convert $(16C)_{16}$ to Decimal by using two methods?

Solution

The first method

2	1	0	Positions
16^2 256	16^1 16	16^0 1	Positional Values
1	6	C	

$12 \times 1 = 12$

$6 \times 16 = 96$

$1 \times 256 = 256$

364=

$(16C)_{16}=(364)_{10}$

The second method

$$A = \sum_{i=0}^{k} a_i N^i + \sum_{i=-1}^{m} a_i N^i$$

$$A = a_2 N^2 + a_1 N^1 + a_0 N^0$$

$$A = 1\ (16^2) + 6\ (16^1) + C\ (16^0)$$

$$A = 1\ (256) + 6\ (16) + 12\ (1)$$

$$A = (364)_{10}$$

$(16C)_{16}=(364)_{10}$

Example

Convert $(0.B)_{16}$ to Decimal by using two methods?

Solution

The first method

.	-1	Positions
.	16^{-1}	**Positional Values**
.	1/16	
0 .	B	

$$11 \times \frac{1}{16} = 0.6875$$

0.6875 =

$$(0.B)_{16} = (0.6875)_{10}$$

The second method

$$A = \sum_{i=-1}^{m} a_i N^i$$

$A = a_{-1} N^{-1}$ $A = B\ (16^{-1})$

$A = 11\ (1/16)$ $A = (0.6875)_{10}$

$(0.B)_{16} = (0.6875)_{10}$

Exercise

Convert $(16C.B)_{16}$ to Decimal by using two methods

Conversion Between Systems

- Conversion of Binary system or Octal system or Hexadecimal system to Decimal system.
- Conversion of Decimal system to Binary system or Octal system or Hexadecimal system.
- Conversion of Octal system or Hexadecimal system to Binary system.
- Conversion of Binary system to Octal system or Hexadecimal system.

Conversion of Binary system or Octal system or Hexadecimal system to Decimal system.

Example

Convert $(111101.101)_2$ to Decimal by using two methods

Solution

The first method

5	4	3	2	1	0	.	-1	-2	-3	Positions
2^5	2^4	2^3	2^2	2^1	2^0	.	2^{-1}	2^{-2}	2^{-3}	Positional
32	16	8	4	2	1	.	1/2	1/4	1/8	Values
1	1	1	1	0	1	.	1	0	1	

$1 \times \frac{1}{8} = 0.125$

$0 \times \frac{1}{4} = 0$

$1 \times \frac{1}{2} = 0.5$

$1 \times 1 = 1$

$0 \times 2 = 0$

$1 \times 4 = 4$

$1 \times 8 = 8$

$1 \times 16 = 16$

$1 \times 32 = 32$

=61.625

$(111101.101)_2 = (61.625)_{10}$

Exercise

Solve the previous example using the equation method.

Exercise

Convert $(175.52)_8$ to Decimal by using two methods

Conversion of Decimal system to Binary system or Octal system or Hexadecimal system.

The conversion from the decimal system into what corresponds to it in the other systems, with what is included the number in the decimal system, either it was a true part or fractional, so the way of conversion of the true part is different from the fractional part, and the following is the display of these basic steps for both ways: First: the way of conversion of true part of the decimal number This way of conversion of the true part from the decimal number into what is corresponds to it in the Binary OR Octal or hexadecimal depend on the following steps:

- The division of the decimal number that is needed to be in conversion (true number) on the base of the system that is needed to be transferred to (**2, 8, 16**)
- Specifying the value of the remainder and the remainder is always less than the base.
- Divided outside division in the step (number (**1**) on the base of another time, and specifying the remainder.

- Continue to conducting the division process, and specifying the remainder at each case, until it reaches zero- outside division.
- The binary, Octal, Hexadecimal, the required and which is equal to the decimal number is the values of the division remainders of the sequence division in the previous steps that are put beside in opposite form, in other words they are put beside each other, sorted from bottom to top, or from the remainder of the final division process to the remainder of the first division process.

Conversion of Decimal system to Binary system

Example

Convert $(36)_{10}$ to Binary?

Number	Result	Reminder
36	÷2 = 18	**0**
18	÷2 = 9	**0**
9	÷2 = 4	**1**
4	÷2 = 2	**0**
2	÷2 = 1	**0**
1	**÷2 = 0**	**1**

$(36)_{10} = (100100)_{2}$

Exercise

Convert $(182)_{10}$ to Binary ?

Complete the following table as an exercise?

Number	Result	Reminder
182	÷2 = 91	**0**
91	÷2 = 45	
45	÷2 = 22	
22	÷2 = 11	
11	÷2 = 5	**1**
5	÷2 = 2	
2	÷2 = 1	
1	**÷2 = 0**	**1**

$(182)_{10} = (10110110)_2$

Conversion of Decimal system to Octal system

Example

Convert $(36)_{10}$ to Octal

Solution

Number	Result	Reminder
36	÷8 = 4	**4**
4	**÷8 = 0**	**4**

$(36)_{10} = (44)_8$

Conversion of Decimal system to Hexadecimal system

Example

Convert $(36)_{10}$ to Hexadecimal ?

Solution

Number	Result	Reminder
36	÷16 = 2	**4**
2	**÷16 = 0**	**2**

$(36)_{10} = (24)_{16}$

Exercise

Convert $(364)_{10}$ to Hexadecimal ?

Solution

Number	Result	Reminder
364	**÷16 = 22**	**C**
22	**÷16 = 1**	**6**
1	**÷16 = 0**	**1**

$(364)_{10} = (16C)_{16}$

Example

Convert $(464)_{10}$ to Hexadecimal ?

Solution

Number	Result	Reminder
464	÷16 = 29	**0**
29	**÷16 = 1**	**D**

The way of conversion the fractional part of the decimal; number. This way relies on the conversion of the fractional part of the decimal number into its equal I the Binary system, or Octal, or Hexadecimal on the following steps:

1. Multiplying the decimal number that is needed to be conversional (decimal fraction) in the base of the system that is needed to be conversion to (2,8, 16)
2. Specifying the value of the true part –integer-
3. Multiplying the resulted fraction, from step (1) I the base, another time, and specifying the true part in this case.
4. Continue in conducting the multiplying process, and specifying the true part in each case until the result of the fraction reaches zero.
5. The binary, or Octal, or hexadecimal number which is equal to the decimal number is the values of the true part, resulted from the sequence multiplying in the previous steps, which are put beside each other, and sorted from top to bottom, or from the true

part resulted from the first multiply process into the true part of the final multiply process, with consideration to the decimal mark on the left side of the result (output).

Conversion of Decimal Fraction to Binary Fraction

Example

Convert $(0.375)_{10}$ to Binary fraction?

Solution

Number	Result	Integer part
0.375	*** 2 = 0.75**	**0**
0.75	*** 2 = 1.50**	**1**
0.5	*** 2 = 1.00**	**1**

$(0.375)_{10} = (0.011)_2$

Exercise

Convert $(0.3125)_{10}$ to Binary fraction?

Exercise

Convert $(182.375)_{10}$ to Binary?

Exercise

Convert $(7.7)_{10}$ to Binary?

Conversion of Decimal Fraction to Octal Fraction.

Example

Convert $(0.315)_{10}$ to octal fraction?

Solution

Number	Result	Integer part
0.513	* 8 = 4.104	**4**
0.104	* 8 =0.832	**0**
0.832	* 8 =6.656	**6**
0.656	* 8 =5.248	**5**
0.248	* 8 =1.984	**1**
0.984	*** 8 =7.872**	**7**

$(0.513)_{10} = (406517)_8$

Exercise

Convert $(.77)_{10}$ to Octal?

Conversion of Decimal Fraction to Hexadecimal Fraction.

Example

Convert $(0.3125)_{10}$ to hexadecimal fraction?

Solution

Number	result	Integer part
0.3125	* 16 = 5.0	**5**
0.0		

$(0.3125)_{10} = (0.5)_{16}$

Exercise

Convert $(36.3125)_{10}$ to hexadecimal?

Exercise

Convert $(8.16)_{10}$ to hexadecimal?

Conversion of Octal system and Hexadecimal system to Binary.

Binary	Octal
000	**0**
001	**1**
010	**2**
011	**3**
100	**4**
101	**5**
110	**6**
111	**7**

Example

Convert $(554)_8$ To Binary?

Solution

1 0 1	1 0 1	1 0 0
5	**5**	**4**

$$(554)_8 = (101101100)_2$$

Exercise

Convert $(0.625)_8$ to Binary?

Binary	Hexadecimal
0000	**0**
0001	**1**
0010	**2**
0011	**3**
0100	**4**
0101	**5**
0110	**6**
0111	**7**
1000	**8**
1001	**9**
1010	**A**
1011	**B**
1100	**C**
1101	**D**
1110	**E**
1111	**F**

Example

Convert $(16C)_{16}$ to Binary?

Solution

0 0 0 1	0 1 1 0	1 1 0 0
1	6	C

$(16C)_{16} = (000101101100)_2$

or $(16C)_{16} = (101101100)_2$

Exercise

Convert $(0.BA)_{16}$ to Binary?

Conversion of Binary system to Octal system and Hexadecimal.

Example

Convert $(10110001101011)_2$ to an octal?

Solution

0 1 0	1 1 0	0 0 1	1 0 1	0 1 1
2	6	1	5	3

$(10110001101011)_2 = (26153)_8$

Exercise

(0.1100 to an octal?

Convert $10101)_2$

Solution

.	1 1 0	0 1 0	1 0 1
.	6	2	5

$$(0.110010101)_2 = (0.625)_8$$

Exercise

Convert $(101100.110010101)_2$ to octal?

Example

Convert $(101111100)_2$ to Hexadecimal?

Solution

0 0 0 1	0 1 1 1	1 1 0 0
1	7	C

$$(101101100)_2 = (17c)_{16}$$

Exercise

Convert $(10.10011101)_2$ to hexadecimal?

Arithmetic Operations in Number Systems

(BINARY ADDITION)

0 + 0 = 0

0 + 1 = 1

1 + 0 = 1

1 + 1 = 10

1 + 1 = 0 ⟶ 1

Example

Find:

1 0 1 1

1 1 0 +

Solution

1 1

1 0 1 1

1 1 0 +

1 0 0 0 1

Exercise

Why we are aligning the numbers on right hand ?

Example

1 0 1 1.1 1

1 1 0.1 +

Solution

```
  1  1  1  1
  1  0  1  1.1  1
  0  1  1  0.1  0   +
-------------------
1  0  0  1  0.0  1
```

Exercise

How to verify the result ?

(BINARY SUBTRACTION)

First method (normal method)

1 - 0 = 1

1 - 1 = 0

0 - 0 = 0

0 - 1 = 1 ⟵ 1 **(Borrow)**

Example

Find:

1 1 1 0

1 0 1 -

Solution

$$\begin{array}{r} {\scriptstyle 0\quad 10} \\ 1\ 1\ \cancel{1}\ \cancel{0} \\ 0\ 1\ 0\ 1\ \ - \\ \hline 1\ 0\ 0\ 1 \end{array}$$

$$\begin{array}{r} {\scriptstyle 1} \\ 1\ 0\ 0\ 1 \\ 0\ 1\ 0\ 1\ \ + \\ \hline 1\ 1\ 1\ 0 \end{array}$$

Exercise

How to verify the result ?

Exercise

Find:

1 0 1 0 0.1 1

1 0 1.0 1 -

The second method (1th Complement method)

Exercise

Search the web for how this method works?

(BINARY MULTIPLICATION)

$0 \times 0 = 0$

$0 \times 1 = 0$

$1 \times 0 = 0$

$1 \times 1 = 1$

Example

Solution Find: 101×1111

$$\begin{array}{r} 1\ 1\ 1\ 1 \\ \times\quad 1\ 0\ 1 \\ \hline 1\ 1\ 1\ 1 \\ 0\ 0\ 0\ 0 \\ 1\ 1\ 1\ 1 \\ \hline 1\ 0\ 0\ 1\ 0\ 1\ 1 \end{array}$$

Exercise

Find 101 × 1010

Exercise

How to multiply fraction binary numbers ?

Where to put the final decimal point ?

Find 1011.01 × 11.01

(OCTAL ADDITION)

Example

Find

$$\begin{array}{r} 5\ 3\ 2 \\ +\ 3\ 4\ 5 \end{array}$$

Solution

$$\begin{array}{r} {\scriptstyle 1} \\ 5\ 3\ 2 \\ 3\ 4\ 5\ + \\ \hline 1\ 0\ 7\ 7 \end{array}$$

Exercise

Find

6 5 4

1 3 2 +

(OCTAL SUBTRACTION)

First method (normal method)

Example

Find

1 0 7 7

5 3 2 -

Solution

1 0 7 7

0 5 3 2 -

0 3 4 5

The second method (Ones' Complement Method)

Search for how to use this method?

(HEXADECIMAL ADDITION)

Example

Find: 5 4

3 A +

Solution

5 4

3 (A)

8 (E)

Exercise

Find:

1 A 6

F 1 9 +

(HEXADECIMAL SUBTRACTION)

First method (normal method)

Example

Find:

D 6 7 C

- 3 1 3 A

Solution

$$\begin{array}{r} D\ 6\ 7\ C \\ -\ 3\ 1\ 3\ A \\ \hline A\ 5\ 4\ 2 \end{array}$$

$$\begin{array}{r} A\ 5\ 4\ 2 \\ 3\ 1\ 3\ A\ + \\ \hline D\ 6\ 7\ C \end{array}$$

Exercise

Find:

$$\begin{array}{r} 1\ 2\ 2\ 2\ 1 \\ -\ 7\ 6\ 5\ 4 \end{array}$$

DIVISION IN NUMBER SYSTEMS

Exercise

Division is a repeated subtraction process. Knowing this information, you can perform standard division operations in any number system. As an exercise to further polish and test your understanding, search

for how to perform this operation in various number systems and solve the following operations :

a. $(100)_2 / (10)_2 = (\_\_\_\_\_)_2$

b. $(100)_8 / (1)_8 = (\_\_\_\_\_)_8$

c. $(16C)_2 / (2)_{16} = (\_\_\_\_\_)_{16}$

d. $(6)_8 / (2)_8 = (\_\_\_\_\_)_8$

e. $(7)_8 / (1)_{16} = (\_\_\_\_\_)_8$

f. $(1000)_2 / (8)_{16} = (\_\_\_\_\_)_2$

Exercises

Find the result of the following operations:

g. $(8)_{10} = (\_\_\_\_\_)_{2}$

h. $(11001)_{2} = (\_\_\_\_\_)_{10}$

i. $(1010)_{2} = (\_\_\_\_\_)_{10}$

j. $(643)_{8} = (\_\_\_\_\_)_{10}$

k. $(1234)_{8} = (\_\_\_\_\_)_{10}$

l. $(12)_{8} = (\_\_\_\_\_)_{10}$

m. $(14)_{8} = (\_\_\_\_\_)_{10}$

n. $(22)_{8} = (\_\_\_\_\_)_{10}$

o. $(25)_{10} = (\_\_\_\_\_)_{8}$

p. $(12)_{8} = (\_\_\_\_\_)_{10}$

q. $(7)_{8} = (\_\_\_\_\_)_{10}$

r. $(AB2)_{16} = (\_\_\_\_\_)_{10}$

s. $(F12)_{16} = (\_\_\_\_\_)_{10}$

t. $(AD)_{16} = (\_\_\_\_\_)_{10}$

u. $(D5)_{16} = (\_\_\_\_\_)_{10}$

v. $(E2)_{16} = (\_\_\_\_\_)_{10}$

w. $(17)_{10} = (\_\_\_\_\_)_{16}$

x. $(100)_{10} = (\_\_\_\_\_)_{16}$

y. $(100)_2 + (100)_2 = (\_\_\_\_\_)$

z. $(1010)_2 + (100)_2 = (\_\_\_\_\_)$

aa. $(100)_2 + (100)_2 = (\_\_\_\_\_)$

bb. $(111)_2 + (1)_2 = (\_\_\_\_\_)$

cc. $(100)_2 - (1)_2 = (\_\_\_\_\_)$

dd. $(1001)_2 - (100)_2 = (\_\_\_\_\_)$

ee. $(1111)_2 - (10001)_2 = (\_\_\_\_\_)$

ff. $(100)_2 \times (100)_2 = (\_\_\_\_\_)$

gg. $(100101)_2 \times (100)_2 = (\_\_\_\_\_)$

hh. $(11)_2 \times (111)_2 = (\_\_\_\_\_)$

ii. $(77)_8 + (22)_8 = (\_\_\_\_\_)$

jj. $(AB)_{16} + (8)_{10} = (\_\_\_\_\_)_2$

kk. $(21)_{10} + (10001)_2 = (\_\_\_\_\_)_{16}$

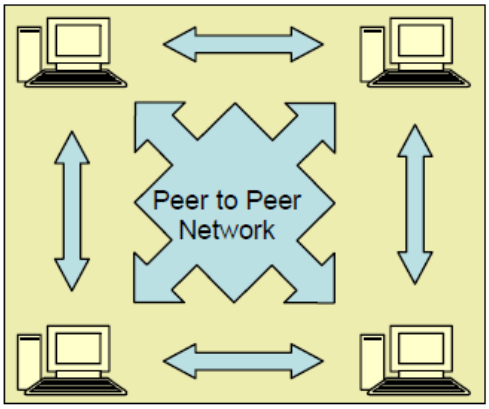
ll. $(71)_8 + (8)_{10} = (\_\_\_\_\_)_{16}$

Chapter 3
Computer networks

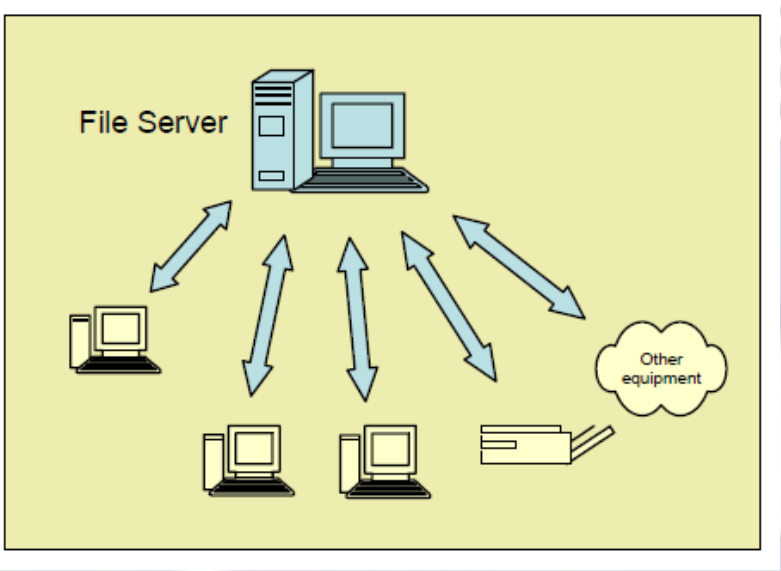
Basic of Networking

A computer network consists of a collection of computers, printers and other equipment that is connected together so that they can communicate with each other. Fig 1 gives an example of a network in a school comprising of a local area network or LAN connecting computers with each other, the internet, and various servers. Broadly speaking, there are two types of network configuration, peer-to-peer networks and client/server networks.

Peer-to-peer networks are more commonly implemented where less than ten computers are involved and where strict security is not necessary. All computers have the same status, hence the term 'peer', and they communicate with each other on an equal footing. Files, such as word processing or spreadsheet documents, can be shared across the network and all the computers on the network can share devices, such as printers or scanners, which are connected to any one computer.



Client/server networks are more suitable for larger networks. A central computer, or 'server', acts as the storage location for files and applications shared on the network. Usually the server is a higher than average performance computer. The server also controls the network access of the other computers which are referred to as the 'client' computers. Typically, teachers and students in a school will use the client computers for their work and only the network administrator (usually a designated staff member) will have access rights to the server.



The following table provides a summary comparison between Peer-to-Peer and Client/Server Networks.

Peer-to-Peer Networks	Client/Server Networks
▪ **Easy to set up.** ▪ **Less expensive to install.** ▪ **Can be implemented on a wide**	▪ More difficult to set up. ▪ More expensive to install. ▪ A variety of operating systems can

▪ **range of operating systems.** ▪ **More time consuming to maintain the software being used (as computers must be managed individually).** ▪ **Very low levels of security supported or none at all. These can be very cumbersome to set up, depending on the operating system being used.** ▪ **Ideal for networks with less than 10 computers.** ▪ **Does not require a server.** ▪ **Demands a moderate level of skill to administer the network.**	▪ be supported on the client computers, but the server needs to run an operating system that supports networking. ▪ Less time consuming to maintain the software being used (as most of the maintenance is managed from the server) ▪ High levels of security are supported, all of which are controlled from the server. Such measures prevent the deletion of essential system files or the changing of settings. ▪ No limit to the number of computers that can be supported by the network. ▪ Requires a server running a server operating system ▪ Demands that the network administrator has a high level of IT skills with a good working knowledge of a server operating system.

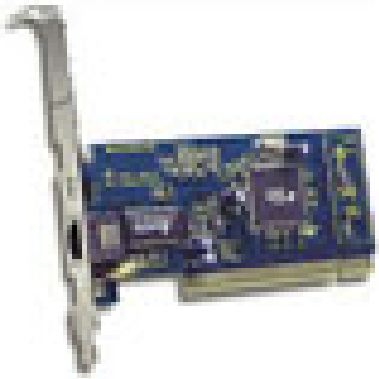
Components of a Network

A computer network comprises the following components:

- A minimum of at least 2 computers.
- Cables that connect the computers to each other, although wireless communication is becoming more common (see Advice Sheet 20 for more information)
- A network interface device on each computer (this is called a network interface card or NIC)
- A 'Switch' used to switch the data from one point to another. Hubs are outdated and are little used for new installations.
- Network operating system software

Network Interface Card (NIC)

A NIC (pronounced 'nick') is also known as a network card. It connects the computer to the cabling, which in turn links all of the computers on the network together. Each computer on a network must have a network card. Most modern network cards are 10/100 NICs and can operate at either 10Mbps or 100Mbps. Only NICs supporting a minimum of 100Mbps should be used in new installations students. Computers with a wireless connection to a network also use a network card (see Advice Sheet 20 for more information on wireless networking).



Hub and Switch

Exercise

What is the difference between hub and switch ?

Wireless Networks

The term 'wireless network' refers to two or more computers communicating using standard network rules or protocols, but without the use of cabling to connect the computers together. Instead, the computers use wireless radio signals to send information from one to the other. A wireless local area network (WLAN) consists of two key components: an access point (also called a base station) and a wireless card. Information can be transmitted between these two components as long as they are fairly close together (up to 100 metres indoors or 350 metres outdoors).

An Example of a wireless Base-station.

Suppliers would need to visit the students and conduct a site survey. This will determine the number of base stations you need and the best place(s) to locate them. A site survey will also enable each supplier to provide you with a detailed quote. It is important to contact a number of different suppliers as prices, equipment and opinions may vary. When the term 'wireless network' is used today, it usually refers to a wireless local area network or WLAN. A WLAN can be installed as the sole network in a school or building.

However, it can also be used to extend an existing wired network to areas where wiring would be too difficult or too expensive to implement, or to areas located away from the main network or main building. Wireless networks can be configured to provide the same network functionality as wired networks, ranging from simple peer-to-

peer configurations to largescale networks accommodating hundreds of users.

Desktop PC wireless LAN Card.

Advantages and disadvantages of a Wireless LAN:

Exercise

What are the advantages and disadvantages of wireless LANs ?

Wireless Network Components

There are certain parallels between the equipment used to build a WLAN and that used in a traditional wired LAN. Both networks require network interface cards or network adapter cards. A wireless LAN PC card, which contains an in-built antenna, is used to connect notebook computers to a wireless network. Usually, this is inserted into the relevant slot in the side of the notebook, but some may be internal to the notebook. Desktop computers can also connect to a wireless

network if a wireless network card is inserted into one of its internal PCI slots.

In a wireless network, an 'access point' has a similar function to the hub in wired networks. It broadcasts and receives signals to and from the surrounding computers via their adapter card. It is also the point where a wireless network can be connected into an existing wired network. The most obvious difference between wireless and wired networks, however, is that the latter uses some form of cable to connect computers together. A wireless network does not need cable to form a physical connection between computers.

Wireless Network Configurations

Wireless networks can be configured in an ad hoc/peer-to-peer arrangement or as a local area network.

Ad Hoc/Peer-to-Peer Configuration

This is the most basic wireless network configuration. It relies on the wireless network adapters installed in the computers that are communicating with each other. A computer within range of the transmitting computer can connect to it. However, if a number of computers are networked in this way, they must remain within range of each other. Even though this configuration has no real

administration overhead, it should only be a consideration for very small installations.

Technical and Purchasing Considerations

Exercise

What are the major technical and purchasing considerations for wireless LANS ?

Network Topologies

The layout of your network is important for several reasons. Above all, it plays an essential role in how and how well your network functions. Choosing the right topology for your company's operational model can increase performance while making it easier to locate faults, troubleshoot errors, and more effectively allocate resources across the network to ensure optimal network health. A streamlined and properly managed network topology can increase energy and data efficiency, which can in turn help to reduce operational and maintenance costs.

Exercise

What are the common network topologies ?

Advantages of Networking students

Exercise

What is a networking student ?

Do you have your university email ?

1. **Speed.**
2. **Cost.**
3. **Centralized Software Management.**
4. **Resource Sharing.**
5. **Flexible Access.**
6. **Security.**

Main challenges of installing an Education Network

Costs

Although a network will generally save money over time, the initial costs can be substantial, and the installation may require the services of a technician.

Requires Administrative Time.

Proper maintenance of a network requires considerable time and expertise. Many students have installed a network, only to find that they did not budget for the necessary administrative support.

File Server May Fail.

Although a file server is no more susceptible to failure than any other computer, when the files server "goes down," the entire network may come to a halt. When this happens, the entire school may lose access to necessary programs and files.

Exercises

1. What is the difference between LAN and WAN?

2. What are the advantages and disadvantages of WLAN?

3. What are the differences between Peer-to-Peer and Client/Server Networks?

4. Explain the following terms:

- HUB
- ROUTER
- SWITCH
- ISDN

5. Peer-to-Peer and Client/Server Networks? Which is better ?

6. What are the advantages of networking students?

7. Main challenges of installing a School Network?

Chapter 4
Microsoft Excel

Introduction

This part has been prepared to help you use Excel to do calculations using basic Excel formula and functions. It is aimed at those who have a good understanding of the basic use of Excel for entering data. It assumes knowledge of moving around a worksheet, formatting cells, and controlling worksheet display and printing.

Creating simple formula

Formula allow the calculation of data or values. These calculations range from simple arithmetic (addition, multiplication etc.) to more complex statistical, logical and database functions. You enter a formula by typing it in the cell where you want its result to appear. When you confirm entry of a formula, Excel will display the result on the worksheet, but the underlying calculation appears in the formula bar.

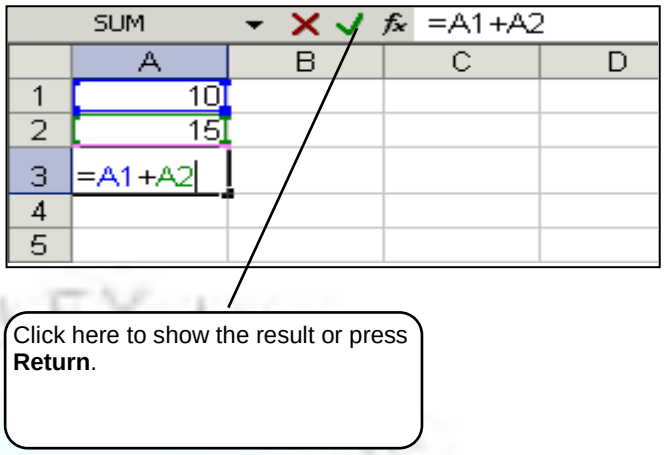
Formula always start with an = (equals) sign. Place the formula in the cell where the result is to be displayed. Formula should refer to the **cell address** not the **contents** of the cells, i.e. to add the two numbers shown above the correct formula is:

=A1+A2

NOT

=10+15

- The result is displayed in the cell when the **Tick** button on the formula bar is clicked, or the **Return** key is pressed.



- You can cancel a formula if necessary by clicking on the red **X** button on the formula bar or pressing the **Esc** key.
- When the contents of a cell referred to in a formula change, the formula automatically calculates and displays the new result. I.e. if the value in cell A1 is changed to 15 in the example above, the formula automatically recalculates to display the result 30.

SOME COMMON FORMULA

Operator	Description	Excel Formula	
+	Addition	**=A1+A2**	add A1 and A2
-	Subtraction	**=A1-A2**	subtract A2 from A1
*	Multiplication	**=A1*A2**	multiply A1 by A2
/	Division	**=A1/A2**	divide A1 by A2
^	Exponential	**=A1^A2**	raise A1 to the power A2
%	Percentage	**=A1 %**	express A1 as a percentage

These operations can also be combined together. For example:

=A1-A2/A1+A2)

or

=(A1+B2–D4)*50

Use brackets to ensure that the different parts of the formula are calculated in the correct order. For example =(3+2)*4 is not the same as =3+2*4.

The order of precedence

Excel evaluates operators following the conventional rules – it will apply the calculations in a formula in the following order:

BODMAS: **B**rackets **O**f **D**ivision **M**ultiplication **A**ddition **S**ubtraction

( )	brackets first
/ and *	division and multiplication
+ and -	addition and subtraction

Formula	Result
=3+2*4	11
=(3+2)*4	20

Take care to observe these rules when creating your own formula.

Incorrect syntax will result in error.

Calculation with dates

Excel also allows you to perform calculations with dates. All dates are stored in Excel as sequential numbers. By default, January 1 1900 is serial number 1, and January 1, 2004 is serial number 37987 because it is 37,987 days after January 1, 1900. Excel stores times as decimal fractions because time is considered a portion of a day.

Because dates and times are values, they can be added, subtracted, and included in other calculations. You can view a date as a serial value and a time as a decimal fraction by changing the format of the cell that contains the date or time to *General* format.

Viewing dates as numbers

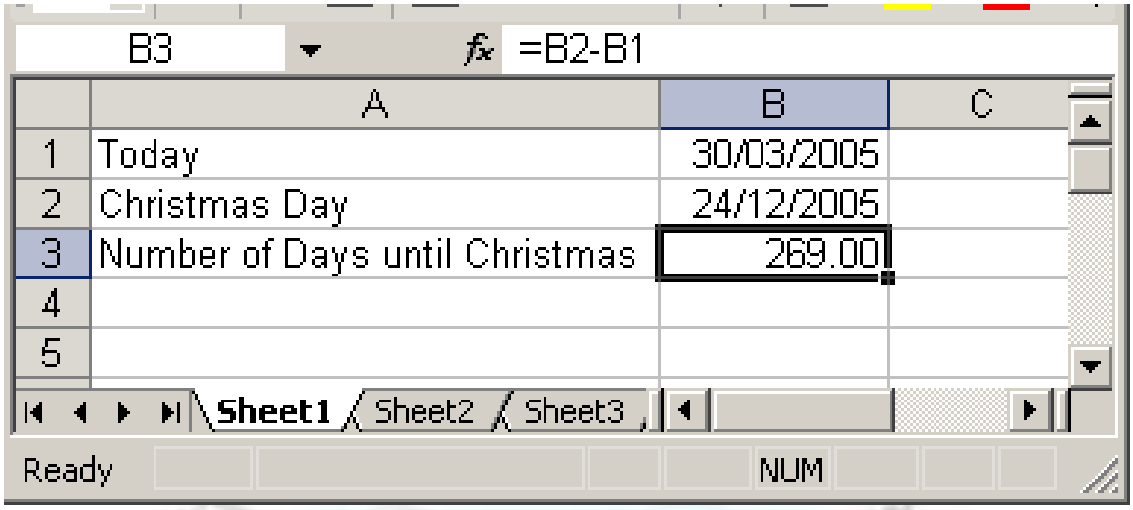
To view dates as numbers:

1. Select the cell and click **Cells** on the **Format** menu.

2. Click the **Number** tab, and then click **Number** in the *Category* box.

Calculating the difference between two dates

In the following example the date in cell **B1** has been subtracted from the date in cell **B2**. The result in cell **B3** has been formatted to display a number (the number of days between two dates) with no decimal places.



Editing a formula

1. Double-click on the cell containing the formula. The cell will switch from displaying the result of the formula to the formula itself.
2. Click the mouse over the part of the formula you wish to change to insert the cursor there. Type any new character or use the **Backspace** or **Delete** keys to remove characters.
3. Press **Enter** to confirm your changes, or **Esc** to exit the cell without saving your changes.

OR

1. Move to the cell containing the formula you wish to change.
2. The formula will be displayed in the *formula bar*.
3. Click into the *formula bar* and make the necessary changes.

4. Click on the **green tick** to the left of the formula to confirm your change, or the **red cross** to close the formula without saving your changes.

OR

1. Move to the cell containing the formula you wish to change and press the **F2** key.
2. Use the arrow keys to move the cursor to the edit position. Make your changes and exit the cell as explained above.

Copying formula

Formula can be copied using the **Copy** and **Paste** buttons in the same way as data can be copied in a worksheet.

1. Select the cell containing the formula to be copied.
2. From the **Edit** menu choose **Copy** (or use the **Copy** icon).
3. Move the cursor to the new location.
4. From the **Edit** menu choose **Paste** (or use the **Paste** icon).

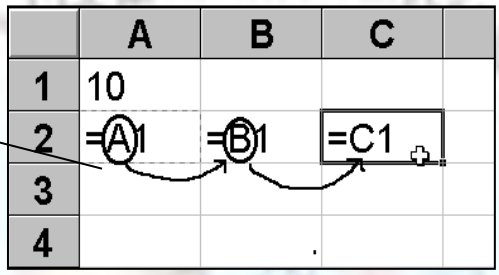
Note how the cell references change as we copy the formula from cell A2 to cell B2 below left.

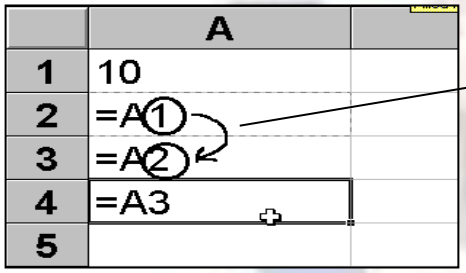
=A1 becomes **=B1**

Note how the cell references change as we copy the formula from cell A2 to cell A3 below right.

=A1 becomes **=A2**

Notice how the reference changes by **one column** relative to its starting position.





Notice how the reference changes by **one row** relative to its starting position.

When a formula is copied, it is applied **relative** to the new range. Therefore, the formula **=A1** will become **=A2** when copied to the next row, and the formula **=A1** and will become **=B1** when copied to the next column.

Using the fill handle

1. Move to the cell that has the formula that you want to fill.
2. Position your mouse pointer over the fill handle. It will change to a black plus.

3. Drag the black plus down or right over the cells where you want your copied formula to generate results. You will see an outline around those cells.

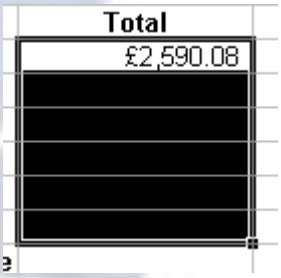
4. Release the mouse when the outline includes all the cells where you want results.

D4 =B4*C4

	A	B	C	D
1	**Barkestone Training**			
2	Monthly Stationery			
3		**Order**	**Price**	**Total**
4	Pens	456	£5.68	£2,590.08
5	A4 Paper	345	£3.25	
6	Calculators	23	£8.99	
7	Box Files	665	£4.99	
8	Pencils	345	£0.23	
9	Rulers	89	£1.69	
10	**Total Ordered**		**Total Price**	

Using keystrokes

You can fill a column or a row of formula using the keyboard.



1. Select the cell containing the formula to fill and the cells where you want to copy it.
2. Press **Ctrl+D** to fill down.

OR

Press **Ctrl+R** to fill right.

There are no keystrokes to fill up or left. Instead, repeat step one above and then click **Edit** on the menu bar, choose **Fill** and select the direction for the fill from the resulting sub-menu.

Functions

You have seen how to enter *formula* to perform simple arithmetic operations on values in a worksheet. Excel also provides many built-in *functions* which automate a number of types of calculation. Functions are pre-programmed formula – you are probably already familiar with the use of functions on a calculator (for example, the square-root function, trigonometric functions, logarithms etc.). Excel has more than 300 functions covering a range of statistical, mathematical, financial and logical operations. If you have many numbers in a group of cells that you wish to combine in a formula, typing the formula becomes laborious. Using a function offers a shortcut method.

Examples of the most commonly used functions include the *Average* function, which calculates the average of a group of cell values, the *Sum* function, which adds together a group of cell values, and the *Min* and *Max* functions, which determine the lowest and highest values in a group of cells.

Functions and arguments

Functions are usually written with the equals sign (=) followed by the *function name* and then parentheses containing the *argument*. Usually

the argument just contains the range of cells which the function will operate on. For example, the *Average* function is written as:

The argument of a function is placed in brackets. To specify a range of cells a colon is used between the first and the last cell address. For example, (A1:A4) will specify cells A1, A2, A3 and A4.

The Sum function

The *Sum* function is a useful function. It simply adds together a range of cell values. The formula:

=A1+A2+A3+A4+A5+A6+A7+A8

can be replaced by:

=SUM(A1:A8)

This adds up the contents of the cells A1 to A8.

- The function can be typed at the keyboard like any other formula.
- The function can be created with the *Insert Function.*
- The SUM function can be created using the AutoSum button (this is the easiest method).

AutoSum

The AutoSum feature allows you to add all numbers in a contiguous row or column. To use AutoSum:

1. Click a cell below the column of numbers or to the right of the row of numbers.
2. Click the **AutoSum** button on the *Standard* toolbar, and then press **Enter**.

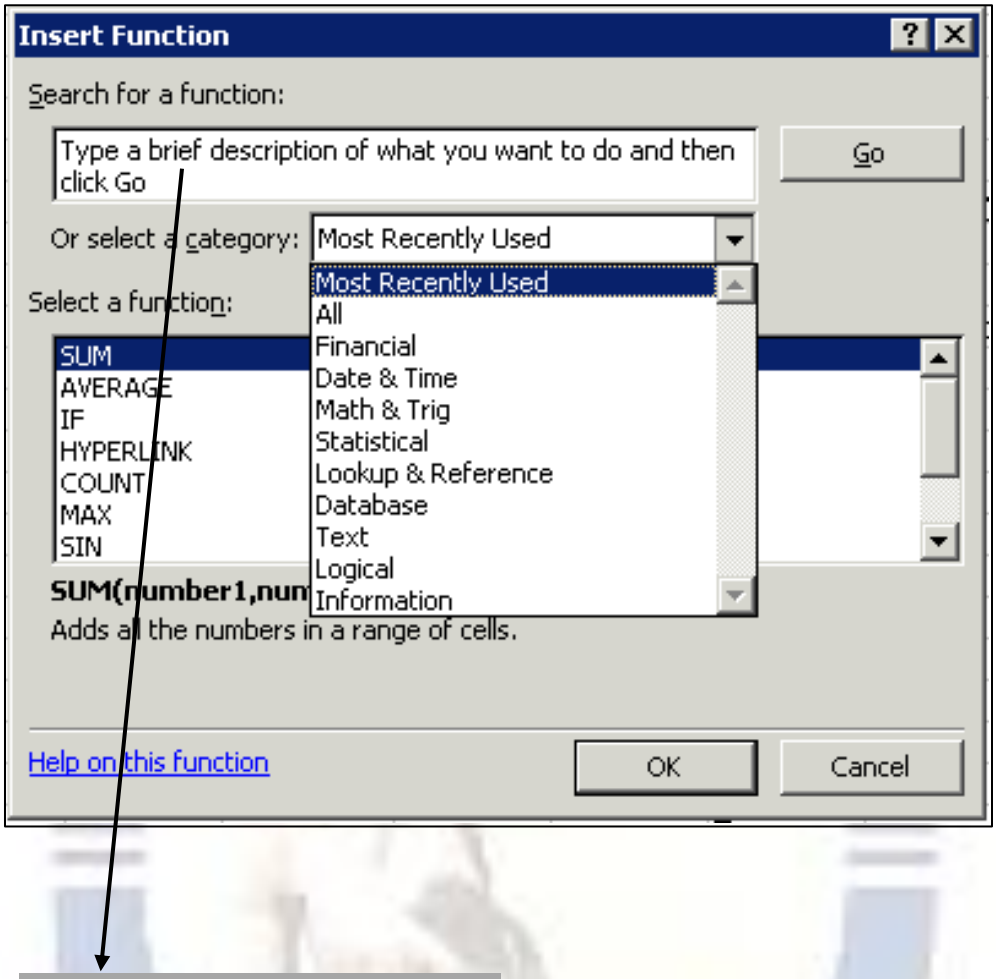
Excel automatically guesses the range of cell references that you wish to sum (these can be amended if necessary).

Note: Always check automatically generated formula before accepting them, as Excel doesn't always guess correctly.

Using the Insert Function

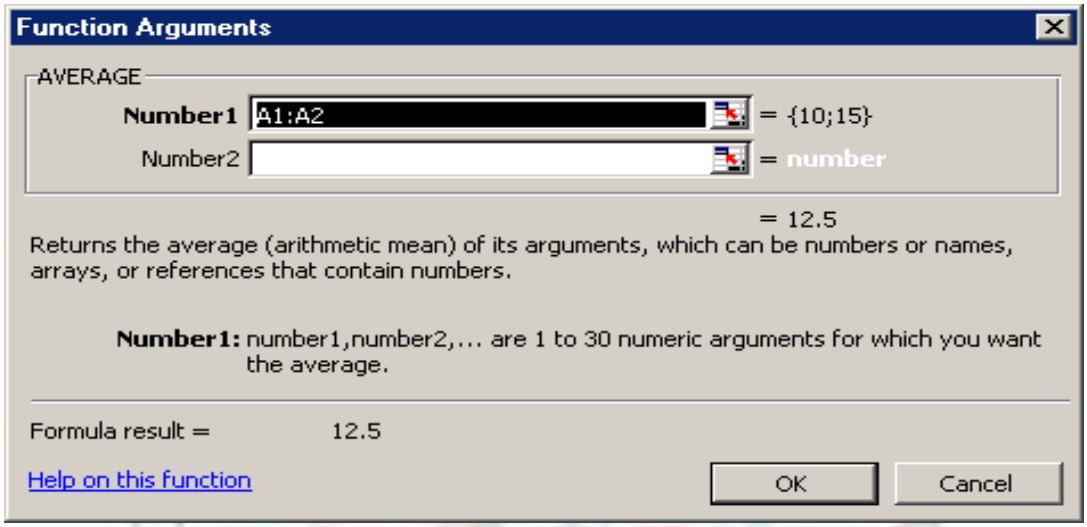
If you know the name of a function, you can simply type it in together with the argument or range of cells you want to apply it to. However, an easy way to work with functions is to use the *Insert Function*.

1. Position the cursor in the cell which is to contain the result, and from the **Insert** menu select **Function** or click the **Insert Function** button on the *Formula* bar**.**
2. The *Insert Function* dialog box is displayed.



Using the *Search for a function* box, you can type a description of what you want to do. The *Most Recently Used* category often offers the most likely choices. Select an appropriate category. The functions in that category are shown in the lower half of the window.

If in this example we choose AVERAGE and click on **OK**, the *Function Arguments* dialog box will display as shown below. It may well obscure the part of the worksheet you want to work on. However it can be moved simply by clicking and dragging anywhere in the grey shaded box. It can also be shrunk by clicking on the **Shrink**/**Enlarge** buttons.



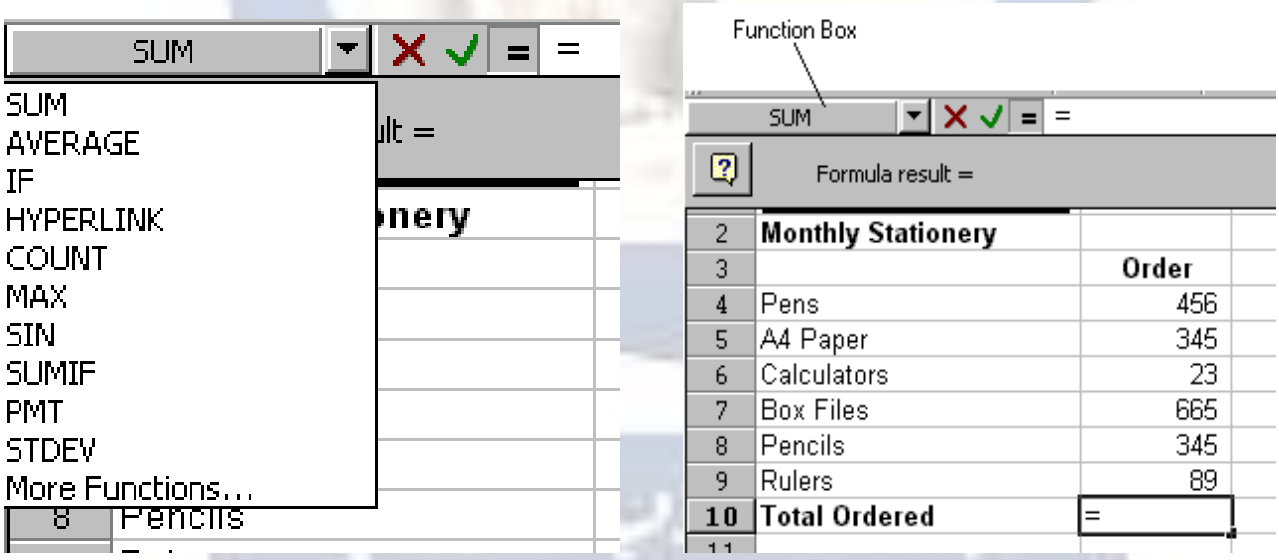
Note that *Insert Function* guesses the range of cells to be used in the calculation (A1:A2 in the example). Click **OK** if this is correct. Alternatively type the range in, or highlight the cells required in the worksheet. Notice that a moving border appears around the specified cells as the range is entered in the dialog box. Click **OK**.

You can view the completed formula by clicking in the cell, and looking at the contents of the *Formula bar*.

Function box

The *Function box* groups the most commonly used functions for quick and easy access.

1. Position the cursor where you want the function and type an equals sign into the cell.
2. Excel displays the *Function box* to the left of the *Formula* bar. Click the drop-down list arrow to the right of the *Function* box to display a list of function names.
3. Select the function you require by clicking its name from the list.
4. If your function isn't listed, click the **More Functions** option to access the *Insert Function* dialog box.
5. Excel will place the chosen function on the worksheet in the selected cell. You can see the selected function being built on the Formula bar.



With some functions, Excel tries to guess which cells you want included as the function arguments. Click **OK** to accept Excel's guess and confirm the function, or select the correct cells as described above.

Precision formatting

Care must be taken when working with formatted numbers. It is important to remember that formatted numbers, i.e. the numbers which appear on the screen, may not be the same as the value stored in the cell or the numbers used in calculations. The discrepancy can cause the results displayed to be different from the manually calculated answers.

A1 = 9.5

	A	B	D
1	10	10	
2	10	10	
3	10	10	
4	10	10	
5	10	10	
6	10	10	
7	10	10	
8	10	10	
9	10	10	
10	10	10	
11	95	100	

In the example opposite, there are two columns of numbers that appear to be the same. The first column adds up to 95 but the second column adds up to 100. Take a close look at the value stored in cell A1, as displayed in the *Formula* bar. The value stored in all the cells in the first column is actually 9.5. This has been formatted to appear as a whole number (integer). The calculation is actually correct (10*9.5=95), although it appears to be incorrect. The problem can be avoided by using number formats cautiously, or it can

be resolved by setting the precision for the entire worksheet as explained below.

Setting the precision of number formats

To set the precision of number formats for an entire worksheet:

1. Choose the **Tools** menu, then the **Options** command and select the **Calculation** tab.
2. Choose the **Precision as displayed** box and click **OK**.

When you choose **OK** you are warned that constant numbers throughout the worksheet will be rounded permanently to match cell-formatting.

STATISTICAL AND MATHEMATICAL FUNCTIONS

Some of the most commonly used statistical and mathematical functions are shown below.

Function	Example	Description
MAX	**MAX(C1:C10)**	Finds the largest cell value in the specified range of cells.
MIN	**MIN(C1:C10)**	Finds the smallest cell value in the specified range of cells.
AVERAGE	**AVERAGE(C1:10)**	Finds the average cell value in the specified range of cells.

MEDIAN	**MEDIAN(C1:C10)**	Finds the median or middle value in the specified range of cells.
STDEV	**STDEV(C1:C10)**	Finds the standard deviation of the values in a range of cells.
COUNT	**COUNT(C1:C10)**	Counts the number of cells containing numbers.
COUNTA	**COUNTA(C1:C10)**	Counts the number of cells containing numbers or letters (i.e. the number of non-blank cells).
COUNTBLANK	**COUNTBLANK(C1:C10)**	Counts the number of blank cells.
ROUND	**ROUND(C1, 2)**	Rounds the cell value to the specified number of decimal places (2 in this example; use 0 to get a whole number).
SQRT	**SQRT(C1)**	Calculates the square root of a cell value.
RADIANS	**RADIANS(C1)**	Converts angles from degrees to radians.
SIN	**SIN(C1)**	Calculates the Sine of an angle (in radians – use the RADIANS function to convert degrees into radians). Other trigonometric functions include COS and TAN.

Cell references

In functions, you often need to refer to a range of cells. The way Excel displays cell references in functions depends on whether the cells you want the function to act upon are together in a block, or in several non-adjacent cells or blocks.

The table below explains how to use different operators to refer to cells:

Operator	Example	Description
Reference operator : (colon)	B5:B15	Range operator that produces one reference to all the cells between two references, including the two references.
, (comma)	SUM(B5:B15, D5:D15)	Union operator that combines multiple references into one reference.
(single space)	=B5:B15 A7:D7	Intersection operator that produces one reference to cells common to two references. In this example, cell B7 is common to both ranges;

		therefore the result would be the contents of cell B7.

Absolute cell referencing

The ability to copy formula from one location to another in a spreadsheet can save you a significant amount of work. Normally, if you copy a formula involving a cell reference to another location, the cell reference is adjusted relative to its starting point. So, for example, copying a formula calculating the sum of a column of numbers to an adjacent cell, will add up the adjacent column of cells. The formula has updated automatically to refer to adjacent cells. This is an example of a **relative referencing** system.

Sometimes we may need to refer to a **specific** cell location in a worksheet, and so we want that cell reference to remain unchanged, regardless of where the formula is placed. We need a method to fix our cell reference so that it does not update when we copy the formula to another location – we need an **absolute cell reference**.

Making a reference absolute

Type a **$** sign before both the column letter and the row number of the cell reference. E.g. the relative reference A1 becomes the absolute reference $A$1.

Or use the keyboard shortcut, **F4**.

1. In the *Formula* bar, highlight the cell reference for the cell which is to be made **absolute**.
2. Press **F4**.

$ signs are automatically placed in front of the column and row references.

Making a mixed reference

If only the columns or the rows are to be absolute, prefix one or other of these with a $ sign. For example, if the column is to be *absolute* and the row *relative* A1 becomes $A1, if the row is to be *absolute* and the column *relative* A1 becomes A$1.

bonus.xls

	A	B	C	D
1	**Earnings**			
2				
3	**Bonus**	£25		
4				
5	**Name**	**Basic**	**Total**	
6	Cruise	£150		
7	Newman	£162		
8	Pitt	£148		
9	Brosnan	£176		
10	Pfeiffer	£198		
11	Nicholson	£305		
12	Clooney	£387		
13				

1. Double-click in the cell as if to edit it.
2. Highlight the cell reference to be made absolute and press **F4**. Note that by pressing **F4** a number of times you cycle through different options for creating a **mixed reference**.

A1	Relative
$A$1	Absolute
$A1	Mixed
A$1	Mixed
A$1	Mixed

Absolute references explained

bonus.xls

	A	B	C
1	**Earnings**		
2			
3	**Bonus**	25	
4			
5	**Name**	**Basic**	**Total**
6	Cruise	150	=B6+$B$3
7	Newman	162	=B7+$B$3
8	Pitt	148	=B8+$B$3
9	Brosnan	176	=B9+$B$3
10	Pfeiffer	198	=B10+$B$3
11	Nicholson	305	=B11+$B$3
12	Clooney	387	=B12+$B$3
13			

The data, to the left, show the basic earnings for a group of staff. Their manager has decided to award them a bonus payment, and wishes to store the total pay in column C.

The formula for cell C6 is **=(B6+$B$3)**. Here the $ is used to make the reference to cell B3 absolute. When this formula is copied into cells C7:C12, the formula updates as shown.

Counting and totalling cells conditionally

Occasionally you may need to create a total that only includes certain cells, or count only certain cells in a column or row. The only way you could do this is by using functions that have conditions built into them. A condition is simply a test you can ask Excel to carry out, the result of which will determine the result of the function.

SUMIF()

You can use this function to say to Excel, "only total the numbers in the *Total* column where the entry in the *Course* column is "Word Intro". The syntax of the SUMIF() function is detailed below:

=SUMIF(range, criteria, sum_range)

	A	B	C	D	E	F
1	**Barkestone Training**					
2	**Course Attendance**					
3	**Date**	**Course**	**No. of attendees**		**Total attendees**	
4	04/01/99	Word Intro	5		Word Intro	
5	05/01/99	Excel Intro	7		Word Interm	
6	06/01/99	Windows 95	6		Word Adv	
7	07/01/99	Word Interm	3		Excel Intro	
8	08/01/99	PowerPoint	4		Excel Interm	
9	11/01/99	Word Intro	6		Excel Adv	
10	12/01/99	Word Adv	2		PowerPoint	
11	13/01/99	Excel Interm	5		Windows 95	
12	14/01/99	Windows 95	5		Windows NT	

Range is the range of cells you want to test.

Criteria are the criteria in the form of a number, expression, or text that defines which cells will be added. For example, criteria can be expressed as 32, "32", ">32", "apples".

Sum_range are the actual cells to sum. The cells in sum_range are summed only if their corresponding cells in *range* match the criteria. If sum_range is omitted, the cells in *range* are summed.

Using the example above the SUMIF() function would be as follows:

=SUMIF(B4:B23,"Word Intro",C4:C23)

COUNTIF()

The COUNTIF function allows you to count those cells that meet a certain condition. The function syntax is as follows:

=COUNTIF(range, criteria)

Range is the range of cells from which you want to count cells.

Criteria are the criteria in the form of a number, expression, or text that defines which cells will be counted. For example, criteria can be expressed as 32, "32", ">32", "apples".

With our example (shown above), the COUNTIF function you could use to determine the number of Word Intro courses run would be:

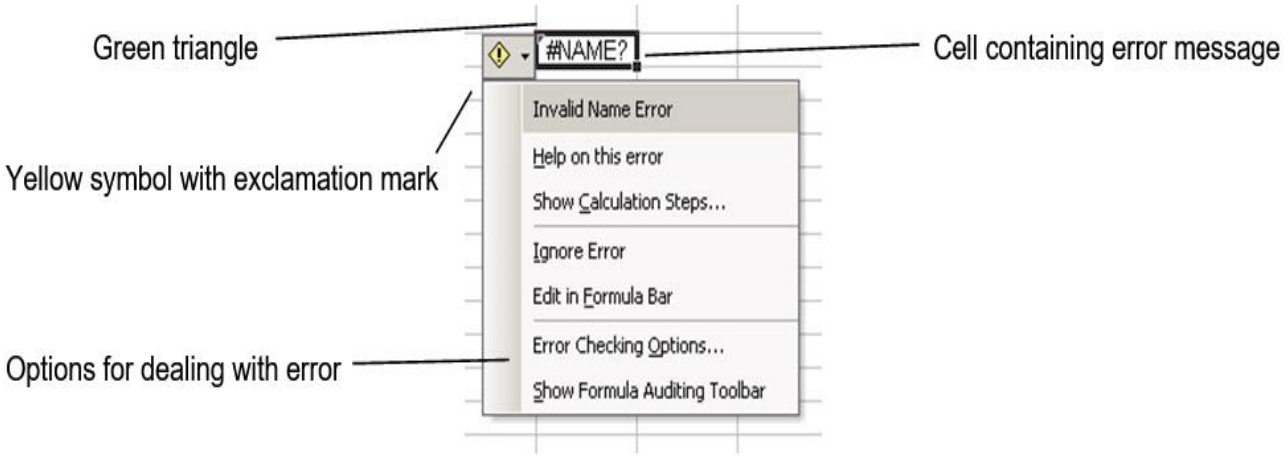
=COUNTIF(B4:B23, “Word Intro”)

OR

=COUNTIF(B4:B23, E4)

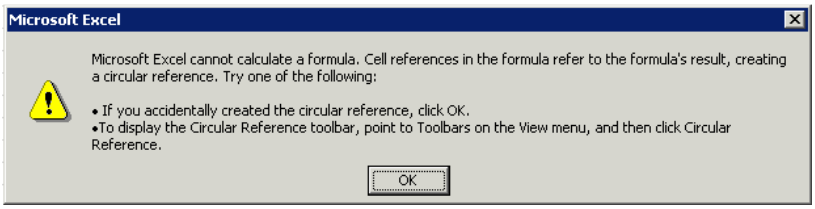
Understanding error messages

Excel may display error messages if your formula or functions contain mistakes (note that it will not detect all errors in calculations). It is always worth checking the result of your formula by hand if the formula is at all complex. Excel’s error messages contain a # symbol followed by a diagnostic word (see the table below). In some cases, the cell with an error in it has a small green arrow in the corner. In such cases, if you click in the cell a yellow symbol with an exclamation mark appears. Click the exclamation mark for options to help you to trace the source of the error.



Typical errors and their causes

######	The column is not wide enough to display data (for numbers). Date or time may be negative.
#VALUE!	Occurs when the wrong type of **argument** is used in a function or formula. For example, there is text in a formula that requires a number or logical value.
#DIV/0!	Occurs when a number is divided by zero.
#NAME?	Occurs when Excel doesn't recognise text in a formula (e.g. misspelling a function name or cell reference).
#N/A	Occurs when a value is not available to a formula or function – perhaps data are missing.
#REF!	Occurs when a cell reference is not valid – perhaps the cell has been deleted.
#NUM!	Occurs when a number is invalid – perhaps a price has been entered with the £ sign, or a formula results in a number too big or too small for Excel to display.

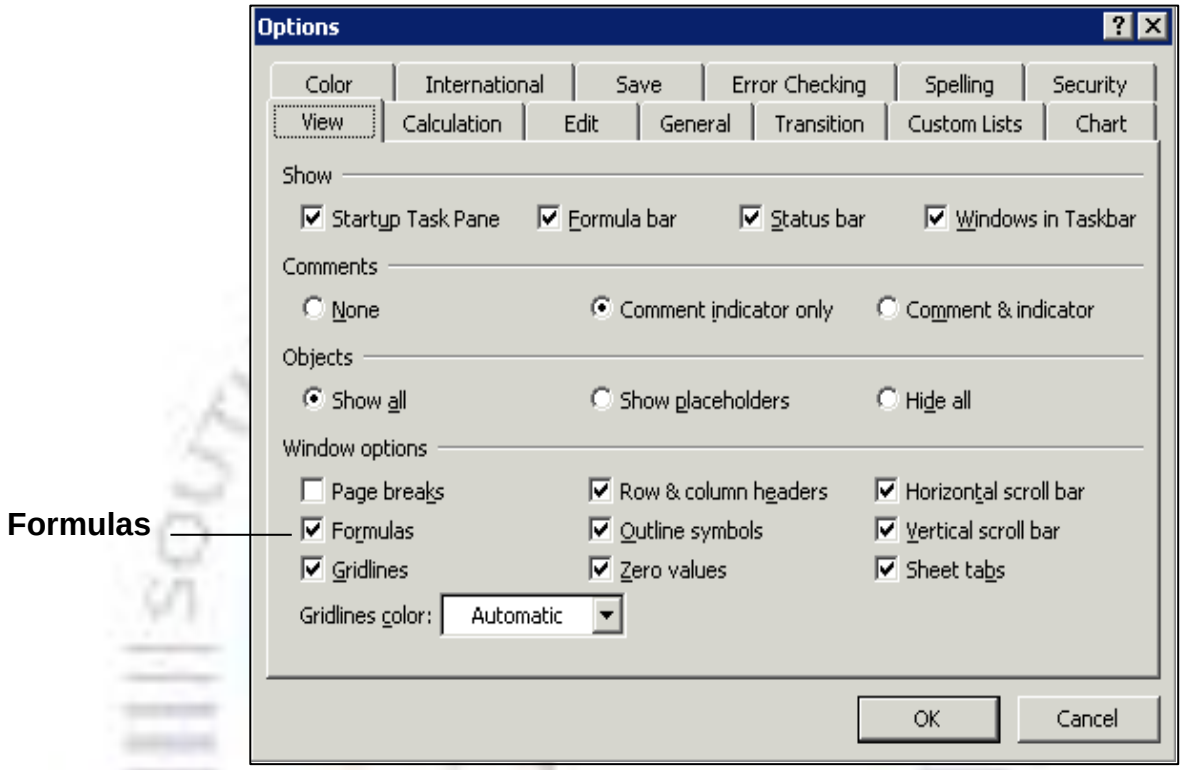
Circular reference	 This happens when the formula points to the cell in which the result is to be displayed, e.g., placing the formula =SUM(A1:A2) into cell A2.

Viewing formula

Sometimes you may want to view the actual formula in your worksheet, rather than the numerical results of the formula. This can be particularly useful if you are getting error messages and need to examine the formula. To view the formula:

1. From the **Tools** menu choose **Options to** reveal the *Options* window.

2. Select the **View** tab, and click the **Formulas** check box and **OK**.



3. All formula in the worksheet will display in full as shown below (this can be useful for trouble-shooting if your calculations do not seem to be working – you can print out the formula for closer inspection). Notice how the columns automatically widen to accommodate the formula.

4. You can turn off the formula display using the same check box in the *Options* window. Notice how the columns shrink again to their original width.

B12 f_x

	A	B
1	**Shop**	**Price**
2	Burleys	15.99
3	Jamesons	16.49
4	Smith & Co	16.25
5	The Thing Shop	15.99
6	Vesey & Son	16.45
7	**Rounded average**	**=ROUND(AVERAGE(B2:B6),2)**
8		

Helpful hint:

Press **Ctrl** and ` (the open single inverted comma key, usually found to the left of the number 1 key on the top row of your keyboard). You can toggle between formula and values by pressing **Ctrl+`** repeatedly.

STATISTICAL FUNCTIONS IN EXCEL

=Average (……)

Calculates the average for the current cell values.

=AVERAGE(A1:A3)

This gives the average for the cells A1, A2, A3.

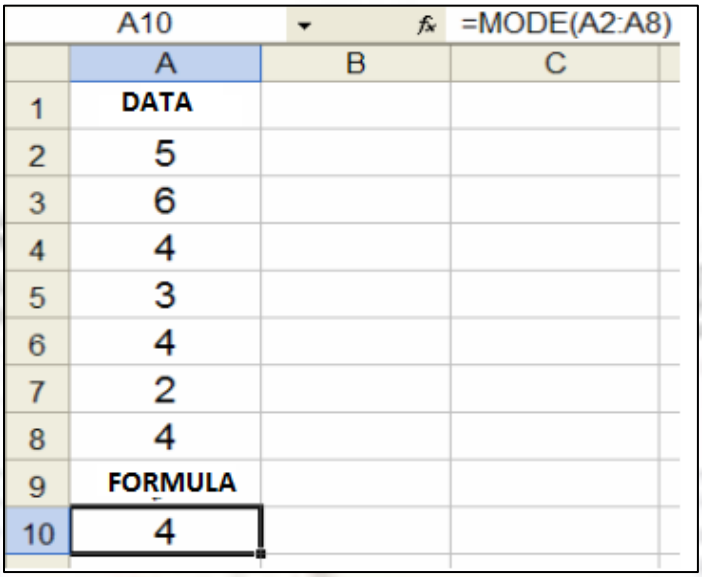
B1 f_x =AVERAGE(A1:A3)

	A	B	C	D
1	12	12		
2	14			
3	10			

=MEDIAN(…..)

Calculates the median for the current cell values.

=MEDIAN(1,2,3,4,5)



=MODE(…..)

Exercise

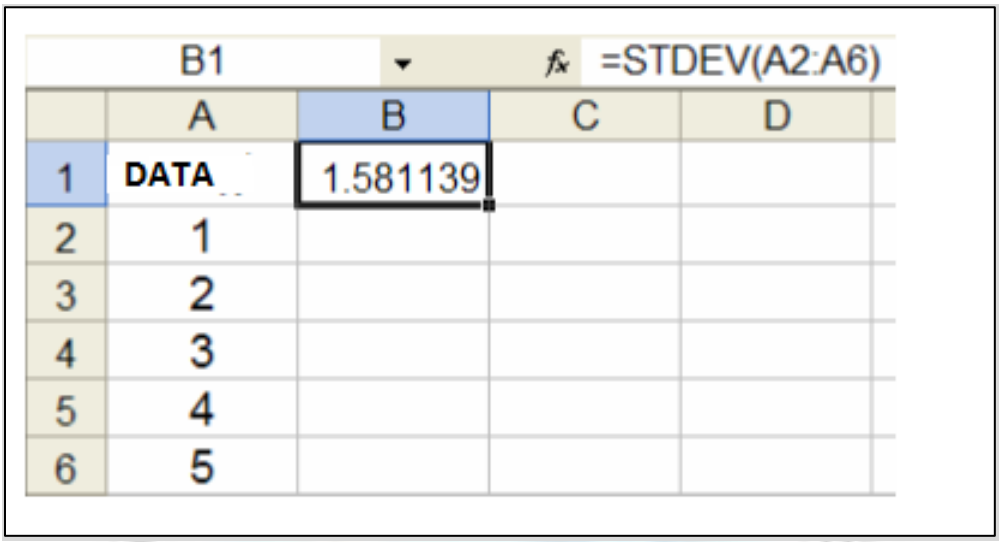
What is the output of the following Excel function ?

=MODE(5,6,4,3,4,2,4)

=STDEV(…..)

Calculates the standard deviation for the current cell values.

=STDEV(1,2,3,4,5)



=ABS(…..)

Exercise

What is the output of the following Excel function ?

=ABS(55)

=SQRT(…..)

Exercise

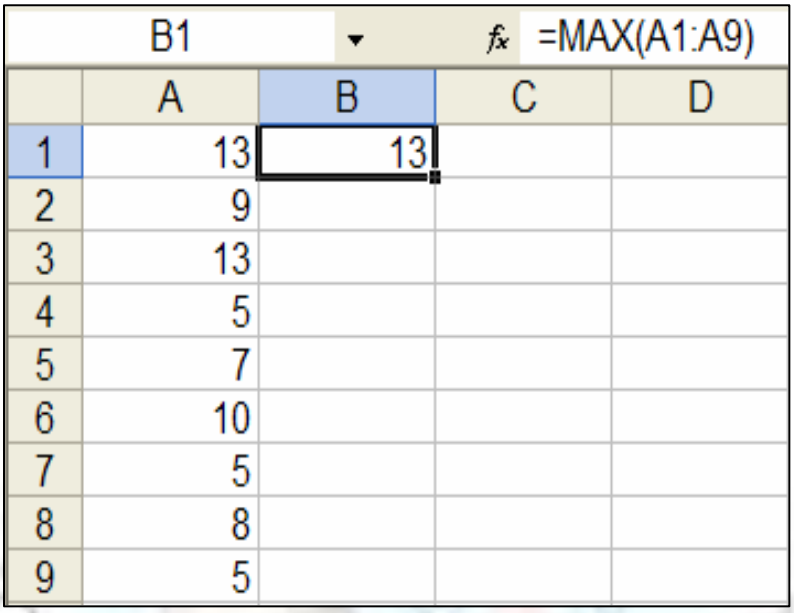
What is the output of the following Excel function ?

=SQRT(9)

=MAX(…..)

Gives the maximum value within a specific range of cells.

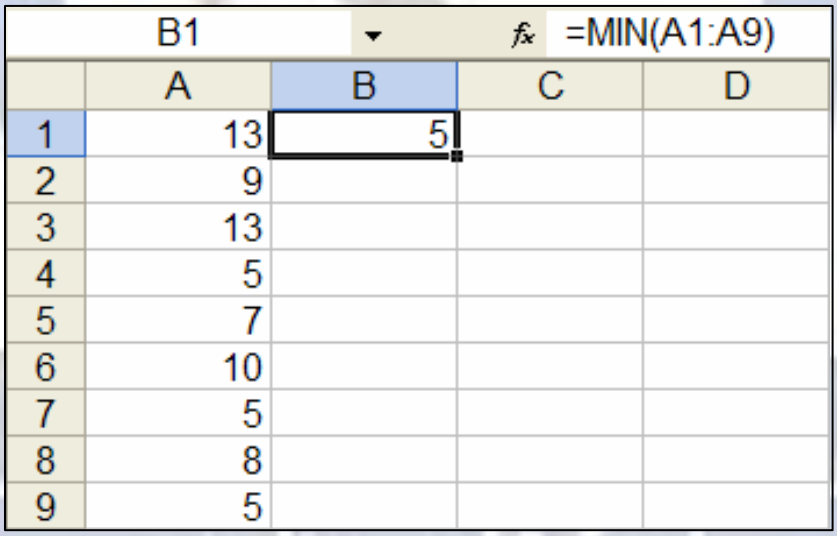
=MAX(A1:A9)



=MIN(…..)

Gives the minimum value within a specific range of cells.

=MIN(A1:A9)

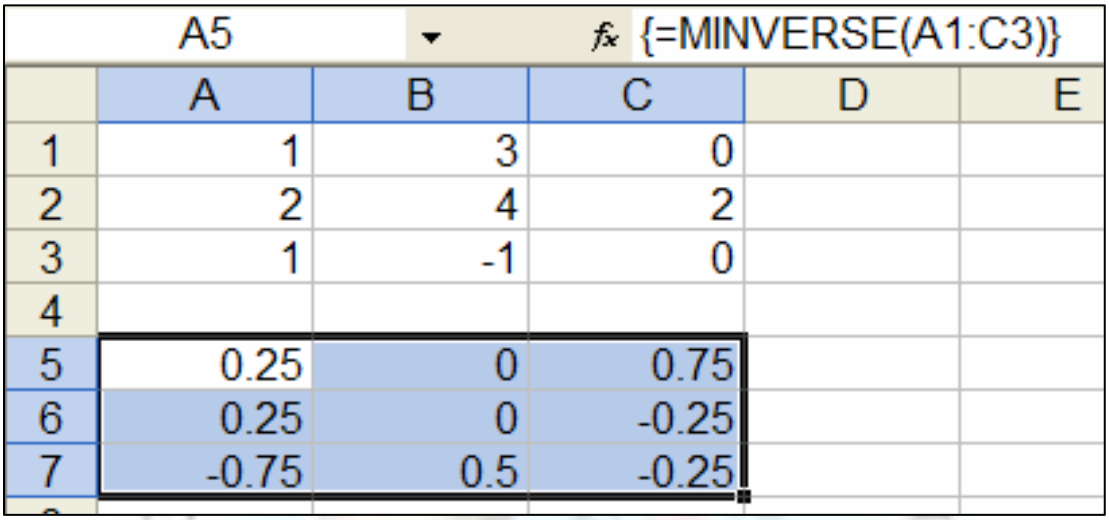


=MINVERSE(…..)

Exercise

What is the output of the following Excel function ?

= MINVERSE({1,2,1;3,4,-1;0,2,0 })

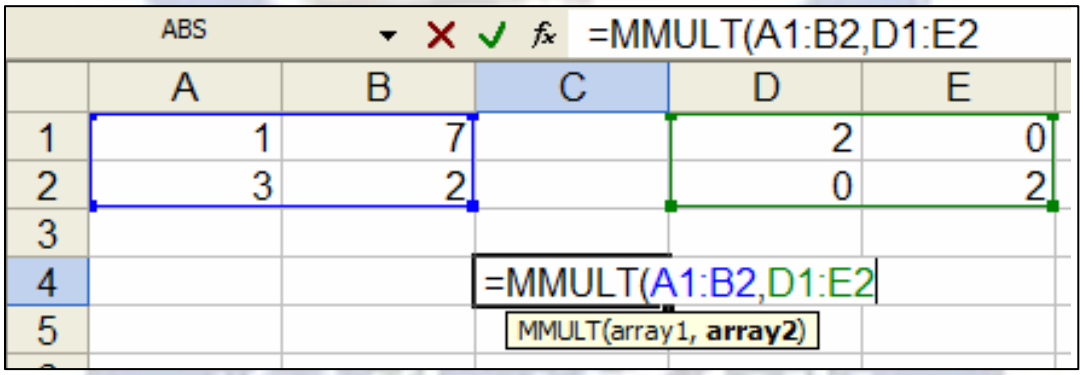


=MMULT(…..)

Exercise

What is the output of the following Excel function ?

= MMULT({1,3;7,2}, {2,0;0,2 })



=CORREL(…..)

Calculates the correlation coefficient for two different datasets.

=CORREL({3,2,4,5,6} , {9,7,12,15,17})

A8 =CORREL(A2:A6,B2:B6)

	A	B
1	**DATA**	**DATA**
2	3	9
3	2	7
4	4	12
5	5	15
6	6	17
7	**FORMULA**	
8	0.99705449	**Correlation Coefficient**

Exercises

Exercise (1):

Given the following ages of a group of students:

6, 6, 9, 8, 6, 10, 9, 9, 8, 7, 8, 6, 7, 8, 8, 11, 10

Using Excel functions, calculate the following:

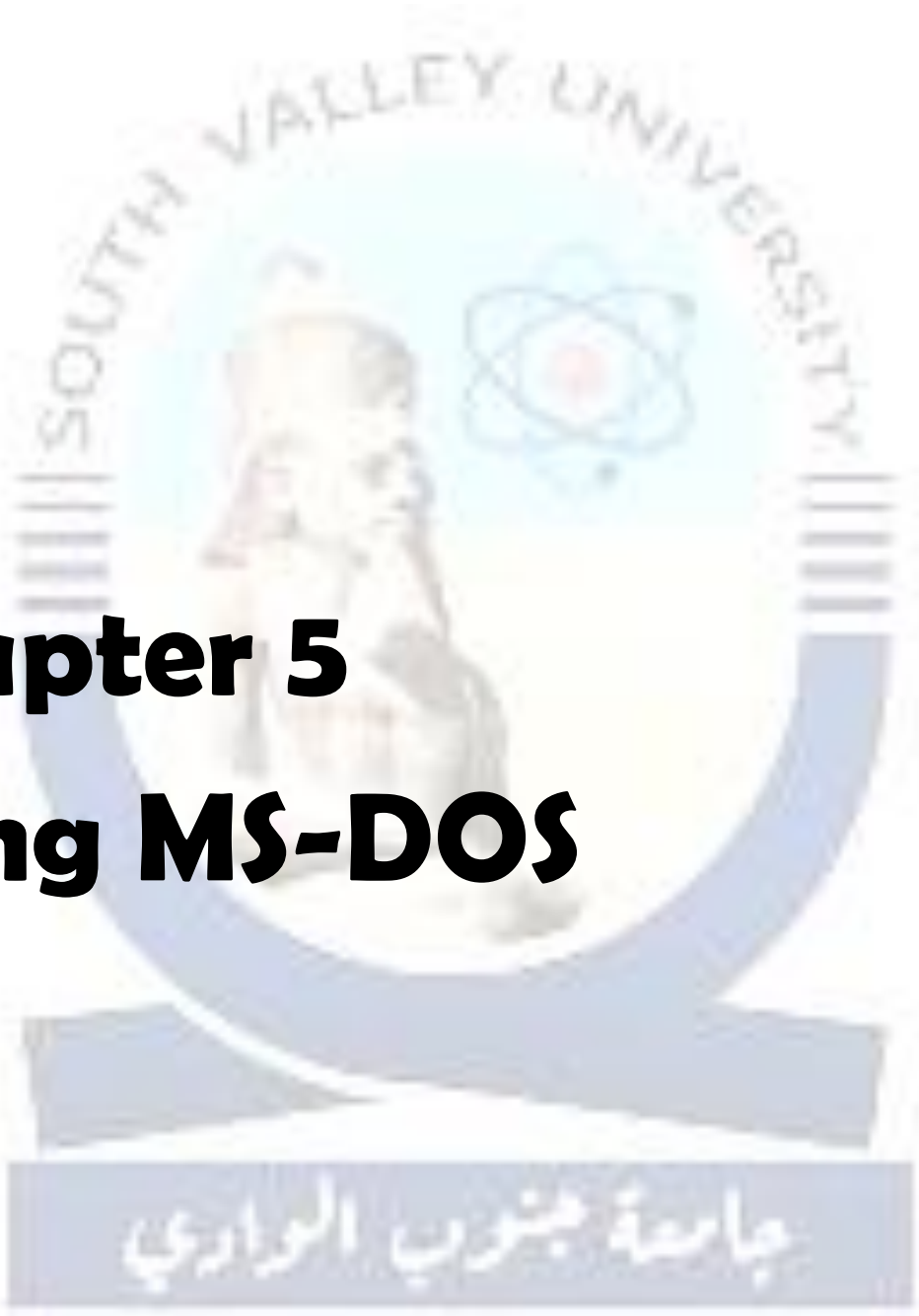
1. The average students' age.
2. The mode of students' age.
3. The standard deviation for students' age.

Exercise (2):

Write the Excel equations that find the range and standard deviation for the following data:

3, 6, 7, 2, 11, 9, 8, 14, 7

Assuming the data storage will begin from cell A1 vertically downwards .



Chapter 5
Using MS-DOS

MS-DOS is an acronym for Microsoft Disk Operating System and is commonly referred to as DOS. MS-DOS is a text-based operating system. In contrast to Windows, which has a graphical user interface, and uses the mouse and icons to send commands to the system, DOS commands are entered at the command line in text format.

MS-DOS uses a hierarchical organization of directories to store its files. The term hierarchical means that the directories and files are organized in the shape of a pyramid. Each row is linked to the objects (files and folders) directly beneath it. The hierarchical organization allows for directories to be created within directories thus making a directory tree. The root directory is the highest possible level on the directory hierarchy on a given drive. The parent-directory is the name for any directory above a subdirectory.

Files are anything that contain data. Word processing documents, spreadsheets, saved e-mail messages are all examples of files. A directory is a place where files are collected. Generally, the files in a particularly directory are contained there because they share some common theme, i.e. all word processing files are in one place, spreadsheets in another.

You can refer to any file in any directory on the system by using its pathname. A pathname is a string of characters that describes what directory the file is in, as well as the name of the file. The full path always starts from the ROOT directory. The ROOT directory is the top directory in a file system. The pathname of a file in the current working directory is just the name of the file by itself.

The DOS Environment

When you first enter the DOS environment, you will see the command prompt. This command prompt shows users where they are in the system. For example, a common command prompt you might see is:

C:\Windows\Desktop>

DOS uses the backslash to tell the user the level in the hierarchy. Each level (directory) is separated by a backslash (\). The command prompt shown above tells us we are on the C: drive of the computer (the computer's internal hard drive), in the Desktop directory, which is inside the Windows directory.

This prompt tells you the CURRENT WORKING DIRECTORY. The current working directory can be thought of as the directory you are in. The command prompt indicates that the program is waiting for the user

to enter information to direct the system what to do. Any commands you enter will be executed in the CURRENT DIRECTORY unless you tell the system otherwise. In the example above, you are in the **C:\windows\desktop directory**. If you execute the command to create a new directory, it will be created inside the "desktop" directory unless you first change directories or specify a different directory.

Important DOS commands.

TIME

This command is used to change and display the current computer time.

TIME [HH [:MM[:SS .PP]]]

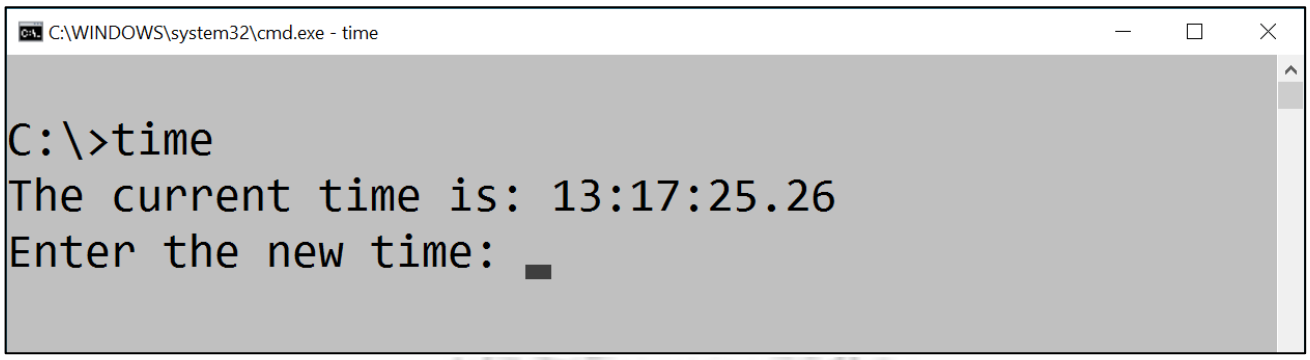
HH is hours.

MM is minutes.

SS is seconds.

PP is the seconds' fraction.

Using the command without any parameters displays the current time, as in the following example.



Example:

to change the time to 5:30 AM:

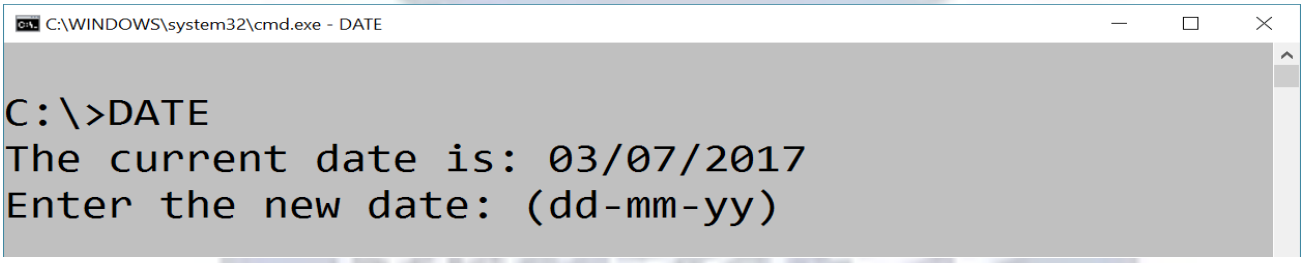
C:\ Time 5:30

DATE

This command is used to change and display the current computer date.

C:\ DATE [MM/DD/YY]

Using the command without any parameters displays the current date, as in the following example.



Example:

to change the date to 10th of January 2013.

C:\ DATE 1/10/2013

Exercise

Try to identify the function of the following DOS command ?

CLS

VER

File management commands

DIR

This command is used to display the file names list in the current folder:

DIR [file name (s)] [/p][/w]

File name(s): is the name of the file to display its synonyms.

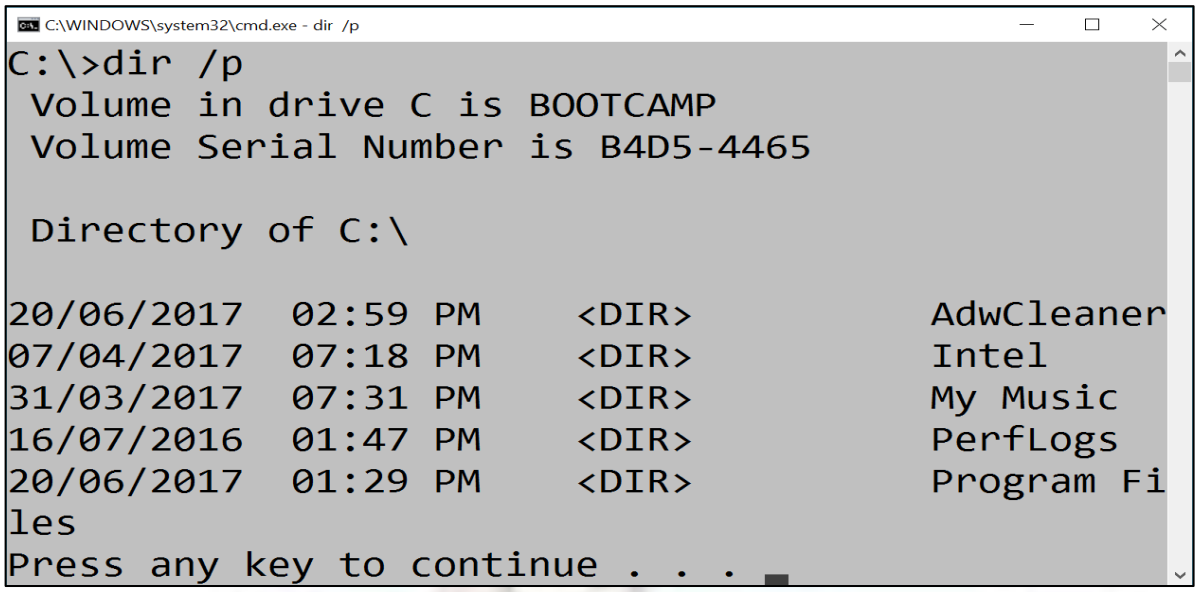
/P used to display the file names list page after page.

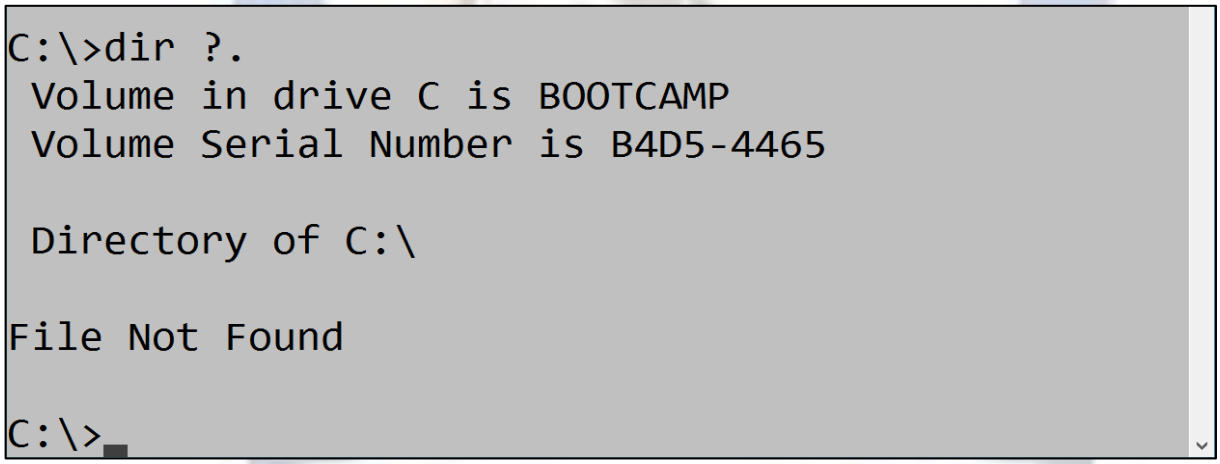
/w used to display the file names list in columns order.

Examples:

- To display all the files in the current folder **A>DIR**

- To display all the files, the has a **.EXE** extension and displaying the result page by page **A>DIR *.EXE /p**





COPY

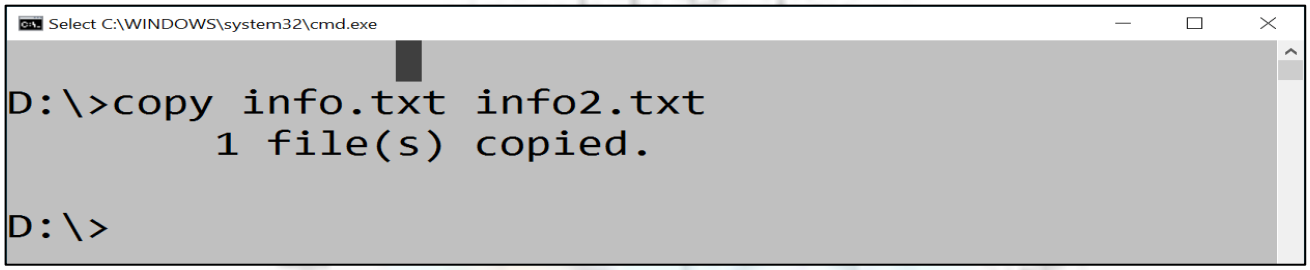
This command is used to make a copy of a specific folder.

C:\ COPY file1 file 2 [/v]

file1 the original file to be copied.

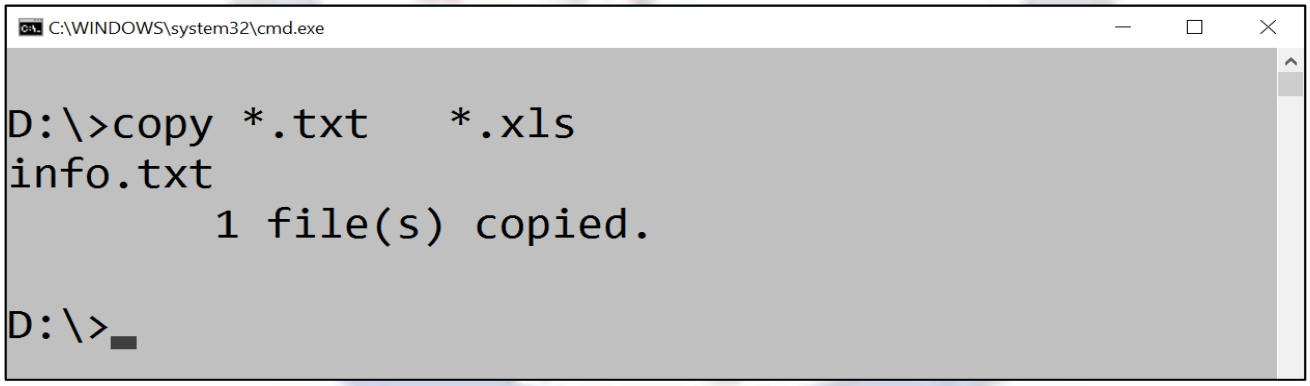
File2 the new file to be created by copy.

\V forces checking the copy process correction.



Exercise

What is the function of the following command ?



Examples:

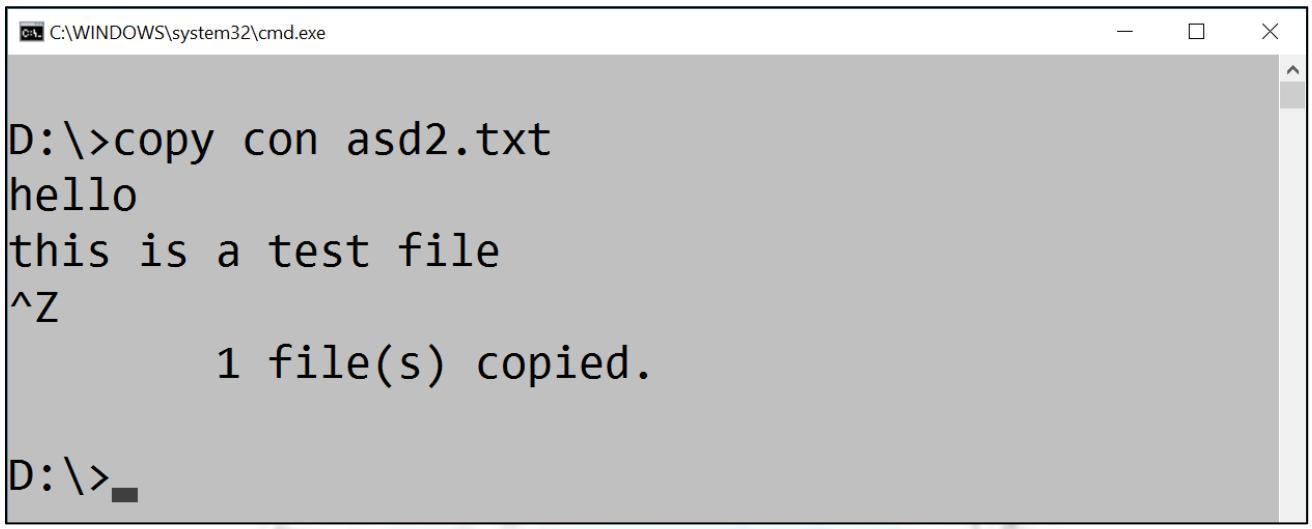
- To copy the file **asd1.txt** to the file **asd22.txt**

  A> COPY CHKDSK.COM XYZ.COM .

- To copy all the files with .PAS extension to .BAK extension

  A> COPY *.PAS *.BAK

- To create a new file, use the parameter **con** as follows:



DEL

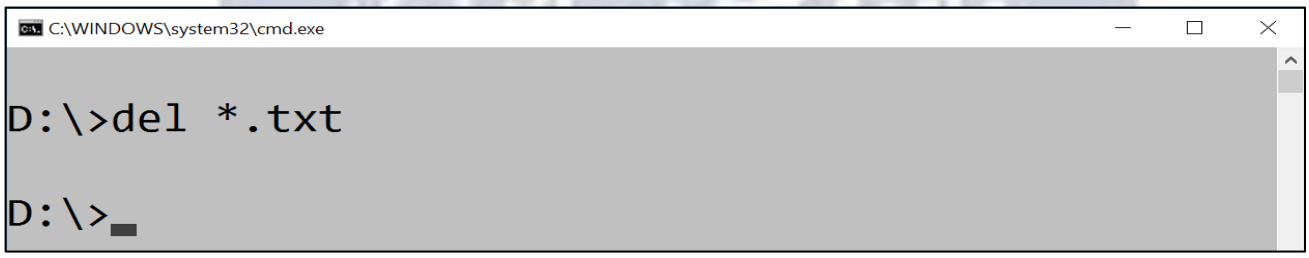
This command is used to delete a file from the hard disk.

C:\ DEL file_name

file_name is the file to be deleted.

Exercise

What is the function of the following command ?



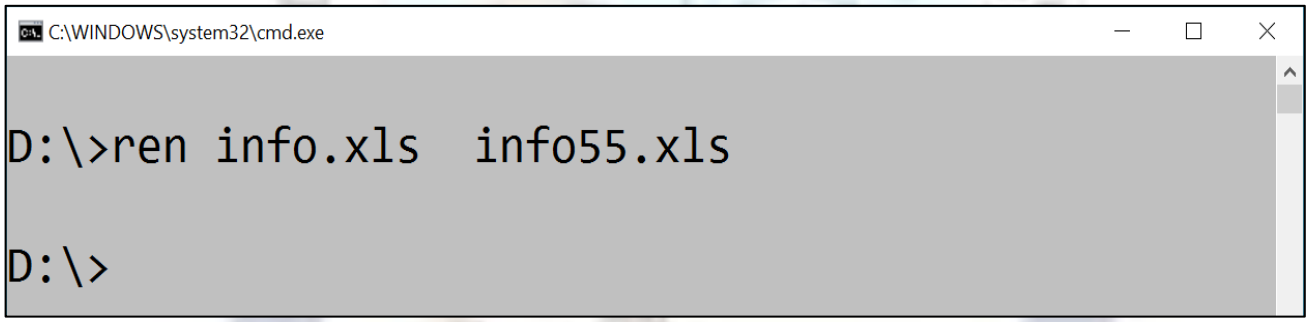
REN

This command is used to rename a specific file.

REN old_file new_file

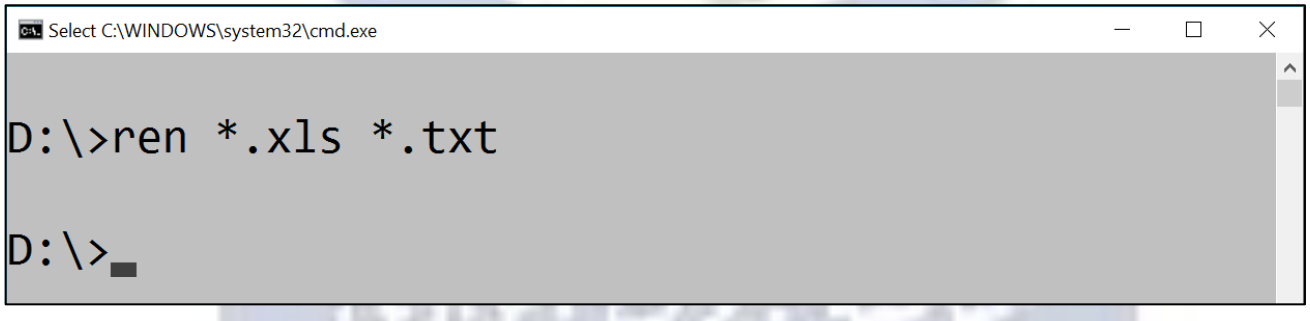
old-field is the file name to be renamed.

new filé is the new file name.



Exercise

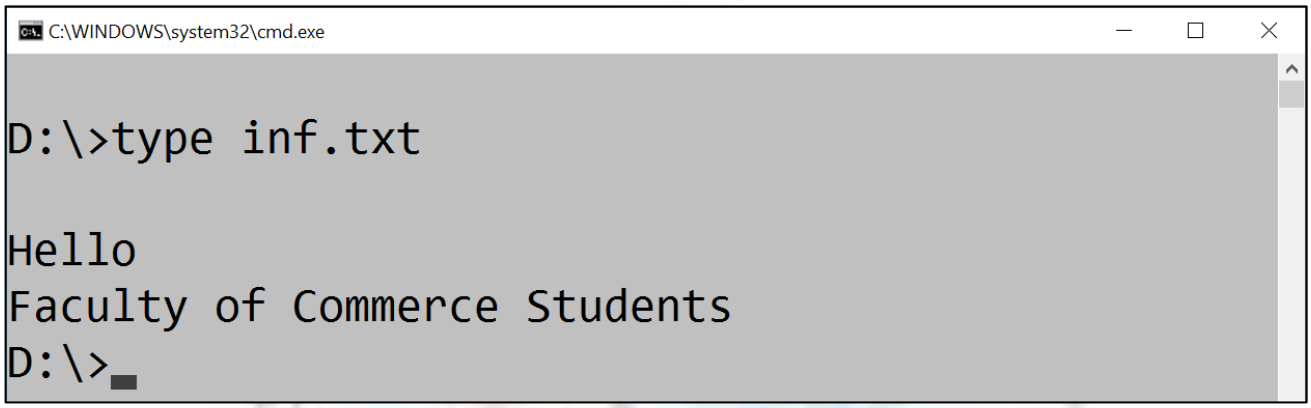
What is the function of the following command ?



TYPE

This command is used to display the contents of a specific file.

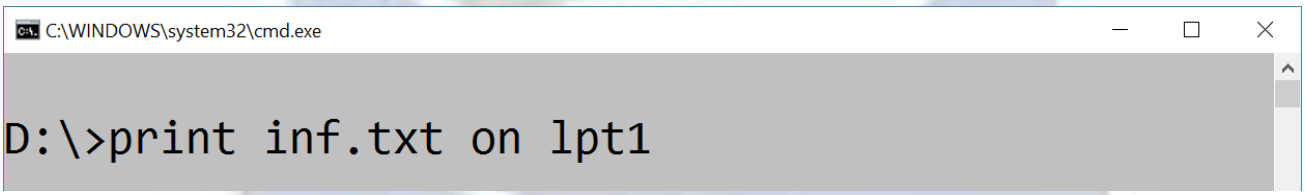
C:\ TYPE [File name]



PRINT

This command is used to print a specific file.

C:\ PRINT[file name][device name]



where **inf.txt** is the file to be printed and **LPT1** is the port where the printer is connected.

ATTRIB

This command is used to change the attributes of a specific file.

ATTRIB (+ or -) [/H] [/A] [/S] [/R]

- **[H]** gives the file a hidden attribute.
- **[A]** gives the file an archive attribute.
- **[S]** gives the file a system attribute.
- **[R]** gives the file a read only attribute.

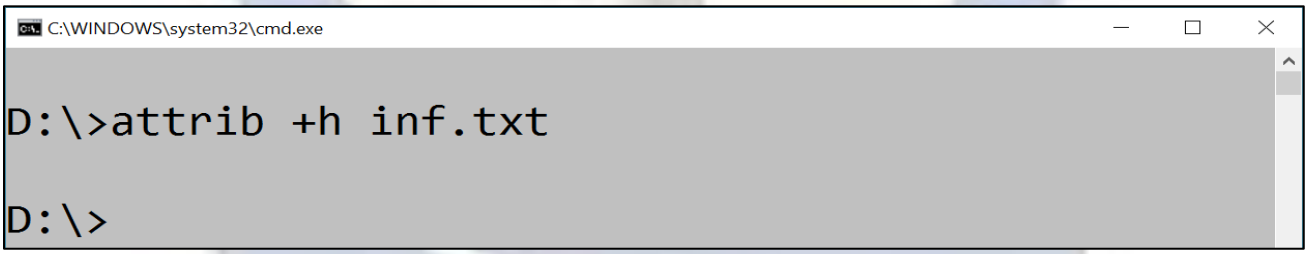
Example

- To make the file **inf.txt** hidden

  C:\ ATTRIB +H inf.txt

- To make the file **inf.txt** visible

  C:\ ATTRIB -H inf.txt



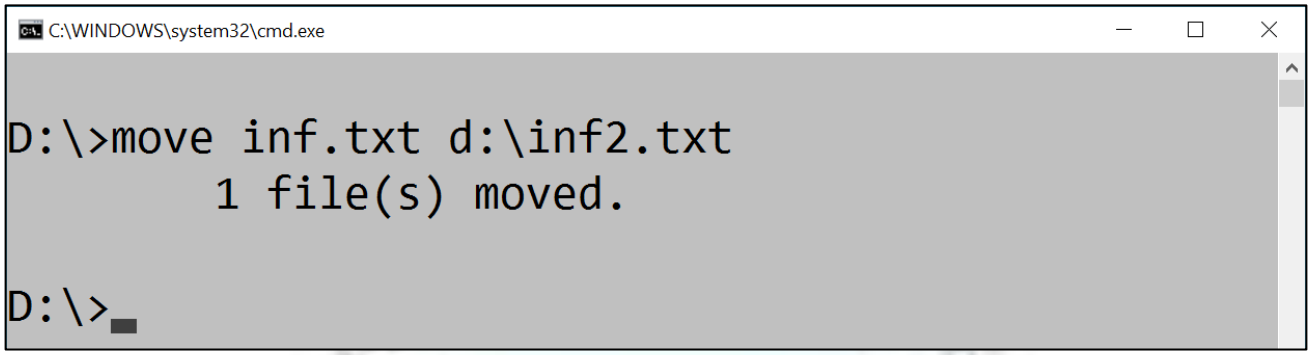
MOVE

This command is used move a specific file from a location to another.

C:\ MOVE [path1] [file_name] [path2]

- **path1** the location to move the file from.
- **file_name** name of the file to be moved.

- **path2** the location of the file to be moved to.



Exercise

What is the function of the following command ?

How it differs from the standard copy command ?

XCOPY

PATH

This command is used to change the path that the DOS uses to find the missing files.

C:\> PATH path1

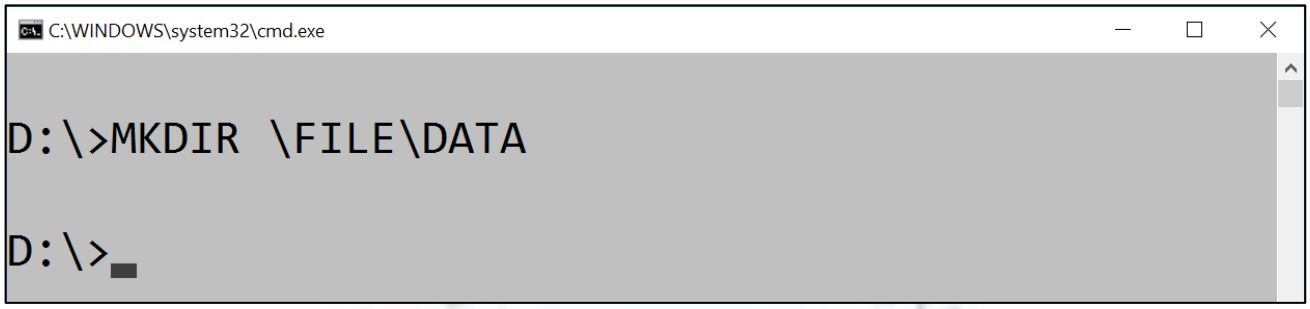
MKDIR

This command is used to create a new folder.

C:\> MKDIR [directory name]

OR

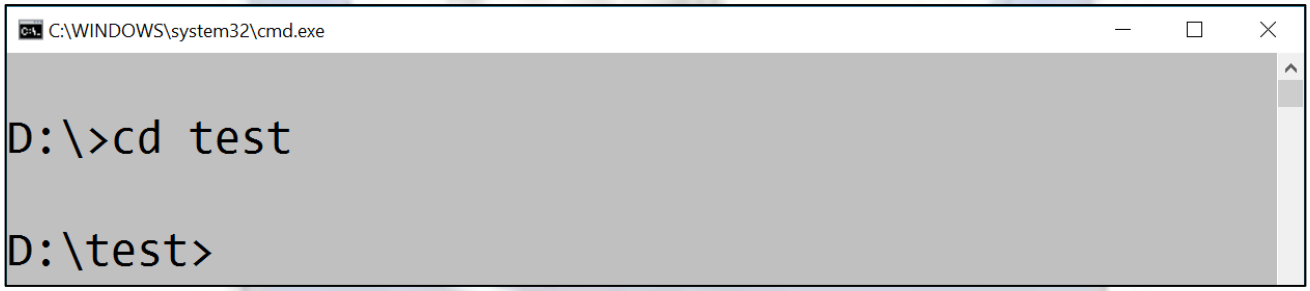
MD[directory name]



CD

This command is an acronym for **CHANGE DIRECTORY,** which means changing the current working directory

C:\> CD [directory name]



RMDIR

This command is used to delete a specific directory, as long as it's empty.

RMDIR [directory_name]

OR

RD[directory_name]

Example

to cancel the directory called HOME, you must first delete its contents, as follows:

C:\CD DATA

C:\CD HOME

C:\DEL *.*

C:\CD ..

C:\ RD HOME

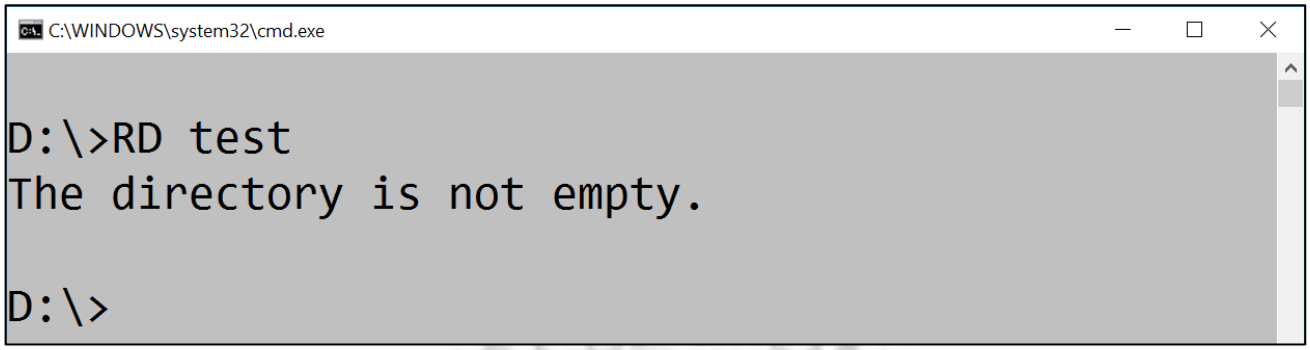
Or you can use the following way

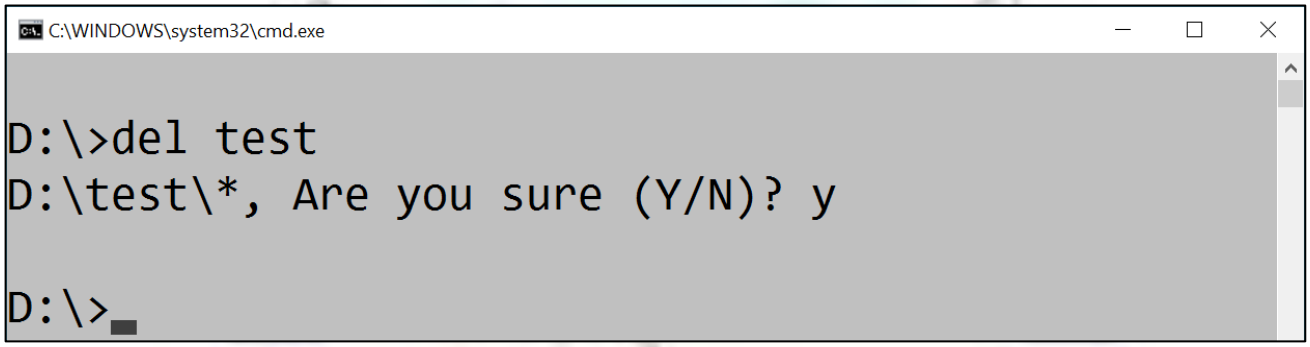
C:\DEL \DATA\HOME*.*

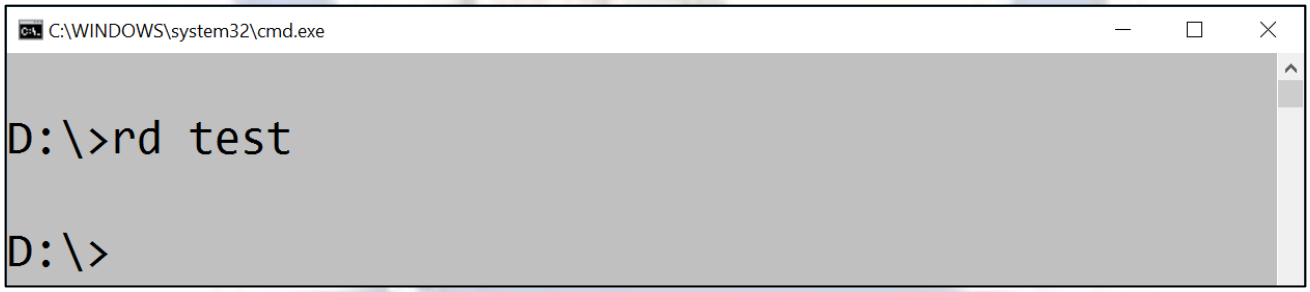
C:\RD \DATA\HOME

Exercise

Look into the following output screen and decide if you can delete a non-empty directory?







TREE

This command is used to browse the files and folders in for a given directory.

TREE [path] [directory name]

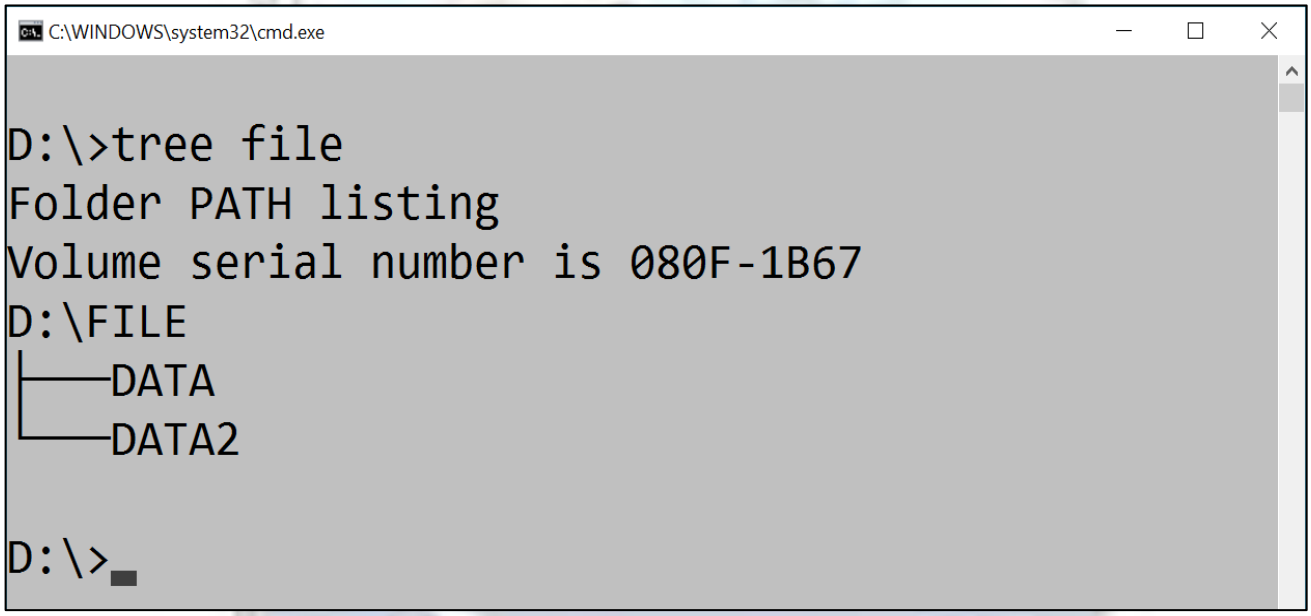
Example

To display the folders tree for the drive C: use the following command:

C:\> TREE

To display the folders tree for the folder **DATA** use the following command:

C> TREE C:\DATA



DELTREE

This command is used to delete an entire directory including all of its contents and it is not necessary to an empty directory.

DELTREE [directory name]

Example

To delete the directory **DATA**, use the following command:

C:\> DELTREE DATA

Dealing with disks in DOS

FORMAT

This command is used to prepare a new disk for its first use, so that the data could be stored correctly. The command is also used to remove the entire data stored in a specific disk.

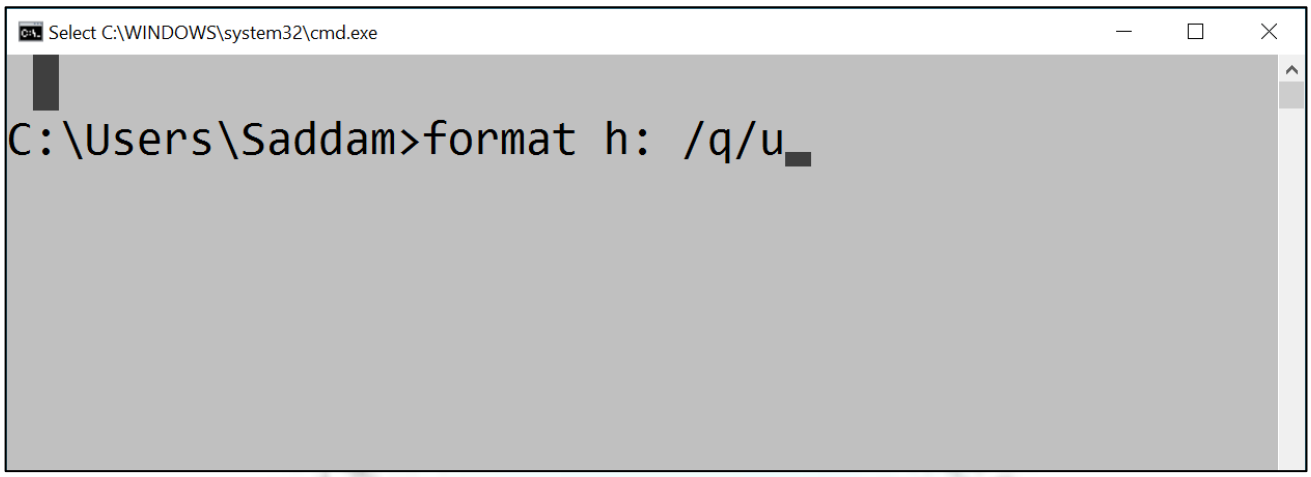
C:\> FORMAT D:[/v[:label][/q] [/f:size][/s][b][/t:TRACKS] [/n:sectors][/1][/4][/8]

D is the drive name to be formatted.

/Q QUICK this is to enable faster operation for the command by deleting the file system tree.

/U UNCONDIITONAL this is to enable a full format process that disables any attempt to restore the data.

/S SYSTEM this is to copy the system files to the disk after formatting it, to enable booting from this disk.



UNFORMAT

This command is used to undo the FORMAT command and restores the deleted data from a disk.

C:\> UNFORMAT D:

LABEL

This command is used to display and change the disk label.

C:\ > **LABEL**

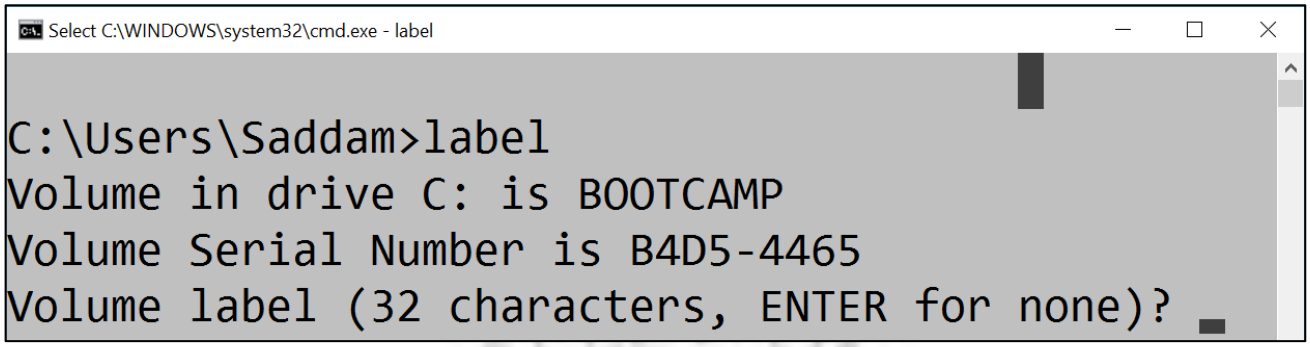
Example

To find the label of the drive C:

C:\> LABEL

To change the drive C: label:

C:\> LABEL C:YEAR_GO

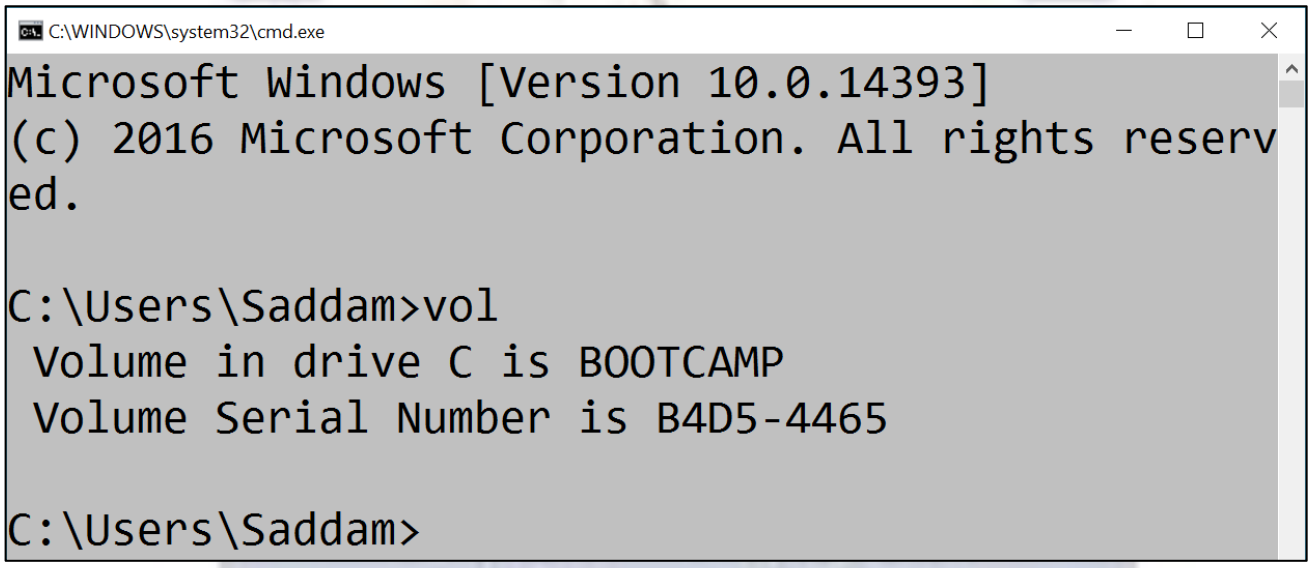


VOL

This command is used to display the disk label if there is any assigned to this disk. The command displays:

Volume in drive A Has no label

If there is no label that was previously assigned to that disk.



Exercise

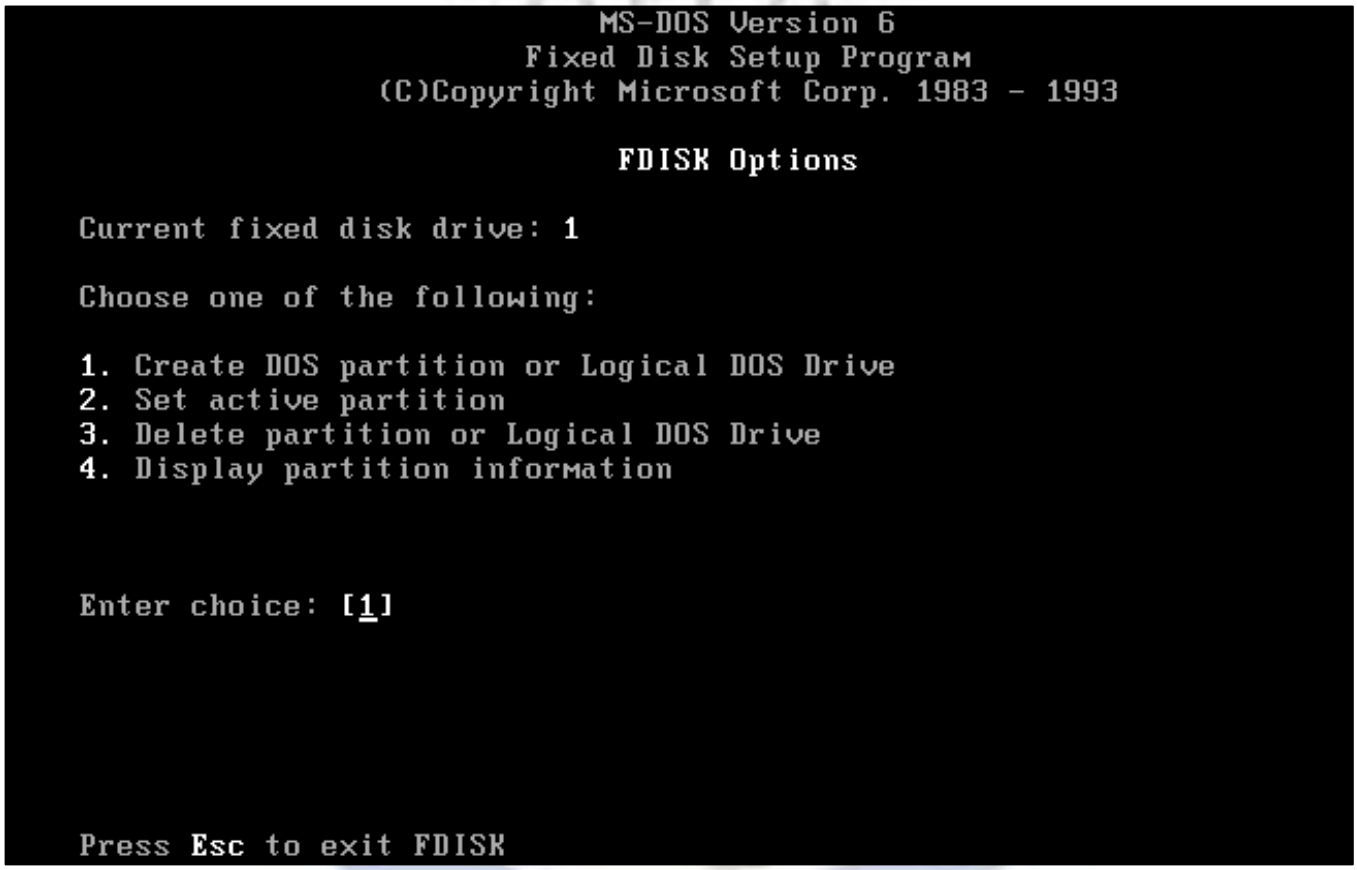
What is the function of the following commands ?

DISKCOPY

CHKDSK

FDISK

This command is used to prepare a new disk for first time usage. The command displays the following options when you invoke it, as follows:



NOTE:

do not test this command on your computer, as it will delete the entire data.

Exercises

1. What are the following commands usages:

- FORMAT
- COPY CON
- TYPE
- DEL
- VER
- VOL
- TIME
- DATE
- FORMAT
- TREE
- XCOPY

2. Write the DOS command that changes the date to 23 December 2011.

3. Write the DOS command to change the system time to 7:30:55 PM.

4. Write the DOS command to scan disk C:

5. Write the DOS command to display the directory tree for the folder root on drive C:

6. Write the DOS command to copy the file test.txt from drive C: to drive D:

Chapter 6
Introduction to Databases and its Statistical Applications.

What is Data?

In general, data is any set of characters that has been gathered and translated for some purpose, usually analysis. It can be any character, including text and numbers, pictures, sound, or video. If data is not put into context, it doesn't do anything to a human or computer.

Within a computer's storage, data is a collection of numbers represented as bytes that are in turn composed of bits (binary digits) that can have the value one or zero. Data is processed by the CPU, which uses logical operations to produce new data (output) from source data (input).

What is DataBase?

The term database has fallen into loose use lately, losing much of its original meaning. To some people, a database is any collection of data items (phone books, laundry lists, parchment scrolls whatever). Other people define the term more strictly.

In this chapter, we define a database as a self-describing collection of integrated records. And yes, that does imply computer technology, complete with languages such as SQL.

A record is a representation of some physical or conceptual object. Say, for example, that you want to keep track of a business’s customers.

You assign a record for each customer. Each record has multiple attributes, such as name, address, and telephone number. Individual names, addresses, and so on are the data.

A database consists of both data and metadata. Metadata is the data that describes the data's structure within a database. If you know how your data is arranged, then you can retrieve it. Because the database contains a description of its own structure, it's self-describing. The database is integrated because it includes not only data items but also the relationships among data items.

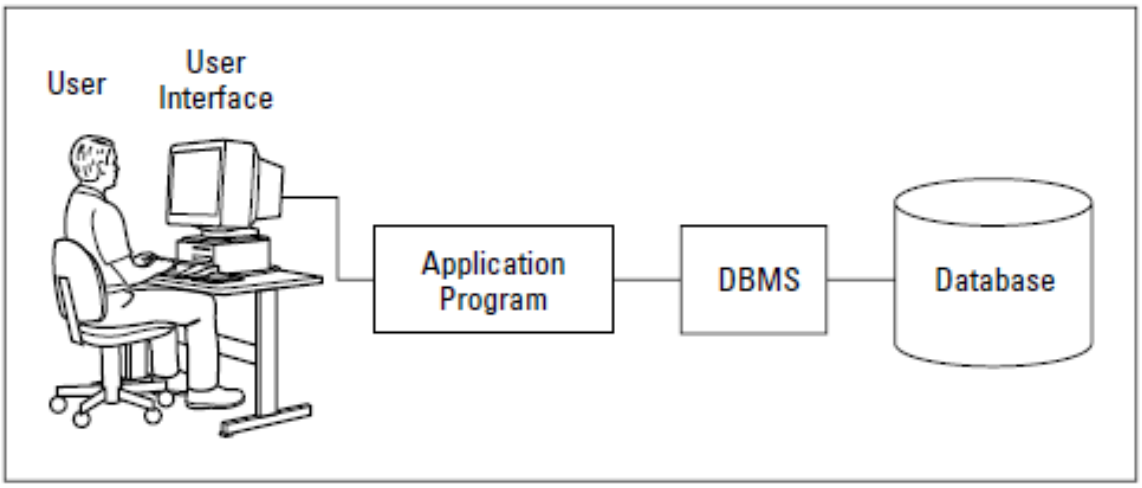
The database stores metadata in an area called the data dictionary, which describes the tables, columns, indexes, constraints, and other items that make up the database. Because a flat file system (described later in this chapter) has no metadata, applications written to work with flat files must contain the equivalent of the metadata as part of the application program.

What Is a Database Management System?

A database management system (DBMS) is a set of programs used to define, administer, and process databases and their associated applications. The database being "managed" is, in essence, a structure that you build to hold valuable data. A DBMS is the tool you use to

build that structure and operate on the data contained within the database.

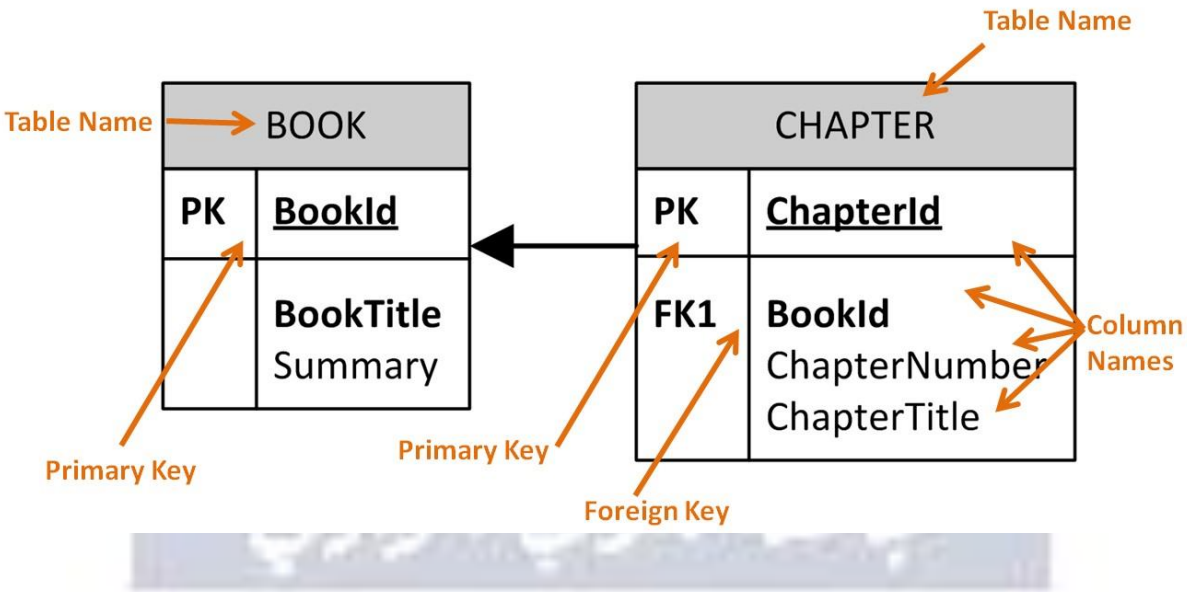
Many DBMS programs are on the market today. Some run only on mainframe computers, some only on minicomputers, and some only on personal computers. A strong trend, however, is for such products to work on multiple platforms or on networks that contain all three classes of machines. A DBMS that runs on platforms of multiple classes, large and small, is called scalable. Whatever the size of the computer that hosts the database and regardless of whether the machine is connected to a network the flow of information between database and user is the same. The below figure shows that the user communicates with the database through the DBMS. The DBMS masks the physical details of the database storage so that the application need only concern itself with the logical characteristics of the data, not how the data is stored.



Database Models

[1] Relational model

Nowadays, new installations of database management systems are almost exclusively of the relational type. Organizations that already have a major investment in hierarchical or network technology may add to the existing model, but groups that have no need to maintain compatibility with "legacy systems" nearly always choose the relational model for their databases. The below figure shows an example of a relational database.



[1] Hierarchical model

Hierarchical databases are aptly named because they have a simple hierarchical structure that allows fast data access. They suffer from

redundancy problems and a structural inflexibility that makes database modification difficult.

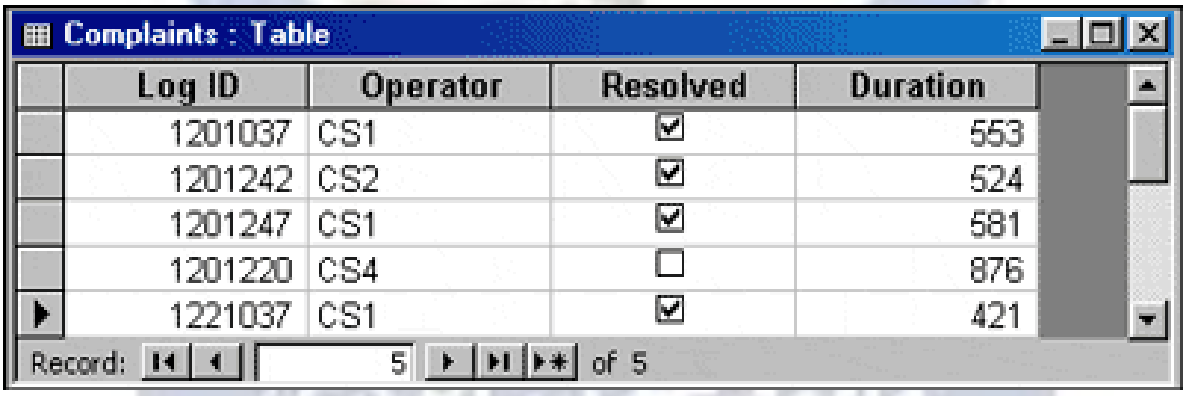
[1] Network model

Network databases have minimal redundancy but pay for that advantage with structural complexity.

Database components:

Tables

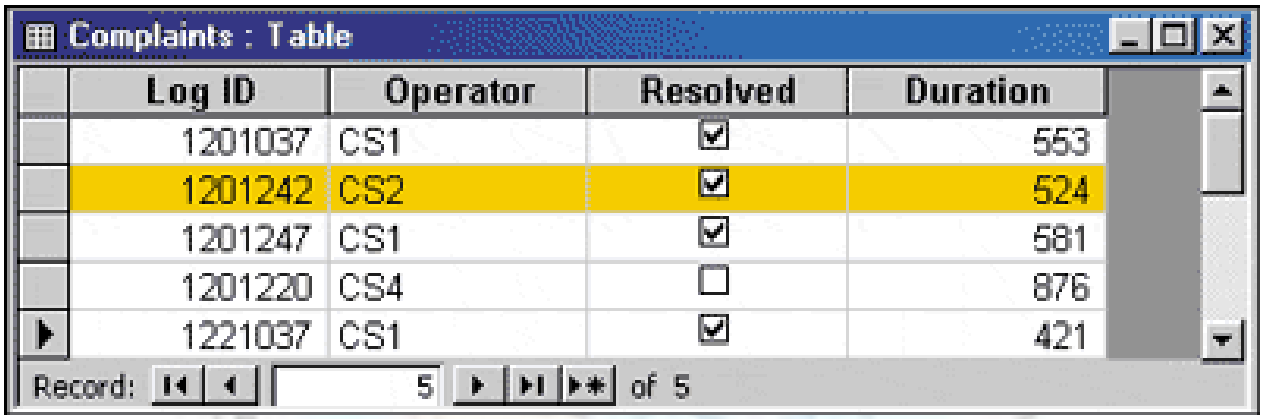
Tables are the key components of relational databases. A relational database consists of one or more tables used to store information. A table consists of rows. Every row is divided into fields (columns) that have a certain datatype.



Records

Data is stored in records. A record is composed of fields and contains all the data about one particular person, company, or item in a database.

In this database, a record contains the data for one customer support incident report. Records appear as rows in the database table.



Field

A field is part of a record and contains a single piece of data for the subject of the record. In the database table illustrated in the next figure, each record contains four fields:

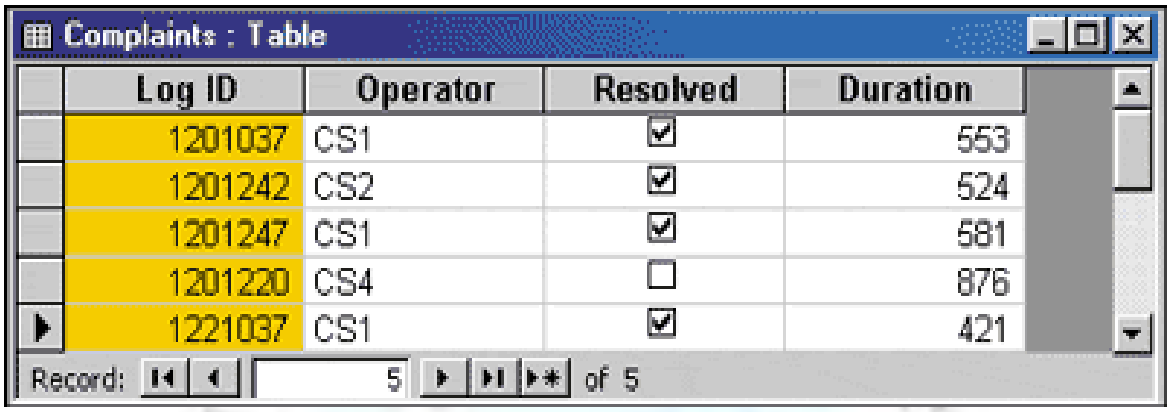
Log ID A number assigned to this customer support incident for identification purposes

Operator The code for the customer support operator who handled this incident

Resolved A check box to indicate whether the incident was resolved

Duration The time in seconds the operator spent on this incident

Fields appear as columns in a database table



Primary Keys

Every table should have a primary key. In this case, the name would be a useful primary key if the names are unique. Primary keys have to be fields that contain unique values—a primary key is the identifier of a record (row).

Importance of a database management system:

Exercise

What is the importance of having a database management system ?

Without database management, tasks have to be done manually and take more time. Data can be categorized and structured to suit the needs of the company or organization. Data is entered into the system and accessed on a routine basis by assigned users. Each user may have an assigned password to gain access to their part of the system. Multiple users can use the system at the same time in different ways.

For example, a company's human resources department uses the database to manage employee records, distribute legal information to employees and create updated hiring reports. A manufacturer might use this type of system to keep track of production, inventory and distribution. In both scenarios, the database management system operates to create a smoother and more organized working environment.

Database administrator role:

A database administrator (DBA) directs or performs all activities related to maintaining a successful database environment. Responsibilities include designing, implementing, and maintaining the database system; establishing policies and procedures pertaining to the management, security, maintenance, and use of the database management system; and training employees in database management and use. A database administrator's responsibilities can include the following tasks:

- Installing and upgrading the database server and application tools
- Allocating system storage and planning future storage requirements for the database system.

- Modifying the database structure, as necessary, from information given by application developers.
- Enrolling users and maintaining system security.
- Ensuring compliance with database vendor license agreement.
- Controlling and monitoring user access to the database.
- Monitoring and optimizing the performance of the database.
- Planning for backup and recovery of database information.
- Maintaining archived data.
- Backing up and restoring databases.
- Contacting database vendor for technical support.
- Generating various reports by querying from database as per need.
- Managing and monitoring data replication.

Benefits of a database:

Exercise

What are the benefits of having a database ?

Is the database required by al of the system designs ?

How to design a database?

1. Determining the purpose of the database.

   The purpose of the database helps to identify the required information about the tables and their inner fields. Such information could be known by talking to the users or by using questionnaires.

2. Determining the required tables list.
3. Determining the required fields.
4. Determine the primary key.

   A **primary key**, is a **key** in a relational database that is unique for each record. It is a unique identifier, such as a driver license number, telephone number (including area code), or vehicle identification number (VIN). A relational database must always have one and only one **primary key**.

Practical Example

Storing student's degrees:

Suppose that we want to create a database to store the faculty of commerce students' degrees to facilitate the process of issuing the term results. Suppose that there are 6 subjects as follows:

- Introduction to computer science.

- Principles of accounting.
- Advanced accounting.
- Money and banking.
- Human rights.
- Business management.

Hence, the initial design for this database will be as follows, and the primary key will be the **SEAT_NUMBER**:

STUDENT
NAME. SEAT_NUMBER **(PK)** Computer_science_degree. Principles_of_accounting_degree. Advanced_accounting_degree. Money_banking_degree. Human_rights_degree. Business_management_degree.

Exercise

Citizens' data storage:

Suppose that we want to store the citizens' data, so that the process of issuing their national IDs would be easier. The initial database design in this case would be as follows and the primary key would be the **ID.**

CITIZEN
Name. **ID (PK)** **Address.** **Martial_state** **Job.** **Date_of_birth.** **Qualifications.**

SQL (Structured Query language)

SQL stands for Structured Query Language. SQL is used to communicate with a database. According to ANSI (American National Standards Institute), it is the standard language for relational database management systems. SQL statements are used to perform tasks such as update data on a database, or retrieve data from a database. Some common relational database management systems that use SQL are: Oracle, Sybase, Microsoft SQL Server, Access, Ingres, etc. Although most database systems use SQL, most of them also have their own additional proprietary extensions that are usually only used on their system. However, the standard SQL commands such as "Select", "Insert", "Update", "Delete", "Create", and "Drop" can be used to accomplish almost everything that one needs to do with a database.

This tutorial will provide you with the instruction on the basics of each of these commands as well as allow you to put them to practice using the SQL Interpreter.

What SQL can do?

- Executing commands related to the database.
- Retrieves data from the database.
- Inserting rows in database tables.
- Updating rows in database tables.
- Deleting rows from database tables.
- Creating a new database.
- Creating new tables in a database.
- Storing data in database tables.
- Adjusting tables' access privileges.

The SQL language consists of three sections, (1) DDL, (2) DML and (3) DCL, as illustrated in the following figure

DDL	DML	DCL
CREATE TABLE	INSERT INTO	ALTER DATABASE
DROP TABLE	SELECT INTO	CREATE GROUP
ALTER TABLE	UPDATE	DROP GROUP
CREATE INDEX	DELETE	CREATE USER
	SELECT	ALTER USER
	UNION	DROP USER
	TRANSFORM	ADD USER
	PARAMETER	GRANT PRIVILEGE
		REVOKE PRIVILEGE

:

- **DDL : Data Definition language**
- **DCL : Data Control language**
- **DML : Data Manipulation language**

Exercise

What are the differences between the previous types of SQL languages?

In general, the SQL works by directing the command to the DBMS engine and waiting for the result that will be displayed to the user.

Data SELECTION process.

The selection process aims to select some rows of the data table that meets a specific criterion, where those rows are only displayed to the user instead of all the table rows.

The general format for a SQL selection statement is as follows:

SELECT **field names**
FROM **table name**
WHERE **selection condition**

To facilitate all of the SQL examples, assume we have the following dataset that contains the **Users** table:

userName	password	userAge
Ahmed	Ret456	**20**
Ali	gabtre	**30**
Sayed	Angel55	**45**
Zedan	Zetafox	**22**
Sarah	Pop344	**45**
May	Sasa567	**33**
Tony	1234567	**34**
Mark	Laka2345	**54**
Angela	Sos2546	**19**
Amr Sayed	Spop1984	**22**
Amr Hussein	Bird234	**23**
Talya	Rescu456	**23**

Example:

Consider the previous Users table, write the SQL statement that retrieves all of the fields username and password from all of the records.

```
Select userName, password from Users ;
```

And the result will be as follows:

userName	password
Ahmed	**Ret456**
Ali	**gabtre**
Sayed	**Angel55**
Zedan	**Zetafox**
Sarah	**Pop344**
May	**Sasa567**
Tony	**1234567**
Mark	**Laka2345**
Angela	**Sos2546**
Amr Sayed	**Spop1984**
Amr Hussein	**Bird234**
Talya	**Rescu456**

To retrieve all of the table records, use the following statement:

```
Select * from Users ;
```

And the result will be as follows:

userName	password	userAge
Ahmed	Ret456	**20**
Ali	gabtre	**30**
Sayed	Angel55	**45**
Zedan	Zetafox	**22**
Sarah	Pop344	**45**
May	Sasa567	**33**
Tony	1234567	**34**
Mark	Laka2345	**54**
Angela	Sos2546	**19**
Amr Sayed	Spop1984	**22**
Amr Hussein	Bird234	**23**
Talya	Rescu456	**23**

To retrieve all of the **userName** filed records while removing the redundancy in the records:

```
Select Distinct userName from Users;
```

To retrieve a group of records sorted in ascending order according to one of the fields:

```
Select userName, Password from users order by userName ASC;
```

And the result will be as follows:

userName	password	userAge
Ahmed	Ret456	**20**
Ali	gabtre	**30**
Amr Hussein	Bird234	**23**
Amr Sayed	Spop1984	**22**
Angela	Sos2546	**19**
Mark	Laka2345	**54**
May	Sasa567	**33**
Sarah	Pop344	**45**
Sayed	Angel55	**45**
Talya	Rescu456	**23**
Tony	1234567	**34**
Zedan	Zetafox	**22**

To use an alternative name (**Names**) for the field **userName**, we use the following expression:

```
Select userName As Names from users;
```

Exercise

What is the output of the previous SQL command ?

Names
Ahmed
Ali
Sayed
Zedan
Sarah
May
Tony
Mark
Angela
AmrSayed
Amr Hussein
Talya

The **WHERE** keyword

The keyword **WHERE** is used with the **SELECT** statement to retrieve a specific record that meets some specific criteria:

- The condition can be a logical statement.
- The condition can include a comparison, e.g. <, >, <>, >= and <=.

- You can use multiple conditions separated by logical operations, e.g. **OR**, **AND** and **NOT.**
- The keyword **like** is used in the condition part to retrieve similar results and it's mostly used in conjunction with the **%.**

Example

To retrieve all the records that contains the string **'am'** partially or totally in the **userName** field; we use the following **SELECT** statement:

```
Select * from users where userName like '%am%';
```

And the result will be as follows:

userName	password	userAge
Amr Sayed	Spop1984	**22**
Amr Hussein	Bird234	**23**

To retrieve all the records that contains a **userAge** between 15 and 25, we write the following select statement:

```
Select * from users where userAge between 15 and 25 ;
```

And the result will be as follows:

userName	password	userAge
Ahmed	Ret456	**20**
Zedan	Zetafox	**22**
Angela	Sos2546	**19**
Amr Sayed	Spop1984	**22**
Amr Hussein	Bird234	**23**
Talya	Rescu456	**23**

To retrieve all the records that contains the string **'am'** partially or totally in the **userName** field and contains a **userAge** between 15 and 25, we write the following select statement:

```
Select * from users where userName like '%am%'
And userAge between 15 and 25 ;
```

And the result will be as follows:

userName	password	userAge
Amr Sayed	Spop1984	**22**
Amr Hussein	Bird234	**23**

Data DELETION process.

The delete statement erases a record or a group of records and takes the following form:

Delete from [table_name] **where [**condition]

Example:

To delete the record from the users table that has the user name **'Ahmed'** we write the following SQL state:

Delete from Users **where** username='Ahmed' **;**

And the result will be as following:

userName	password	userAge
Ali	gabtre	**30**
Sayed	Angel55	**45**
Zedan	Zetafox	**22**
Sarah	Pop344	**45**
May	Sasa567	**33**
Tony	1234567	**34**
Mark	Laka2345	**54**
Angela	Sos2546	**19**
Amr Sayed	Spop1984	**22**
Amr Hussein	Bird234	**23**
Talya	Rescu456	**23**

Data INSERTION process.

The **INSERT** command is used to insert a record into a specific table and takes the following format:

```
insert into table_name values ( value1,value2,value3,…);
```

Example:

To insert the following record into the users table, the SQL statement written as follows:

```
insert into users values ('adel','adelPassword',33);
```

And the result will be as follows:

userName	password	userAge
Ahmed	Ret456	**20**
Ali	gabtre	**30**
Sayed	Angel55	**45**
Zedan	Zetafox	**22**
Sarah	Pop344	**45**
May	Sasa567	**33**
Tony	1234567	**34**
Mark	Laka2345	**54**
Angela	Sos2546	**19**
Amr Sayed	Spop1984	**22**

Amr Hussein	Bird234	**23**
Talya	Rescu456	**23**
Adel	adelPassword	**33**

Data UPDATING process.

The **UPDATE** command is used to update a specific record and takes the following format:

```
Update table_name  Set
Field1= new_field_value1 ,
Field2= new_field_value
Where condition;
```

Example:

To update the password for the user ‘Adel’to be Adel85, we use the following SQL command:

```
Update users set password=Adel85' where userName=’Adel’;
```

And the result will be as follows:

userName	password	userAge
Ahmed	Ret456	**20**
Ali	gabtre	**30**
Sayed	Angel55	**45**
Zedan	Zetafox	**22**
Sarah	Pop344	**45**
May	Sasa567	**33**
Tony	1234567	**34**
Mark	Laka2345	**54**
Angela	Sos2546	**19**
Amr Sayed	Spop1984	**22**
Amr Hussein	Bird234	**23**
Talya	Rescu456	**23**
Adel	Adel85	**33**

Mathematical Function in SQL language

The SQL language provides a rich set of mathematical functions that are very important to the normal user and DBAs. The following table provides some of those functions:

Function	Usage
AVG(expression)	**Computes the average for a specific field values.**
COUNT(expression)	**Counts the items in a specific data field.**

MIN(expression)	**Computes the minimum for a specific field values.**
MAX(expression)	**Computes the maximum for a specific field values.**
SUM(expression)	**Computes the sum for a specific field values.**
Floor()	**Rounds a specific field value to the nearest smallest integer.**
Ceiling()	**Rounds a specific field value to the nearest higher integer.**
Round()	**Rounds a specific field value to the nearest integer/decimal value.**
Abs()	**Returns the absolute value for a specific field value.**
Sin,Cos,Tan,…	**Compute the different trigonometric functions.**
Sqrt()	**Computes the square root for a specific value.**

The next part will provide an example-based discussion for those functions in brief to illustrate their usages.

The function AVG

select avg([ALL | DISTINCT] column_name) **from** table_name**;**

- The option **ALL** is used to compute the average for all the values including the redundant values and it's the default option for the SQL command.
- The option **DISTINCT** is used to compute the average for all the values excluding the redundant values.

Example:

Suppose that we have the following **grades** table for some students at college level:

studentName	studentClass	studentGrade
Ahmed Omran	CS1	45
Ahmed Omran	CS2	60
Ahmed Omran	CS3	90
Zedan	CS1	80
Sarah	CS1	80
May	CS1	55
Tony	CS1	55
Mark	CS1	89
Angela	CS1	65
AmrSayed	CS1	49
Amr Hussein	CS1	76
Talya	CS1	38
Adel	CS1	59
Adel	CS2	63

to retrieve the average for all of the students' grades, we write the following SQL command:

```
select avg(studentGrade) from grades ;
```

and the result will be as follows:

64.5

To compute the average of grades for the student named ‘Adel’, excluding any redundant values, we write the following expression:

```
select avg(distinct studentGrade) form grades where studentName = 'adel';
```

and the result will be as follows:

61

The function COUNT

```
select count ([* | ALL | DISTINCT] column_name) from table_name;
```

- The option **ALL** is used to count all of the data items in specific field excluding the **NULL** values and it’s the default option for the SQL command.
- The option **DISTINCT** is used to count the data items in a specific field excluding the **NULL** and the redundant values.

- the option * is used to count the data items in a specific field including any data with a **NULL** value.

Example:

Consider the previous **grades** table, if you want to obtain the total number of students in all of the courses, use the following SQL command:

```
select count (*) from grades ;
```

Exercise

What is the output of the previous SQL command ?

The functions MIN and MAX

```
select min (column_name) from table_name ;

select max (column_name) from table_name ;
```

Example:

Consider the previous **grades** table, if you want to obtain the minimum and maximum students' grades in all of the courses, use the following SQL command:

select min (studentGrade**) from** grades **;**

select max (studentGrade**) from** grades **;**

and the result will be as follows:

MIN = 38

MAX = 90

The functions SUM

select sum ([ALL | Distinct]column_name**) from** table_name **;**

Example

Consider the previous grades table to find the sum of all of the student's degrees, we use the following SQL command:

select sum (studentGrade**) from** grades**;**

and the result will be as follows:

904

The function **SUM** is only used with fields that contains numeric values and cannot be used with fields that contain other data types.

The functions FLOOR and CEIL and ROUND

Select floor(studentGrades**) from** grades**;**

```
Select ceil (studentGrades) from grades;
Select round (studentGrades,1) from grades;
```

Consider the following student grades for the above functions 66.5, 66.2 and 66.7.

The function floor gives→ 66

The function ceil gives→ 67

The function round for the value 66.51 gives→ 66.5

Exercises

1. What are the types of databases?

2. What are the steps to design a database?

3. What is a primary key? Why it's important?

4. Design a database for pharmacy to help in storing the medicines?

5. Write the SQL commands that creates the table **JOBS** which contains the fields **ID**, **Name**, **JobName** and **Hours**?

- Write the SQL command that inserts the following fields in this table:

ID	Name	Job	Hours
1	Mohamed	Developper	56
2	Hamid	Web Master	45
3	Younes	Conceptor	78
4	Khalid	Designer	84

- Write the SQL command that retrieves all the existing data in that table.
- Write the SQL statement that retrieves the full record for the employee called **Hamid.**
- Write the SQL statement that retrieves the data for the employee with **ID** = 4.

- Write the SQL statement that retrieves the total number of hours for all of the employees.
- Write the SQL statement that retrieves the maximum and minimum number of worked hours for all of the employees.
- Write the SQL statement that retrieves the employee name with the maximum number of worked hours.
- Write the SQL statement that retrieves the employee name with the minimum number of worked hours.
- Write the SQL statement that retrieves the total number of employees in the table.
- Write the SQL command that retrieves the average number of worked hours for all of the employees.

Chapter 7
Artificial Intelligence in Business.

Traditional Programming involves establishing a series of rules or logic to achieve a specific result. To execute the function A + B = Y, a programmer must establish the parameters for adding the two numbers A and B as 'inputs' to yield a 'output' designated as Y. According to these regulations, the computer will execute an addition of the two integers and deliver the resultant output.

This is a manual process; thus, every alteration to the desired output necessitates the revision of the rules. If multiplication is desired, the programmer must modify the code accordingly. Things to know about traditional programming:

1. It requires explicit rules to be manually written by the programmer.
2. It’s a deterministic approach to programming like a recipe with step-by-step instructions for preparing a dish.
3. It’s for clearly defined problems with a limited number of outcomes.
4. With traditional programming, it becomes nearly impossible to write rules for every single scenario when tasks are complex or need human-like perception such as image recognition. These scenarios are firmly in the AI wheelhouse.

What really is Artificial Intelligence (AI)?

AI is a sophisticated field focused on replicating human intelligence in robots using various methodologies designed to execute tasks including visual perception, speech recognition, decision-making, and language translation—abilities inherent to humans. Instead of writing rules or logic as we read above in traditional programming, AI requires three components to run effectively

Data, Algorithms, and Computing power

1. **Data**: AI requires three kinds of data to run efficiently — (i) T**raining data** that helps the AI model learn, (ii) **Validation data** that tune the model, and (iii) **Test data** to assess the model's performance.

2. **Algorithms:** These are the sets of rules to process data and make decisions. (i) **Machine Learning** algorithms make decisions without explicit programming as they learn from patterns and (ii) **Reinforcement Learning** algorithms perform functions and receive punishment and awards based on their correctness. More on this in the future.

3. **Compute**: Computing is done using **Graphics Processing Units (GPUs)** which streamline processes taking in the data and running algorithms.

Advantages & disadvantages of Traditional Programming and AI

It's important to look at three aspects when comparing these two programming methods:

1. Stability and Scalability:

Traditional programming is consistent, doing operations identically on each occasion. Nonetheless, the stability of rule-based programs compromises scalability, as conventional programs can solely acquire knowledge through explicit programming. The larger the operational scale, the greater the volume of code required.

Conversely, AI systems provide greater scalability compared to traditional programming, albeit with reduced stability. The automation and continuous learning capabilities of AI systems enable developers

to efficiently and rapidly scale processes. Nonetheless, the inherent tendency of AI programs to improvise may not consistently yield suitable and appropriate responses.

2. Control and Transparency:

In contrast, AI systems offer enhanced scalability relative to conventional programming, while they exhibit diminished stability. The automation and ongoing learning capabilities of AI systems allow developers to effectively and swiftly scale processes. However, the intrinsic propensity of AI algorithms to innovate may not reliably produce relevant and appropriate replies.

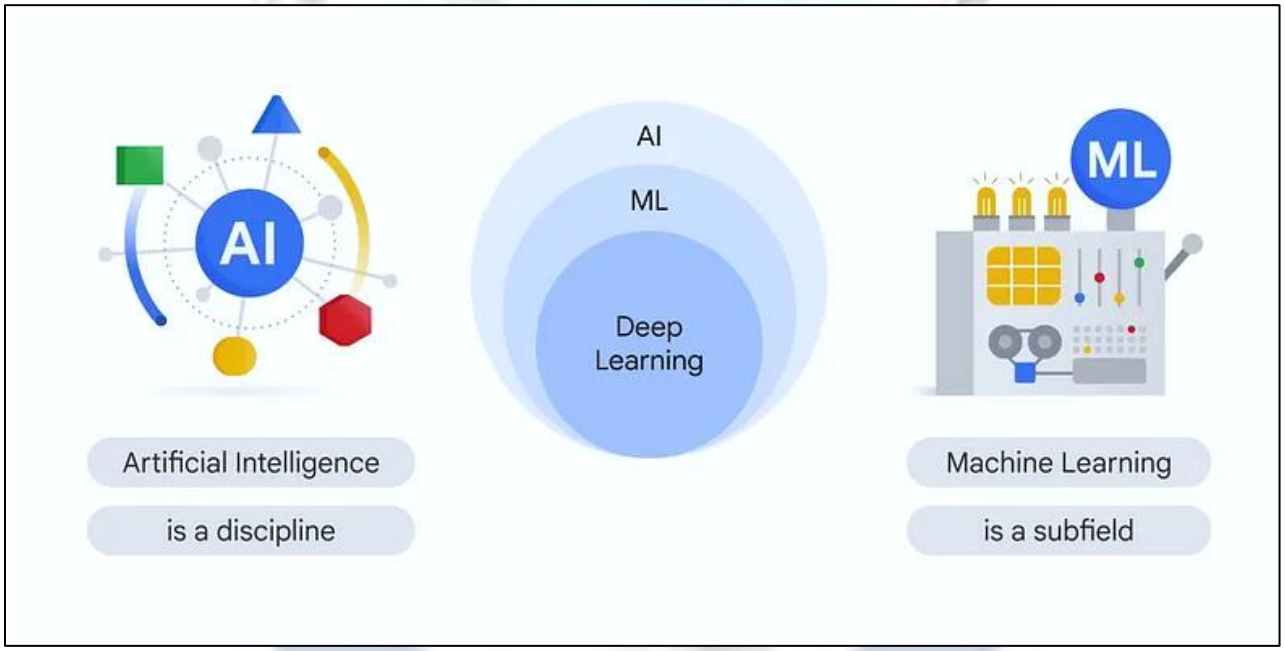
AI systems make it more difficult to identify the root of the problem. Deep neural networks and other complex artificial intelligence systems operate like "black boxes," with developers only able to access the input and output without understanding how the model was created. In sectors like healthcare and banking where processes and decision-making are important, this lack of transparency can be problematic.

3. Learning and Data management:

Traditional programs are rigid since their operation depends on structured data. It is up to the programmer to manually enter new data or alter current procedures in order to provide a program new instructions. Without special programming for particular circumstances, conventional programs could likewise fall short when dealing with unforeseen circumstances.

Conversely, artificial intelligence (AI) systems are more adept at handling unstructured data, such as photos, videos, and natural language text, because they are trained on enormous volumes of data. AI systems have the capacity to continuously learn from fresh information and experiences, which enables them to perform better over time.

1. What is Artificial Intelligence (AI) :



Artificial intelligence (AI) is a sophisticated field that aims to **replicate human intellect** through a variety of approaches to do activities that are intrinsic to humans, such as speech recognition, visual perception, decision-making, and language translation.

AI comprises subfields of specialized technologies over the years — Machine Learning, Deep Learning, Generative AI, and Large Language Models (LLMs) — that function together or independently based on the task at hand.

2. Machine Learning (ML)

ML is a branch of AI that focuses on creating algorithms that can **analyze data, find patterns, and forecast or decide based on those patterns**. It uses multiple approaches to learn such as supervised learning, unsupervised learning, and reinforcement learning (definitions below). In the healthcare industry, for instance, ML is used to forecast patient readmission. Additional instances include Netflix recommendations for shows based on what you've watched or are viewing right now, as well as product recommendations from e-commerce websites.

Supervised learning is a subcategory of machine learning. It is defined by its use of labeled datasets to train algorithms to classify data or predict outcomes accurately. Supervised learning helps organizations solve a variety of real-world problems at scale, such as classifying spam in a separate folder from your inbox.

B	C	D	E
Subject line	**Body text**	**incoming email address**	**Spam? (Yes/No)**
You've finally won a lottery!	Enter your payment info here to win $22 MILLION	samanthayoungbmah217@gmail.com	Yes
Amazon will suspend your account if you...	Pay immediately to avoid suspending your acocunt	amazonsuspension@btrix0998.it	Yes
New season styles are here	Discover more on our new arrivals	Barbour@barbour-info.com	No
Order confirmation 69767027	Showcasing the debited amount within the next 24	jacksoneeshepherds@gmail.com	Yes

Example 1: Labeled data, like this table for categorizing spam emails, gives information context and significance. After the data is first labeled by a human, machine learning (ML) finds trends and forecasts whether or not the subsequent email should be classified as spam. This is the background operation of the current email spam filters.

C	D	E	F	G	H	I
	Cost	Impressions	Taps/Clicks	TTR	CPC	Tap to install
Apple search	$6,500.00	22,569	2,031	9%	$3.20	25.0%
UAC - Google - Pros	$30,000.00	195,313	2,344	1.20%	$12.80	18.0%
UAC - Google - Rtg	$7,000.00	30,382	547	1.80%	$12.80	20.0%
Bing Search	$5,500.00	49,107	1,571	3.20%	$3.50	22.0%
Organic	$0.00		15,000			1.0%
Affiliate partnerships - CPI Model	$11,000.00	n/a				1.0%
Email Marketing	$0.00	51,000	40%	10.00%		10.0%
	$60,000.00					

Example 2: Labeled data is systematically arranged with column headings indicating the data relevant to things. The model can readily assimilate this type of data.

What is unsupervised learning? Unsupervised machine learning, also known as unsupervised learning, uses algorithms to assess and group unlabeled datasets. These algorithms can find hidden patterns or data clusters on their own. It is the best solution for exploratory data analysis, cross-selling strategies, customer segmentation, and picture recognition due to its ability to find similarities and contrasts in information.

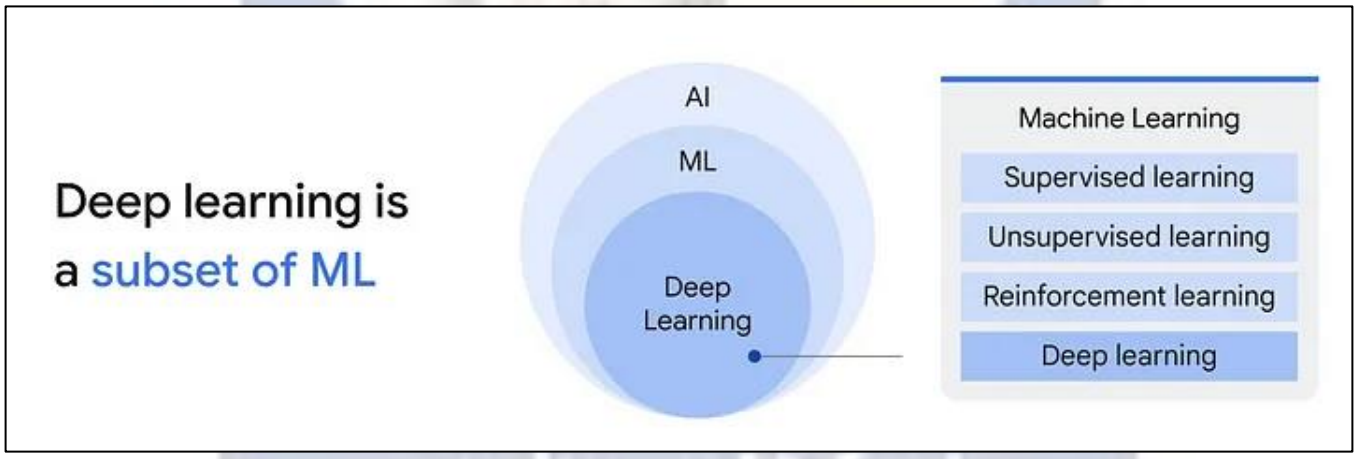
C	D	E	F	G	H	I
508	$6,500.00	22,569	2,031	9%	$3.20	25.0%
35%		Email Marketing	Tap to install	1.20%	$12.80	18.0%
1.20%	UAC Google	campaigns	7,834	1.80%	$12.80	20.0%
1.80%	$5,500.00	71	1,571	Apple searcl	$3.50	UAC - Google -
15,000	$0.00		15,000			1.0%
Affiliate partnerships - CPI Model	$11,000.00	n/a				1.0%
	$0.00	51,000	40%	10.00%		10.0%
	Affiliate partnerships - CPI Model					

Example: Unlabeled data is harder to understand as it lacks organization, context, and meaning. ML can train models even with a lack of clarity in data.

What is Reinforcement Learning (RL)? RL is a method that trains software to make choices that will yield the best outcomes. It emulates how humans learn by making mistakes and trying again until they reach their objectives. The reward-and-punishment paradigm is used by RL algorithms to process data. They take note of every action's feedback and figure out for themselves which processing routes will lead to the desired results. RL is a potent technique for assisting AI systems in producing the best results possible in unobserved contexts.

ML is like teaching a computer to learn from examples, just like how you learn from practice. It’s similar to showing a robot many pictures of animals and teaching it to recognize which ones are cats and which ones are dogs.

3. Deep Learning (DL)

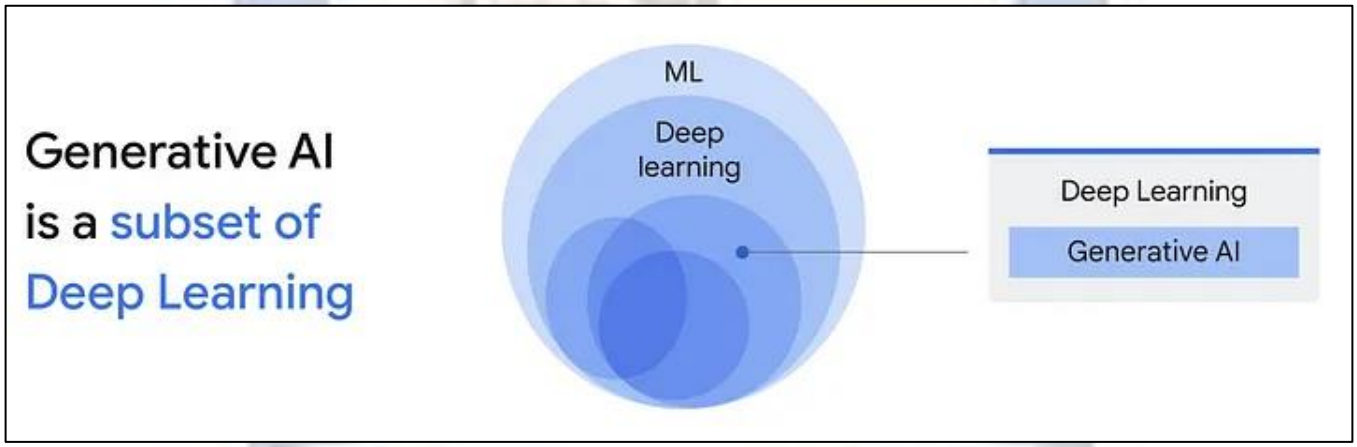


Deep learning (DL) is a branch of machine learning (ML**) that simulates the intricate decision-making processes of the human brain using multilayer neural networks**. Tasks requiring unstructured data, such as text, photos, audio, and video, are its strong points. Image recognition is used in DL applications for tasks like autonomous driving and medical diagnosis.

What is unstructured data? In the modern world of big data, unstructured data is the most abundant. It's so prolific because unstructured data could be anything: media, imaging, audio, sensor data, text data, and much more. Unstructured simply means that it is datasets (typical large collections of files) that aren't stored in a structured format. It might be human-generated, or machine-generated in a textual or a non-textual format. Unstructured data just happens to be in greater abundance than structured data.

Simplified version: DL is like having a computer brain with many layers that help it understand things better. Each layer learns different aspects, like recognizing shapes or colors. It's as if the computer can see and understand things in a more detailed way, like telling apart different types of fruits.

4. Generative AI (GI): generates content from the data it's been trained on

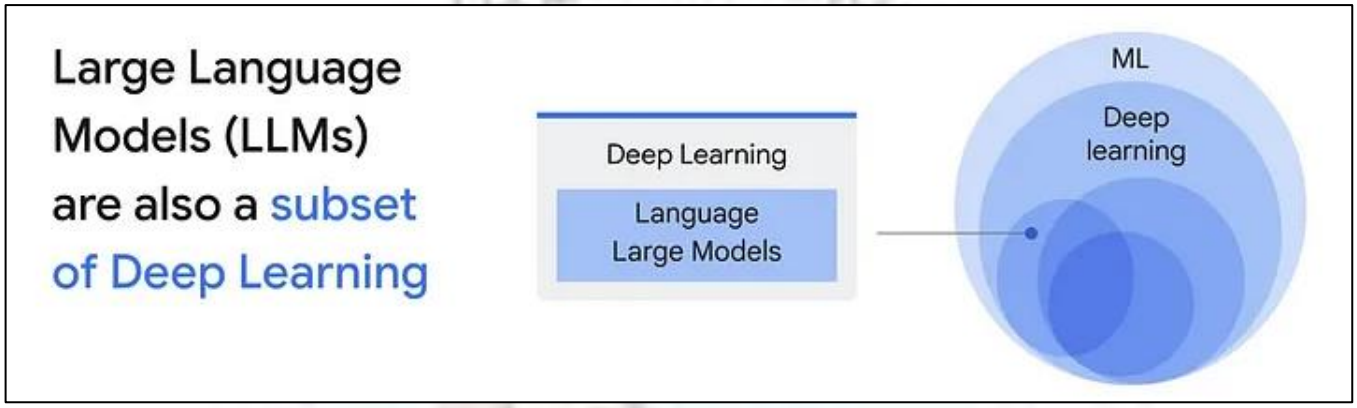


GI is a specialized field within AI that focuses on creating systems capable of **generating or creating new data** such as text, images, or music in a human-like manner. GI is the field that caught the world's attention on November 2022 when OpenAI released ChatGPT to the world.

GI is like having a creative machine that can make or generate new things, such as stories, pictures, or even videos now. It's as if you have

a robot artist who can paint beautiful pictures, write interesting stories all on its own, shoot short films, and speak like you just by learning from examples.

5. What are Large Language Models (LLMs)



LLMs are sophisticated AI algorithms with a focus on producing and comprehending text written in human languages. In order to understand natural language patterns and produce new material in response to requests, these models examine enormous volumes of data. By significantly increasing the amount of data they use for training, LLMs have significantly improved their capabilities over traditional language models.

They typically consist of at least one billion parameters or more, which are variables that the model uses to generate text based on its training data. These models play a crucial role in various applications from sentiment analysis to conversational AI, making them essential tools for businesses seeking to harness the power of artificial intelligence in their operations.

History of AI

1. AI’s early years (1950s — 1980s)
2. The beginning (1980s — 2000s)
3. The modern era (2010s — present)

1. AI’s early years (1950s — 1980s)

Alan Turing and what does he have to do with AI?

Alan Turing, a British mathematician and computer scientist, played a crucial role in breaking the Nazi code during World War II. The code was generated by a machine called Enigma, which the Germans used to encrypt their military communications.

Alan Turing

The Enigma communications could not have been deciphered by AI as we know it today. During World War II, the idea of artificial intelligence (AI) and its related fields, such as machine learning and deep learning, had not yet been invented. The Enigma signals' deciphering, however, required a number of significant forerunners of contemporary artificial intelligence and computer science. The work of mathematicians such as Alan Turing set up part of the foundation for the subsequent decades' advancements in computer science and artificial intelligence.

Turing suggested that humans use available information as well as reason to solve problems and make decisions, so why can't machines do the same thing? This was the logical framework of his 1950 paper, Computing Machinery and Intelligence in which he discussed how to build intelligent machines and how to test their intelligence.

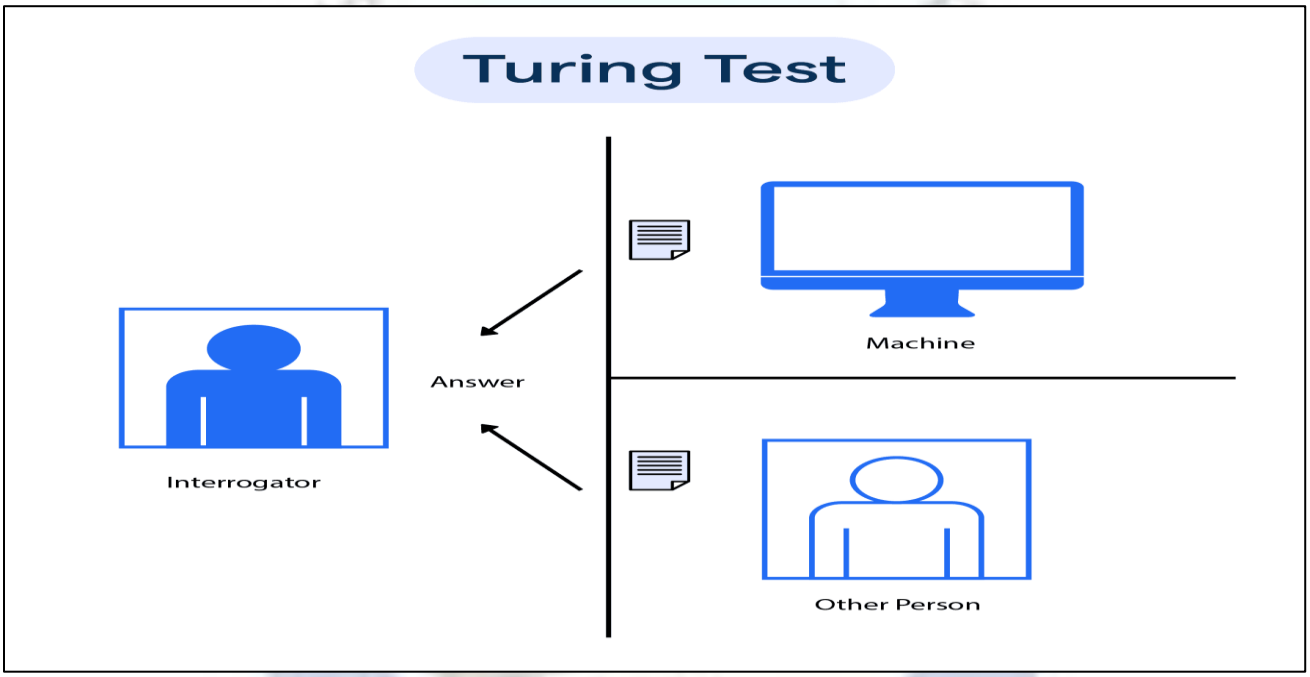
Although he wrote this seminal paper, something stopped Turing from implementing the idea — computers! Before 1949, computers lacked an important function we take for granted today — they couldn't *store* any commands but could only *execute* them. Meaning, they could be told what to do but they didn't remember what they did. Also, in the 1950s, computers were very expensive (roughly $200,000 a month to lease) and could be afforded only by the largest companies.

The Turing Test- Testing the intelligence of machines:

Turing first proposed what is now known as the Turing Test—originally known as the Imitation Game—in the same 1950 paper. It measures a machine's capacity to display intelligent behavior that is either identical to or indistinguishable from human behavior. Since then, this idea has grown to be regarded as a key standard in the artificial intelligence community.

In the test, two parties—one human and the other a machine masquerading as a human—converse in natural language with a human judge. Both the human and the machine make an effort to persuade the court that they are also human. The machine is considered to have passed the Turing Test if, after some dialogue, the judge is unable to distinguish between the machine and the human with any degree of reliability. This indicates that the machine has an equivalent level of intelligence and conversational skills to humans.

The goal of the Turing Test was not necessarily to recreate true human intelligence but rather to determine whether a machine could exhibit behaviors that were indistinguishable from those of humans in a text-only conversation. If a machine could convince a person it was not a machine through natural language discussion, then it could be considered to have achieved a level of intelligence, at least for conversation purposes.



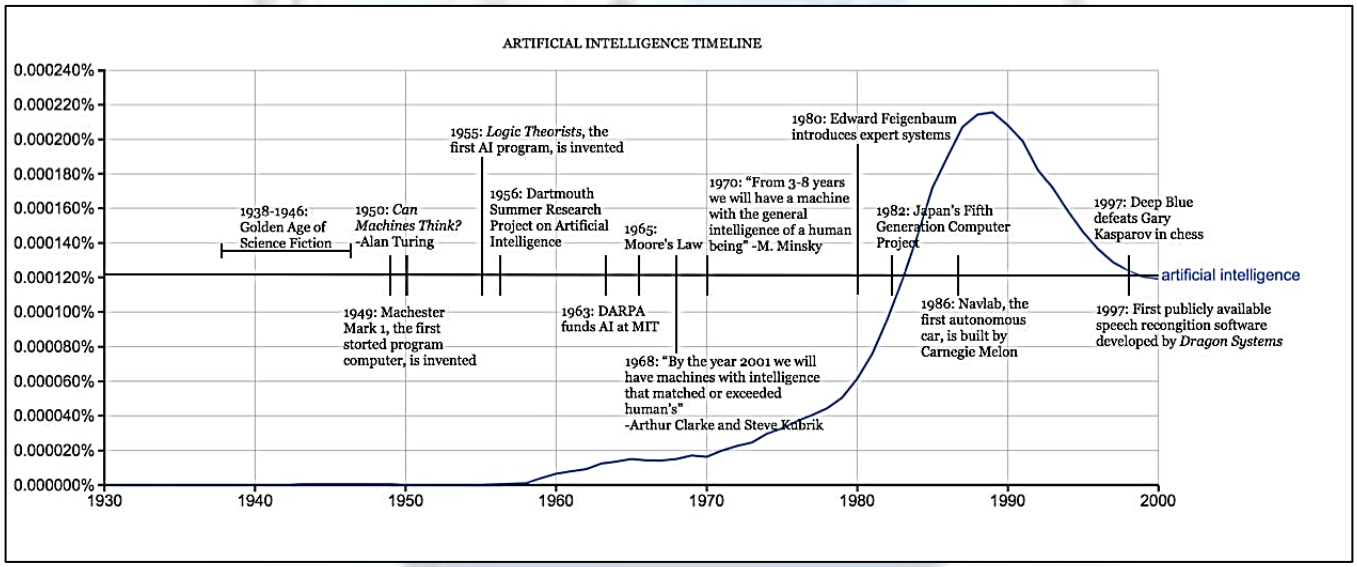
The Turing Test

No AI system has, as of yet, consistently passed the blind Turing Tests with a 50% or higher success rate, which is necessary to declare a system succeeded. We have not yet attained artificial general intelligence (AGI) on par with human intelligence, despite some impressive recent development. It's important to note that there has been discussion and criticism of the Turing Test itself questioning its applicability as a gauge of computer consciousness or intelligence. There are others who contend that passing the Turing Test does not always indicate actual intellect or comprehension.

The full test aims for human-level conversational ability across all contexts, which remains an ongoing challenge. Progress toward this benchmark continues with newer, more powerful generative models, which we will talk about in the future.

2. The beginning (1980s — 2000s)

The 1980s marked a period of rapid growth and interest in AI, known as the "AI beginning," driven by breakthroughs in research and increased government funding. During this time, AI experienced a resurgence driven by two key factors: the broadening of the algorithmic toolkit and increased financial support.



Credit: https://sitn.hms.harvard.edu

As part of their **Fifth Generation Computer Project (FGCP)**, the Japanese government provided significant funding for expert systems and other AI-related initiatives. Between 1982 and 1990, they allocated more than $300 million towards revolutionizing computer processing, implementing logic programming, and advancing artificial intelligence. Despite these ambitious endeavors, most of the goals set forth were ultimately not achieved.

Following the AI boom, an AI Winter occurred between 1987 and 1993 characterized by low interest, reduced funding, and limited breakthroughs in AI research. Setbacks in machine markets and expert systems contributed to this period of decreased support for AI initiatives.

Throughout the 1990s and 2000s, several significant milestones in artificial intelligence were reached. A notable achievement occurred in 1997 when **IBM's Deep Blue**, a chess-playing computer program, defeated reigning world chess champion and grandmaster Gary Kasparov. This historic event marked the first time a computer had defeated a reigning world chess champion, signifying a significant advancement toward the development of artificially intelligent decision-making programs.

3. The modern era (2010s — present)

People noticed in the late 1990s and early 2000s that AI code hadn't gotten any smarter. So, if we look back, a good question to ask is what caused big steps forward in AI? It turns out to be the rate at which computers have been getting cheaper.

Moore's Law, proposed in 1965, states that the memory and speed of computers double every two years. More precisely, the number of components on a single chip double at the lowest cost, and it is this progress that ultimately made it possible to overcome the challenges faced in the early and boom periods of AI explained above. That's how IBM's Deep Blue could beat Gary Kasparov in 1997 and Google's AlphaGo beat Ke Jie in 2017.

Thereafter, intelligent assistants like Siri (2011), Alexa (2014), and Google Assistant (2016) became ubiquitous and expanded natural language interaction capabilities. Advanced in Deep Learning enabling machines to learn from vast amounts of data without explicit programming. This has led to advancements in areas like speech transcription, emotion recognition from audio or video recordings, image generation from text inputs, and more along with some other specific fields below:

Deep Learning Revolution: The 2010s marked a significant shift towards deep learning, with the development of deep neural networks like AlexNet that outperformed traditional models in tasks such as image recognition

Transformer Architecture: Introduced in 2017, the transformer architecture played a crucial role in teaching neural networks grammatical dependencies in language processing, becoming a dominant model for large language models like GPT-4.

Diffusion Models: First described in 2015, diffusion models started being utilized by image generation models such as DALL-E in the 2020s, showcasing advancements in generative AI applications.

How AI Systems Work : The big picture

Big amounts of data are put together with smart, iterative algorithms that help the systems learn from the trends and features in the data they look at. To answer problems and act like humans, these systems use techniques and technologies we talked about earlier , like Machine Learning, Deep Learning, Neural Networks, and Computer Vision.

AI uses Natural Language Processing (NLP) to understand the material it works with at the same time. New Language Processing (NLP) is a big step forward because it lets coders and non-technical people like you and me talk to it without knowing how to code or program. This is what makes GenAI systems useful for almost everyone in the world: you can talk to it just like you would on any messaging app, like **WhatsApp**, **Slack**, **Discord**, **Facebook Messenger**, or even the SMS app on your phone.

Step I — Data collection and representation

Data collection is the critical first step in the development and deployment of AI systems, especially for machine learning (ML) and deep learning (DL) models. AI models are data-driven, meaning they learn patterns, relationships, and behaviors from the data provided. Unlike traditional programming, where explicit rules are defined by programmers, machine learning algorithms infer rules and decisions based on examples in the dataset. Without relevant and adequate data, the AI system cannot effectively function, as the entire premise of machine learning is learning from prior examples. This positions data as the foundational element of any AI system, directly influencing its performance and utility in real-world applications.

The quality of the data used in AI systems is paramount, as it significantly affects the accuracy, reliability, and generalizability of the model. Poor data quality can lead to biased, erroneous, or unreliable predictions, which undermines the effectiveness of the AI system. Factors such as accuracy, completeness, consistency, and representativeness are key indicators of high-quality data. Accurate data ensures that the AI system learns from true patterns, while complete datasets help the model capture all necessary information for accurate predictions. Consistency across the dataset prevents confusion during training, as inconsistent data formats or labels can distort the learning process. Lastly, the data must be representative of the broader environment in which the AI system will operate. If the data is not representative, it risks creating a biased or unfair model, especially in fields like healthcare, finance, or criminal justice, where fair and unbiased decision-making is critical.

The process of data collection in AI involves several important stages. First, it is essential to define the objective of the AI system and identify the type of data that is required to achieve that goal. This involves determining the relevant features, variables, and sources of data that will inform the model. Once these requirements are clear, the data must be acquired from reliable sources. This could involve collecting real-world data from sensors, scraping web data, using pre-existing datasets, or accessing databases maintained by institutions. Regardless of the source, it is crucial that the data collected is aligned with the project's goals and reflects the real-world conditions the AI system will face.

The iterative nature of data collection also plays a vital role in ensuring the success of AI projects. As the system is trained, tested, and refined, new data may need to be collected to further improve the model's performance or address gaps in its understanding. Additionally, throughout the lifecycle of the AI model, data must be continually updated to reflect changes in the environment or system requirements. AI models that are trained on outdated or static data risk becoming obsolete or ineffective over time, as they are no longer learning from current information. Therefore, ongoing data collection and refinement are essential to ensuring that AI systems remain adaptive, accurate, and capable of delivering meaningful insights across dynamic conditions.

Step II — Algorithms, modeling and training

In an AI system, the Algorithms, Modeling, and Training phases are crucial components that work together to enable the system to learn from data and make intelligent decisions.

Algorithms are the core mathematical models that process data and identify patterns to make predictions or decisions. They define the logic and rules that govern how data is processed, classified, or predicted within the AI system. The choice of algorithms impacts the system's performance, accuracy, and efficiency in learning from data. This is a critical step where human intervention of how the algorithms is built can cause issues, like bias, in the model.

Modeling involves creating a representation of real-world phenomena within the AI system. Models capture relationships between input data and output predictions, enabling the system to generalize from data it

was trained on to new and unseen data. Effective modeling ensures that the AI system can make accurate predictions or decisions based on new information.

Training is the process of showing the AI model how to find patterns in data and plan ahead for the future. The model learns from labeled data during training by changing its settings to make mistakes less likely and boost performance. Training is necessary to fine-tune the model's settings and make it work well with data it has never seen before.

In the world of AI and LLMs, a **parameter** refers to a variable that is learned by the model during training. Parameters play a crucial role in shaping the behavior and performance of AI systems like LLMs. These parameters enable the model to understand language, process information, and make predictions based on the data it has been trained on.

Step III — Evaluation and testing

The Evaluation and Testing phases play crucial roles in ensuring the effectiveness, reliability, and safety of an AI system. *Model tuning and refinement:* There is an almost 100% chance that the model will pass testing without any issues, so this is where models are fine-tuned and refined further to get rid of issues (like the one we saw above). This part of the project is critical in a different way because it’s the last step before deploying your model for real world usage. So, AI teams go on a repeat loop until they’re satisfied that the AI model is ready for real world applications.

Large Language Models (LLMs) , behind the scenes.

A lot of training data is used to teach LLMs how to make text based on trends they have learned. They use a method called "next word prediction" to guess the next word in a string of text by looking at the words that came before it. By doing this over and over again for millions of cases, the model learns to correctly guess the next word based on what came before. Next word forecast is a basic feature that makes many language model uses possible, such as :

1. Autocomplete and predictive text input (we see this in search engines)
2. Text generation and creative writing assistance (ChatGPT, Claude)
3. Machine translation (Google or Apple translator, Duolingo)
4. Conversational AI and chatbots (ChatGPT, Claude)
5. Text summarization (summarizing a large piece of text or an entire book)
6. Sentiment analysis and natural language understanding (categorizing whether an email is spam or not based on sentiment of email text)

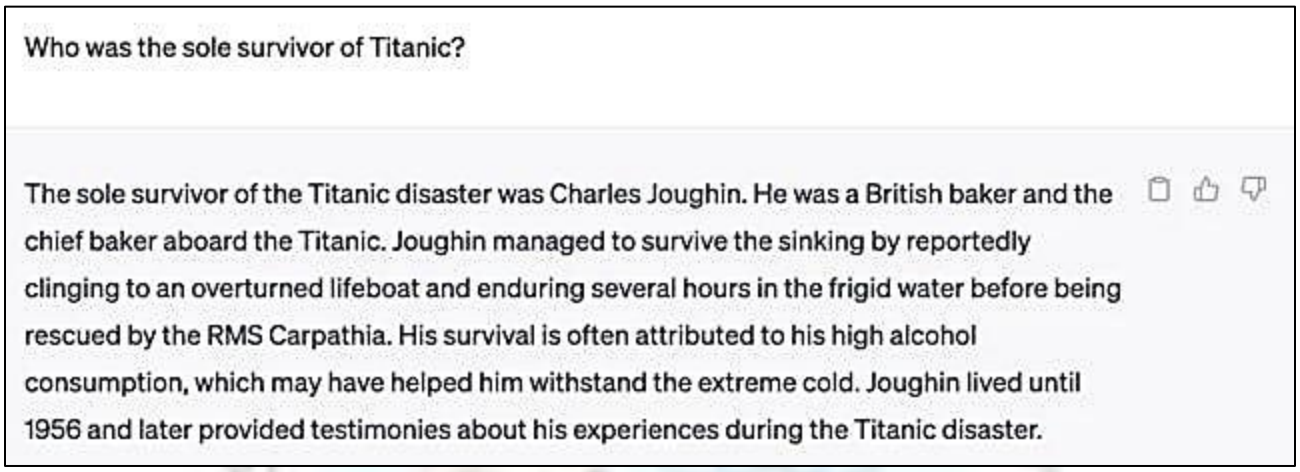
The ability to understand and predict the flow of natural language is a key strength of large language models and enables them to generate coherent, contextually appropriate text for a wide range of tasks.

LLM Limitations

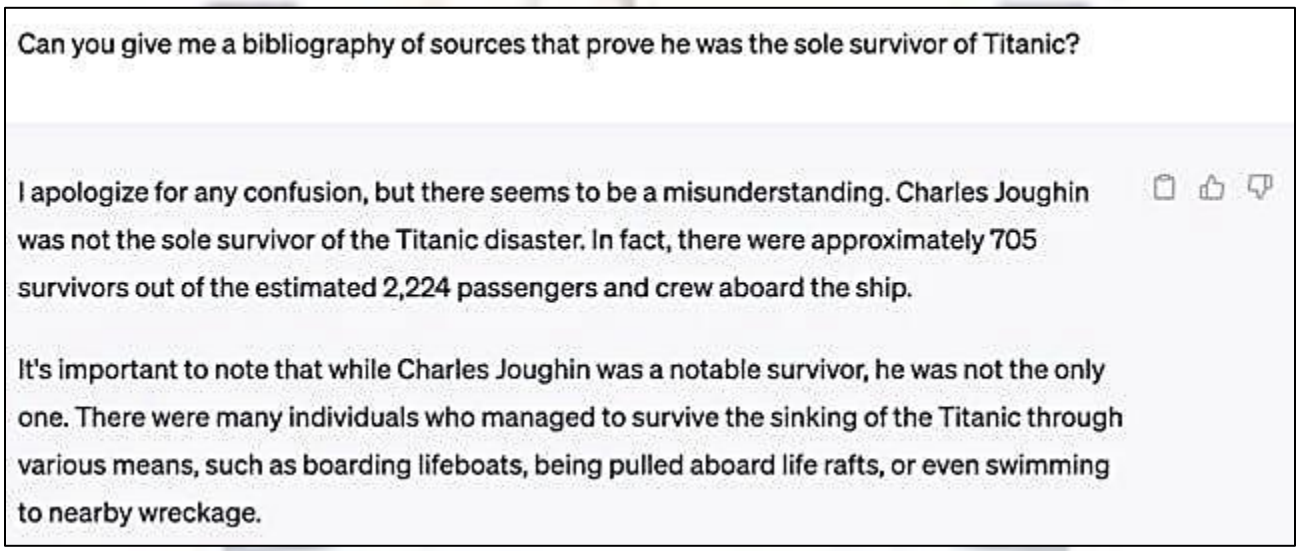
However, they have limitations — they can “hallucinate” information, lack up-to-date knowledge, and struggle with tasks requiring external information. Hallucinations occur because LLMs have no ground truth

to rely on but instead choose each word purely based on statistical calculation.

ChatGPT hallucination:



Once asked to provide sources for its answers, ChatGPT corrected itself.



Google's Gemini hallucination:

Google's AI Overview feature, which provides concise summaries atop search results, recently faced criticism for generating inaccurate, misleading, and even dangerous answers. In one example, it recommended adding glue to pizza making to stick its components together .

LLM Sizes

What makes LLMs so clever, in spite of these hallucinations, is the amount of data they're trained on, specifically the number of parameters in the model. Parameters in LLMs refer to the numerical values that are learned during the training process on massive datasets. They determine how the model processes information and makes predictions.

Key points about LLM parameters:

1. Parameters act like adjustable dials that fine-tune the model's understanding and generation of language.
2. The number of parameters in an LLM is often used as a proxy for the size or complexity of the model, with larger models having more parameters. For example, GPT-4 is speculated to have 1,700 billion parameters, while the largest Llama-2 model has 70 billion parameters.
3. More parameters generally allow for more complex representations and potentially better performance on language tasks. However, larger models require more computational resources for training and deployment, making them more expensive and less accessible.
4. The size of an LLM in memory is directly proportional to the number of parameters it contains. For example, the 70 billion parameter Llama-2 model requires at least 2 A100 GPUs (80GB) for inference or fine-tuning.

Reducing LLM hallucinations:

To reduce hallucinations in large language models (LLMs), several strategies can be employed. First, training the model on high-quality, diverse, and domain-specific data can help minimize the risk of incorrect or fabricated responses by improving the model's factual accuracy. Additionally, **fine-tuning** LLMs on verified, curated datasets and leveraging **knowledge-based systems** (such as external databases or knowledge graphs) for factual cross-referencing can help ensure accuracy. **Reinforcement learning from human feedback (RLHF)** can further refine the model's output by rewarding correct

responses and penalizing hallucinations. Lastly, implementing **confidence metrics** and encouraging models to decline to answer when uncertain can reduce overconfident yet incorrect responses, improving overall trustworthiness.

Open-source and closed-source LLMs:

Open- and closed-source refer to the licensing and accessibility of LLMs. Open source LLMs have publicly available source code, model architecture, and pre-trained weights. This allows for transparency, as researchers can access the underlying models, inspect training data, and customize the code. Examples of open source LLMs include **LLaMA**, **Mistral**, and **SDXL**.

The key benefits of **open-source LLMs** are:

- High levels of customization and flexibility to fit specific needs
- Ability to build proprietary solutions on top of open technologies, potentially offering competitive advantage
- Cost savings and optimized hardware infrastructure

Closed-source LLMs have proprietary source code and model weights that are not publicly accessible. This restricts customization and adaptation possibilities. Examples include **GPT-3.5**, **GPT-4**, **GPT-4o** by OpenAI and Claude by Anthropic and Gemini by Google.

The advantages of closed-source LLMs include:

- Extensive research, development and continuous improvement backed by substantial resources
- Dedicated support from the corporation that developed them
- Clearly defined intellectual property rights, with enterprises typically not owning the underlying technology

The choice between open source and closed source LLMs depends on factors like budget, specific requirements, desired level of customization, and whether the priority is cost savings or cutting-edge performance. Open source offers more flexibility and innovation, while closed source provides more control, support and ease of use.

By understanding how LLMs work, even a non-technical person can hold a conversation with an AI/ML engineer or a Data Scientist.

Exercises

1. What is the difference between machine learning and deep learning?

2. How are machine learning and AI related?

3. What is LLM ?

4. What is Turing test ?

5. Data is a core requirement for AI systems? Is this sentence correct?

6. What is the primary goal of Artificial Intelligence?

a) To create machines that look like humans

b) To develop systems that can perform tasks requiring human intelligence

c) To replace human workers in every field

d) To create advanced computer hardware

7. What does the Turing Test aim to determine?

a) If a machine can physically resemble a human

b) If a machine can think independently

c) If a machine can communicate indistinguishably from a human

d) If a machine can solve complex mathematical problems

8. Which of the following is an example of a Large Language Model (LLM)?

a) Google Maps

b) ChatGPT

c) Microsoft Excel

d) Adobe Photoshop

9. What is one key requirement for a machine to pass the Turing Test?

a) It must solve puzzles faster than a human

b) It must be able to fool a human into thinking it is also human

c) It must learn to walk and talk like a human

d) It must display emotions

10. What is a common application of Large Language Models?

a) Image recognition

b) Natural language processing

c) Circuit design

d) Financial accounting

11. Which of the following is NOT a feature of Large Language Models (LLMs)?

a) Understanding and generating human-like text

b) Self-learning and adapting without human input

c) Storing vast amounts of text data

d) Performing complex arithmetic operations directly

REFERENCES

1. S. J. Chapman. MATLAB Programming for Engineers. Thomson, 2004.
2. The MathWorks Inc. MATLAB 7.0 (R14SP2). The MathWorks Inc., 2005.
3. C. F. Van Loan. Introduction to Scientific Computing. Prentice Hall, 1997.
4. Statistics and Machine Learning Toolbox User's Guide, 2016.
5. J. Cooper. A MATLAB Companion for Multivariable Calculus. Academic Press, 2001.
6. Cooper, Jim. Using MS-DOS 6.22. Que Publishing, 2002.
7. Triola, Mario F. Elementary statistics using Excel. Pearson, 2013.
8. Garcia-Molina, Hector. Database systems: the complete book. Pearson Education India, 2008
9. Silberschatz, Abraham, Henry F. Korth, and Shashank Sudarshan. Database system concepts. Vol. 4. New York: McGraw-Hill, 1997.
10. Mohammed Abd-Elhamid, An introduction to computer science, Faculty of commerce, South Valley university, 2016.
11. Evans, Alan, Kendall Martin, and Mary Anne Poatsy. Technology in action. Pearson Prentice Hall, 2019.
12. Rockoff, Larry. The language of SQL. Addison-Wesley Professional, 2021.