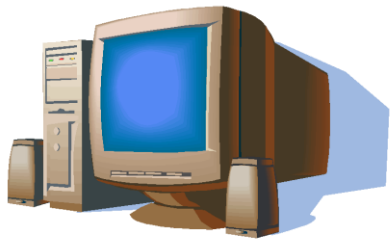
CSC 111



INTRODUCTION TO COMPUTER SCIENCE

CSC 113: Computer For Arts, Social Science And Management

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Section A: Introduction to Computer Science

Meaning and History of Computer Science

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1.0 Meaning of Computer Science

The following definitions are the various ways people have made attempt to explain the meaning of computer science.

a. Computer Science is the study of computing, programming, and computation in correspondence with computer systems. This field of study utilizes theories on how computers work to design, test, and analyze concepts. Computer science usually has a stronger mathematical foundation than a scientific one and on some occasions may not focus directly on computers and their systems.

b. Computer science is the scientific and practical approach to computation and its applications. It is 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, whether such information is encoded as bits in a computer memory or transcribed in genes and protein structures in a biological cell.

c. 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 subfields can be divided into a variety of theoretical and practical disciplines.

d. Computer Science is a branch of science that deals with the theory of computation or the design of computers. It is the study of computers, their design, and their uses for computation, data processing and systems control, including design and development of computer hardware and software, and programming. The field encompasses theory, mathematical activities such as design and analysis of algorithms, performance studies of systems and their components, and estimation of reliability and availability of systems by probabilistic techniques. Because computer systems are often too large and complicated for failure or success of a design to be predicted without testing, experimentation is built into the development cycle.

e. The study of computation and computer technology, hardware, and software.

f. Computer is the science that deals with the theory and methods of processing information in digital computer hardware and software, and the applications of computers.

g. The study of the design and operation of computers and their application to science, busin ess, and the arts.

h. Computer science is a discipline that involves the understanding and design of computers and computational processes. In its most general form it is concerned with the understanding of information transfer and transformation. Particular interest is placed on making processes efficient and endowing them with some form of intelligence. The discipline ranges from theoretical studies of algorithms to practical problems of implementation in terms of computational hardware and software.

1.1 Who is a Computer Scientist:

Computer science is a discipline that spans theory and practice. It requires thinking both in abstract terms and in concrete terms. The practical side of computing can be seen everywhere.

Nowadays, practically everyone is a computer user, and many people are even computer programmers. Getting computers to do what you want them to do requires intensive hands-on experience. But computer science can be seen on a higher level, as a science of problem solving.

i. Computer scientists must be adept at modeling and analyzing problems. They must also be able to design solutions and verify that they are correct. Problem solving requires precision, creativity, and careful reasoning.

ii. Computer scientists often become proficient in other subjects since computer science also has strong connections to other disciplines. Many problems in science, engineering, health care, business, and other areas can be solved effectively with computers, but finding a solution requires both computer science expertise and knowledge of the particular application domain.

iii. Computer Science is practiced by mathematicians, scientists and engineers. Mathematics, the origins of Computer Science, provides reason and logic. Science provides the methodology for learning and refinement. Engineering provides the techniques for building hardware and software.

iv. A computer scientist must have a firm foundation in the crucial areas of the field and will most likely have an in-depth knowledge in one or more of the other areas of the discipline, depending upon the person's particular area of practice.

v. A well-educated computer scientist should be able to apply the fundamental concepts and techniques of computation, algorithms, and computer design to a specific design problem.

The work includes detailing of specifications, analysis of the problem, and provides a design that functions as desired, has satisfactory performance, is reliable and maintainable, and meets desired cost criteria.

Clearly, the computer scientist must not only have sufficient training in the computer science areas to be able to accomplish such tasks, but must also have a firm understanding in areas of mathematics and science, as well as a broad education in liberal studies to provide a basis for understanding the societal implications of the work being performed.

1.2 Major Subject Areas within Computer Science include:

Computer science has a wide range of specialties. These include computer architecture, software systems, graphics, artificial intelligence, computational science, algorithms and data structures, programming methodology and languages, and software engineering. Drawing from a common core of computer science knowledge, each specialty area focuses on particular challenges. Other areas include software engineering, artificial intelligence, computer networking and communication, database systems, parallel computation, distributed computation, computer-human interaction, computer graphics, operating systems, and numerical and symbolic computation.

i. *Operating Systems:* concerned with the development and structure of complex programs which facilitate man-machine communications.
ii. *Computational Science:* the analysis of numerical methods for solving mathematical problems with a computer.
iii. *Programming Languages:* the study of the design and properties of languages by which humans communicate with computers.
iv. *Digital Logic & Computer Architecture:* the study and use of mathematical logic to design electronic circuits.
v. *Intelligent Systems*: concerned with means by which computers may perform tasks which might be characterized as "intelligent" if performed by humans.
vi. *Automata Theory:* an abstract study of computers and their capabilities.
vii. *Information Storage and Retrieval*: the study of methods for storing a vast amount of data in a computer and methods for searching and retrieving this data.
viii. *Software Engineering*: the study of tools and techniques for software design, development, testing and maintenance.
ix. *Database Systems*: A database is an organized collection of data which typically model aspects of reality in a way that supports processes requiring information. Database management systems are computer software that interacts with user, other applications, and the database itself to capture and analyze data.
x. *Network & Data Communications*: Network systems and data communications analyst plan, design, build, maintain, and test networks and other data communication systems. The principal focus is to make computers and other electronic device to share data, files and other computing resources.
xi. *Artificial Intelligence & Experts Systems*: The study of designing and developing computer system that emulates the decision making ability of human experts.
xii. *Discrete Mathematics*: the study of mathematical structures that is fundamentally discrete rather than continuous. The study focus on combinatorics, graph theory, theory of computation, and number theory: congruence and recurrence relations.

1.3 Techniques and Methods used in Computer Science

One to view or understand any science is to study the methods used within that science. In some sense these methods are similar in many sciences, but they can take on different characteristics in each discipline. Four important methods used in the study of computer science are:

i. *Invention/Conceptual Modeling:* formulation of new algorithmic and new architectural paradigms
ii. *Design*: software engineering uses design principles to build complex systems to solve computational problems
iii. *Analysis*: certainly a major focus within computer science is the analysis and evaluation of software, algorithms and architecture.
iv. *Experimentation:* use of experiments to reveal computing principles is an important method of scientific investigation within computer science.
v. *Simulation:* A computer simulation is a simulation run on a single computer, or a network of computers, to reproduce the behavior of a system. The simulation uses an abstract or conceptual computational model to simulate the system.

1.4 History of Computer Science

The historical development of any subject discipline (Computer Science not an exemption) is vital to studying, learning and understanding the key components required towards gaining mastery of the subject.

Here's a brief history of "computer science". Really it's a mix of hardware and software innovations over the years.

- 1834: Babbage/Lovelace design "Analytical Engine"
- 1854: Bool published "Laws of Thought" (Boolean Algebra and logic)
- 1928: ENIGMA coding machine, Germany
- 1930: Model 1, electromechanical computer, Bell Labs
- 1938: COLOSSUS, Alan Turing primitive computer
- 1941: Electromechanical calculator,Korad Zuse, Austria, 64 word memory, 3 secs multiplication.
- 1944: Mark I, Electromechanical computer, Howard Aiken
- 1945: ENIAC, Electrial Numerical Integrator and Computer, J.W. Mauchly/J.P. Eckert.
- 1948: 1st transistor, Bell Labs
- 1949: EDVAC, built by Alan Turing, acoustic memory storage tubes, oscilloscope display, 1st library of subroutines * 1st Assembly Language for UNIVAC I
- 1951: EDVAC, operational, built by John von Neumann and team
- 1952: 1st commercial compiler * Microprogramming announced by Maurice Wilkes
- 1954: UNIVAC I, 1st computer sold to U.S. Defense Dept. (built at Harvard) * MATH_MATIC, 1st compiled language for UNIVAC I * FORTRAN, developed at IBM * 1st Assembler, IBM * IBM 650, 1st mass produced computer
- 1955: TRIDAC, 1st computer to use transistors
- 1957: DEC founded * IPL, Information Processing Language
- 1958: ALGOL 58, ALGOrithmic Language * Atlas, designed at University of Manchester, England * LISP, LISt Processor

- 1959: COBOL, COmmon Business Oriented Language * DEC PDP-1
- 1960: ALGOL 60, popular in Europe
- 1962: CTSS, Compatible Time-Sharing System
- 1964: PL/1 and APL * DEC PDP-8, 1st mass produced minicomputer
- 1965: Control Data 6600, 1st successful commercial computer * Control Data PDP-8, 1st commercial supercomputer * BASIC programming language * XDS-940, University of California at Berkeley, time-shared system * Simula * ARPANet
- 1966: OS/360 * MULTICS, time sharing operating system, MIT
- 1968: THE, operating system, Netherlands, layer structure and concurrent processing * Burroughs B2500/3500, 1st commercial computer to use IC chip
- 1969: Laser Printer * UNIX (Thompson and Ritchie, AT&T)
- 1970: Pascal * RC 4000, designed by Regenecentralen, operating-system nucleus, or kernel
- 1971: Intel, 1st commercial microprocessor (4004), 4 bit, .06 MIPS, $300
- 1972: C * Smalltalk
- 1973: Ethernet at Xerox PARC * Winchester hard disk
- 1975: Altair, 1st hobbyist desktop computer, Intel 8080, 256 bytes, $480
- 1976: MCP, multi-CPU operating system * SCOPE, multi-CPU system * Cray 1 supercomputer, 138 megaFLOPS
- 1977: Personal computers: Apple II, Radio Shack TSR80, Commodore PET * CPM operating system
- 1978: DEC VAX with VMS operating system
- 1979: UNIX 3BSD * Ada * Visicalc
- 1981: IBM PC, 16K of RAM * Xerox Alto, 1st workstation, graphic-user interface, ethernet, mouse, smalltalk
- 1982: Compaq, 1st portable computer * Turbo Pascal * Modula 2
- 1984: Apple Macintosh, 1st personal computer w/ graphic-user interface * TrueBASIC * SunOS * PostScript
- 1985: C++ * Microsoft Windows
- 1987: OS/2 * 4Mbit DRAM chip * Introduction of LANS (Local Area Networks) within large organizations
- 1988: NeXT, UNIX workstation, object oriented system, graphic-user interface
- 1989: Motif, standard graphic-user interface for UNIX workstation * Intel 80486 chip
- 1990: Windows 3.0 * Modula 3
- 1992: Sun Solaris multi-threaded, multi-processing, real-time UNIX operating system
- 1993: Windows NT * IBM/Apple/Motorola PowerPC processor * Intel Pentium

Some interesting notes for those of you keeping score:

1. Computer science has always been a progressive field. The first programmer, Ada Lovelace, was female.
2. About the time I was busy being born, they had just invented the modern hard drive design. Today, something about half the size of a bar of soap can hold 500 megabytes of data. And the really expensive drives can put at least 100 megabytes of data on a drive platter the size of a half dollar. (And there was a point a 10 megabyte harddrive was the size of a briefcase, and they thought you'd never need to store more than 10 megs. Gee, they obviously didn't have Tie Fighter back then.)
3. For all of you getting so very excited about the new "Information Superhighway" (and if I hear that one more time, I'm going to scream): It's already here, you're just now finding

out about it. The rest of us call it the Internet; and it isn't new. It first started evolving way back in 1965 with ARPAnet, a Defense Department project. Another note, for those of you wanting censorship and control and all that... ARPAnet (and therefore Internet) was designed to ALWAYS get data through, even if large portions of it are wiped out, say, by nuclear war. You can't stop it, it was designed to be a free-form anarchy.

4. Interesting thing to know: Digital logic (ie: processors) shrink by half every 3 years, and double in speed every 4. Memory and hard drive capacity quadruples every 3 years, and are 1.4x faster every 10 years. Pretty soon, re-writeable CD's will become commonplace, storing 650 megabytes per disk. (And yet, 8086's and tape drives still do useful things, and FORTRAN is written in columns because of punchcards.)

1.5. Generations of Computers

The history of computer development is often referred to in reference to the different *generations of computing devices*. Each of the five generations of computers is characterized by a major technological development that fundamentally changed the way computers operate, resulting in increasingly smaller, cheaper, more powerful and more efficient and reliable computing devices.

In this section, you'll learn about each of the five generations of computers and the technology developments that have led to the current devices that we use today. Our journey starts in 1940 with vacuum tube circuitry and goes to the present day -- and beyond -- with artificial intelligence.

Each of the five generations of computers is characterized by a major technological development that fundamentally changed the way computers operate.

First Generation (1940-1956) Vacuum Tubes

The first computers used vacuum tubes for circuitry and magnetic drums for memory, and were often enormous, taking up entire rooms. They were very expensive to operate and in addition to using a great deal of electricity, generated a lot of heat, which was often the cause of malfunctions.

First generation computers relied on machine language, the lowest-level programming language understood by computers, to perform operations, and they could only solve one problem at a time. Input was based on punched cards and paper tape, and output was displayed on printouts.

The UNIVAC and ENIAC computers are examples of first-generation computing devices. The UNIVAC was the first commercial computer delivered to a business client, the U.S. Census Bureau in 1951

A UNIVAC computer at the Census Bureau. ***Image Source:*** *United States Census Bureau*

Second Generation (1956-1963) Transistors

Transistors replaced vacuum tubes and ushered in the second generation of computers. The transistor was invented in 1947 but did not see widespread use in computers until the late 1950s. The transistor was far superior to the vacuum tube, allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable than their first-generation predecessors. Though the transistor still generated a great deal of heat that subjected the computer to damage, it was a vast improvement over the vacuum tube. Second-generation computers still relied on punched cards for input and printouts for output.

Second-generation computers moved from cryptic binary machine language to symbolic, or assembly, languages, which allowed programmers to specify instructions in words. High-level programming languages were also being developed at this time, such as early versions of COBOL and FORTRAN. These were also the first computers that stored their instructions in their memory, which moved from a magnetic drum to magnetic core technology.

The first computers of this generation were developed for the atomic energy industry.

Third Generation (1964-1971) Integrated Circuits

The development of the integrated circuit was the hallmark of the third generation of computers. Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers.

Instead of punched cards and printouts, users interacted with third generation computers through keyboards and monitors and interfaced with an operating system, which allowed the device to run many different applications at one time with a central program that monitored the memory. Computers for the first time became accessible to a mass audience because they were smaller and cheaper than their predecessors.

Fourth Generation (1971-Present) Microprocessors

The microprocessor brought the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip. What in the first generation filled an entire room could now fit in the palm of the hand. The Intel 4004 chip, developed in 1971, located all the components of the computer—from the central processing unit and memory to input/output controls—on a single chip.

In 1981 IBM introduced its first computer for the home user, and in 1984 Apple introduced the Macintosh. Microprocessors also moved out of the realm of desktop computers and into many areas of life as more and more everyday products began to use microprocessors.

As these small computers became more powerful, they could be linked together to form networks, which eventually led to the development of the Internet. Fourth generation computers also saw the development of GUIs, the mouse and handheld devices.

Fifth Generation (Present and Beyond) Artificial Intelligence

Fifth generation computing devices, based on artificial intelligence, are still in development, though there are some applications, such as voice recognition, that are being used today. The use of parallel processing and superconductors is helping to make artificial intelligence a reality. Quantum computation and molecular and nanotechnology will radically change the face of computers in years to come. The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization. One major technology that has characterized the fifth generation is the development of smart technology devices.

1.6 Definition of Computer

A **computer** is an electronic device for storing and processing data, typically in binary form, according to instructions given to it in a variable program.

A **computer** is a device that accepts data and manipulates it for some result based on a program or sequence of instructions on how the data is to be processed.

A **computer** generally means a programmable machine. The two principal characteristics are: it responds to a specific instruction in a well-defined manner, and it can execute a pre-recorded list of instructions (program).

1.7 Basic Characteristics (Strenghts/Capabilities) of a Computer

The power of computers is derived from their capability to process information with speed, reliability, accuracy, resilience, fault-tolerance and huge storage capacity. Here, we explain why computers are powerful processing tools.

1. **Speed: -** Computer can work very fast and requires only few seconds to complete calculations that will take hours to complete by humans. Computer can perform millions

(1,000,000) of instructions and even more per second. Thus, the processing speed of computers is in the range of millions to billions of instructions per second.

The speed of computer is therefore measured in terms of microsecond (10-6 part of a second) or nanosecond (10 to the power -9 part of a second). In other words, the time required to execute an instruction can be measured in nanoseconds or picoseconds. From this you can imagine how fast your computer performs work.

For example, it may take you about three minutes to find the location of a book in the library by searching the index cards. However, if you use a computerised library system to search the book's location, it may only take you about a few seconds, depending on how fast you can type. Normally, the computer only takes less than a second to process your request.

Units of Time :- Computer operations are measured in milliseconds, microseconds, nanoseconds, and picoseconds. The table below summarized how computer operation are measured in units of time.

Units of time	Abbreviation	Fraction of a second
Millisecond	Ms	Thousandth: 0.001
Microsecond	µs	Millionth: 0.000001
Nanosecond	ns	Billionth: 0.000000001
Picosecond	ps	Trillionth: 0.000000000001

2. **Accuracy: -** The degree of accuracy of computer is very high and every calculation is performed with the same accuracy. The accuracy level is determined on the basis of design of computer. The errors in computer are due to human and inaccurate data.

Computers can generate accurate results, provided that the input data is correct and the program of instructions is reliable.
They are not affected by emotion and do what they are programmed to do. Hence, they can produce consistent result.

- If inaccurate data is entered, the computers will generate incorrect results. This is known as "Garbage In; Garbage Out" (GIGO).
- Most of the "computer errors" can be traced to human errors such as incorrect input data and unreliable programs.
- For example, the item prices determined by scanning the bar-codes at the point-of-sale terminals in supermarkets are far more accurate than those typed in by cashiers.

3. **Reliability (Diligence)**

Computers built with integrated circuits are more reliable. They have a low failure rate. A computer is free from tiredness, lack of concentration, fatigue, etc. It can work for hours without creating any error. Computers are most suitable to handle repetitive tasks because they do not take tea breaks and sick leaves, and they never complain. If millions of calculations are to be performed, a computer will perform every calculation with the same accuracy and resilince. Due to this capability it overpowers human being in routine type of work. For example, the automatic teller machines (ATM) are in operation 24 hours a day, 7 days a week.

4. **Versatility: -** It means the capacity to perform completely different type of work. You may use your computer to prepare payroll slips. Next moment you may use it for inventory management or to prepare electric bills.

5. **Power of Remembering: -** Computer has the power of storing any amount of information or data. Any information can be stored and recalled as long as you require it, for any numbers of years. It depends entirely upon you how much data you want to store in a computer and when to lose or retrieve these data.

6. **No Intelligent Quotient (IQ): -** Computer is a dumb machine and it cannot do any work without instruction from the user. It performs the instructions at tremendous speed and with accuracy. It is you to decide what you want to do and in what sequence. So a computer cannot take its own decision as you can.

7. **No Feeling: -** It does not have feelings or emotion, taste, knowledge and experience. Thus it does not get tired even after long hours of work. It does not distinguish between users.

8. **Storage: -** The Computer has an in-built memory where it can store a large amount of data. You can also store data in secondary storage devices such as floppies, which can be kept outside your computer and can be carried to other computers.
Imagine, if you can, how many filing-cabinet drawers would be required to hold the thousands of student records kept by your school. It would take a lot of space to store data and information in paper form. However, computers can store them on several disks that take up less space than a first-aid box.

- Units of computer storage

Units of storage	Abbreviation	Number of bytes
Kilobyte	KB	1,024 or (2^{10})
Megabyte	MB	1,048,576 or (2^{20})
Gigabyte	GB	1,073,741,824 or (2^{30})
Terabyte	TB	About one trillion or (2^{40})

- How much is a MB?

A diskette of 1.44 MB capacity can store 300 pieces of composition of 500 words each.

1.8. Classification of Computers

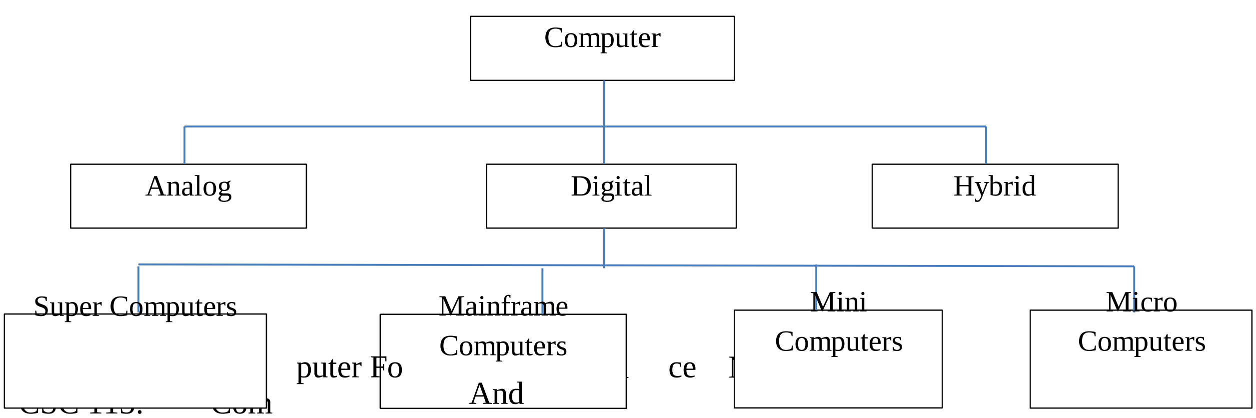
Computers differ based on their data processing abilities. They are classified according to

i. Purpose,
ii. Data handling,
iii. Size, and
iv. Functionality

i. According to **Purpose**, computers are either general purpose or specific purpose.
General purpose computers are designed to perform a range of tasks. They have the ability to store numerous programs, but lack in speed and efficiency.
Specific purpose computers are designed to handle a specific problem or to perform a specific task. A set of instructions is built into the machine.

ii. According to **data handling**, computers are analog, digital or hybrid.
Analog computers work on the principle of measuring, in which the measurements obtained are translated into data. Modern analog computers usually employ electrical parameters, such as voltages, resistances or currents, to represent the quantities being manipulated. Such computers do not deal directly with the numbers. They measure continuous physical magnitudes.
An analog computer (spelt analogue in British English) is a form of computer that uses continuous physical phenomena such as electrical, mechanical, or hydraulic quantities to model the problem being solved
Digital computers are those that operate with information, numerical or otherwise, represented in a digital form. Such computers process data into a digital value (in 0s and 1s). They give the results with more accuracy and at a faster rate.
A digital computer performs calculations and logical operations with quantities represented as digits, usually in the binary number system
Hybrid computers incorporate the measuring feature of an analog computer and counting feature of a digital computer. For computational purposes, these computers use analog components and for storage, digital memories are used.
A combination of computers those are capable of inputting and outputting in both digital and analog signals. A hybrid computer system setup offers a cost effective method of performing complex simulations.

iii. According to **size**, computers are classified as Super Computer, Mainframe Computer, Mini Computer, and Micro Computer or Personal Computer.



a. Super Computer:- The fastest and most powerful type of computer Supercomputers are very expensive and are employed for specialized applications that require immense amounts of mathematical calculations. For example, weather forecasting requires a supercomputer. Other uses of supercomputers include animated graphics, fluid dynamic calculations, nuclear energy research, and petroleum exploration.

The chief difference between a supercomputer and a mainframe is that a supercomputer channels all its power into executing a few programs as fast as possible, whereas a mainframe uses its power to execute many programs concurrently.

b. Mainframe Computer:- A very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously. In the hierarchy that starts with a simple microprocessor (in watches, for example) at the bottom and moves to supercomputers at the top, mainframes are just below supercomputers. In some ways, mainframes are more powerful than supercomputers because they support more simultaneous programs. But supercomputers can execute a single program faster than a mainframe.

c. Mini Computer: - A midsized computer. In size and power, minicomputers lie between workstations and mainframes. In the past decade, the distinction between large minicomputers and small mainframes has blurred, however, as has the distinction between small minicomputers and workstations. But in general, a minicomputer is a multiprocessing system capable of supporting from 4 to about 200 users simultaneously.

d. Micro Computer or Personal Computer

- Desktop Computer: a personal or micro-mini computer sufficient to fit on a desk.
- Laptop Computer: a portable computer complete with an integrated screen and keyboard. It is generally smaller in size than a desktop computer and larger than a notebook computer.
- Palmtop Computer/Digital Diary /Notebook /PDAs: a hand-sized computer. Palmtops have no keyboard but the screen serves both as an input and output device.
- Smaller microcomputers are also called mobile devices:
  - **Tablet computer** – Like laptops, but with a touch-screen, entirely replacing the physical keyboard.
  - **Programmable calculator**– Like small handhelds, but specialized on mathematical work.
  - **Handheld game consoles** – The same as game consoles, but small and portable.

iv. According to **functionality**, computers are classified by function such as Servers, Workstations, Information appliances, and Embedded computers.

a. **Server** usually refers to a computer that is dedicated to provide a service. For example, a computer dedicated to a database may be called a "database server". "file servers" manage a large collection of computer files. "Web servers" process web pages and web applications. Many smaller servers are actually personal computers that have been dedicated to provide services for other computers.

b. **Workstations:-** A terminal or desktop computer in a network. In this context, workstation is just a generic term for a user's machine (client machine) in contrast to a "server" or "mainframe."

Workstations are computers that are intended to serve one user and may contain special hardware enhancements not found on a personal computer. By the mid 1990s personal computers reached the processing capabilities of Mini computers and Workstations. Also, with the release of multi-tasking systems such as OS/2, Windows NT and Linux, the operating systems of personal computers could do the job of this class of machines.

c. **Information appliances** are computers specially designed to perform a specific "user-friendly" function—such as playing music, photography, or editing text. The term is most commonly applied to mobile devices, though there are also portable and desktop devices of this class.

d. **Embedded computers** are computers that are a part of a machine or device. Embedded computers generally execute a program that is stored in non-volatile memory and is only intended to operate a specific machine or device.

Embedded computers are very common and are typically required to operate continuously without being reset or rebooted, and once employed in their task the software usually cannot be modified.

An automobile may contain a number of embedded computers; however, a washing machine and a DVD player would contain only one. The central processing units (CPUs) used in embedded computers are often sufficient only for the computational requirements of the specific application and may be slower and cheaper than CPUs found in a personal computer.

Section B: Computer Hardware and Software

Computer Hardware: functional components, modern input and output units

Computer Software: Operating systems, application packages

2.1 Computer Hardware

2.1.1 Introduction

Computers are often compared to human beings since both have the ability to accept data, store, work with it, retrieve and provide information. The main difference is that human beings have the ability to perform all of these actions independently. Human beings also think and control their own activities. The computer, however, requires a program (a predefined set of instructions) to perform an assigned task. Human beings receive information in different forms, such as eyes, ears, nose, mouth, and even sensory nerves. The brain receives or accepts this information, works with it in some manner, and then stores in the brain for future use. If information at the time requires immediate attention, brain directs to respond with actions. Likewise the Central Processing Unit (CPU) is called the brain of the computer. It reads and executes program instructions, performs calculations and makes decisions.

2.1.2 Computer system components

1. **Hardware** – provides basic computing resources (CPU, memory, I/O devices).
2. **Operating system** – controls and coordinates the use of the hardware among the various application programs for the various users.
3. **Applications programs** – define the ways in which the system resources are used to solve the computing problems of the users (compilers, database systems, video games, business programs).
4. **Users** (people, machines, other computers).

2.2 Computer Hardware

A computer system is the integration of physical entities called hardware and non-physical entities called software. The hardware components include input devices, processor, storage devices and output devices. The software items are programs and operating aids (systems) so that the computer can process data. The main components of a computer system are showing in figure 1 below.

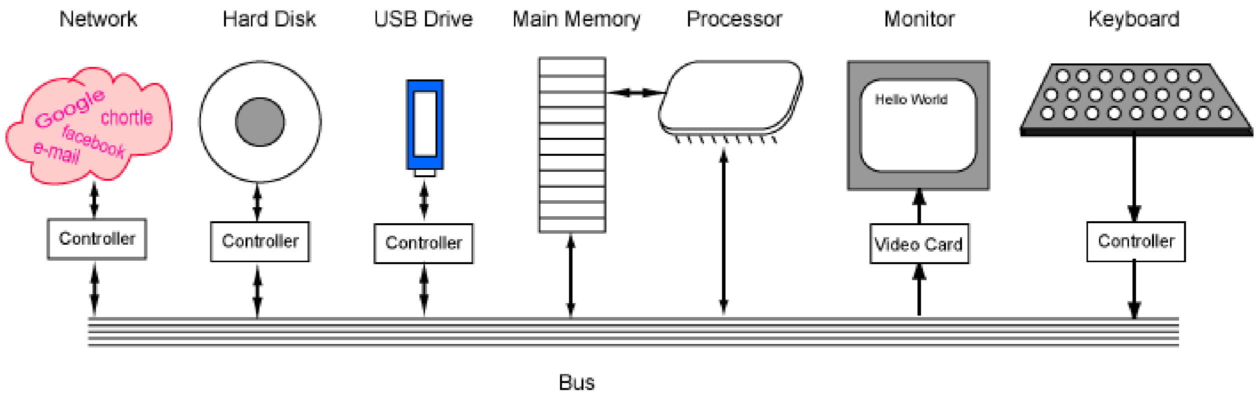


Figure 1: Main components of a computer system

2.2.1 Functional Units of a Computer System

Computer system is a tool for solving problems. The hardware should be designed to operate as fast as possible. The software (system software) should be designed to minimize the amount of idle computer time and yet provide flexibility by means of controlling the operations. Basically any computer is supposed to carry out the following functions.

- Accept the data and program as input - Store the data and program and retrieve as and when required.
- Process the data as per instructions given by the program and convert it into useful information.
- Communicate the information as output.

Based on the functionalities of the computer, the hardware components can be classified into four main units, namely

1) Input Unit
2) Output Unit
3) Central Processing Unit
4) Memory Unit

These units are interconnected by minute electrical wires to permit communication between them. This allows the computer to function as a system. The block diagram is shown below.

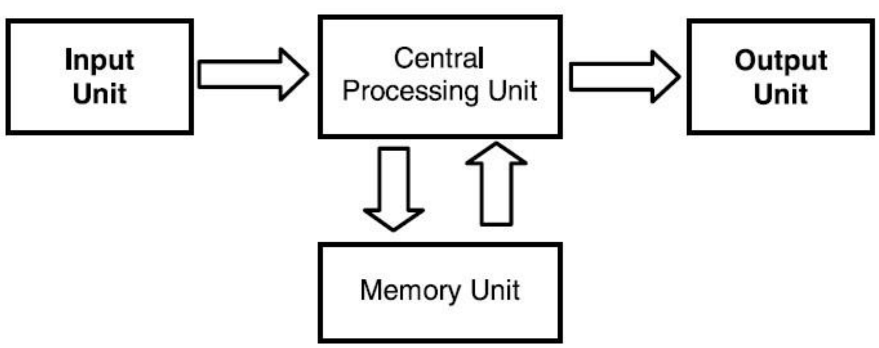


Figure 2: Functional Units of a Computer System

Input Unit

A computer uses input devices to accept the data and program. Input devices allow communication between the user and the computer. In modern computers keyboard, mouse, light pen, touch screen etc, are some of the input devices.

Output Unit

Similar to input devices, output devices have an interface between the computer and the user. These devices take machine coded output results from the processor and convert them into a form that can be used by human beings. In modern computers, monitors (display screens) and printers are the commonly used output devices

Central Processing Unit

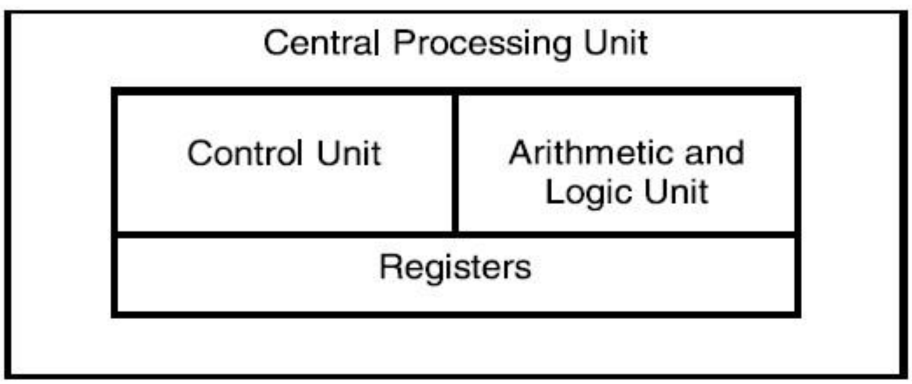


Figure 3. Central Processing Unit

Central processing unit (CPU) is the brain of any computer system. It is just like the human brain that takes all major decisions, makes all sorts of calculations and directs different parts of the computer function by activating and controlling the operation. It consists of arithmetic and logic units, control unit and internal memory (registers). The control unit of the CPU coordinates the action of the entire system. Programs (software) provide the CPU, a set of instruction to follow and perform a specific task.
Between any two components of the computer system, there is a pathway called a **bus.**
A **bus** is a group of wires on the main circuit board of the computer. It is a pathway for data flowing between components. Most devices are connected to the bus through a controller which coordinates the activities of the device with the bus.

Control unit controls all the hardware operations, i.e, those of input units, output units, memory unit and the processor. The arithmetic and logic units in computers are capable of performing addition, subtraction, division and multiplication as well as some logical operations. The instructions and data are stored in the main memory so that the processor can directly fetch and execute them.

Memory Unit

RAM is also known as main memory: A fast central processing unit is useless without an adequate amount of RAM (Random Access Memory). RAM is usually referred to as a computer's memory -- meaning it stores information that is used by running programs or applications. More memory lets you run more applications at the same time without degrading your system's performance.

The main memory holds data and program only temporarily. Hence there is a need for storage devices to provide backup storage. They are called secondary storage devices or auxiliary memory devices. Secondary storage devices can hold more storage than main memory and is much less expensive. All modern computers use Von – Neumann concept to store program.

The essentials of the stored program concept are

I. The program and data are stored in a primary memory (main memory).
II. Once a program is in memory, the computer can execute it automatically without manual intervention.
III. The control unit fetches and executes the instructions in sequence one by one.
IV. An instruction can modify the contents of any location in the stored program concept is the basic operating principle for every computer.

Central Processing Unit

The CPU is the brain of the computer system. It performs arithmetic operations as well as controls the input, output and storage units. The functions of the CPU are mainly classified into two categories:

- Co – ordinate all computer operations
- Perform arithmetic and logical operations on data

The CPU has three major components.

1. Arithmetic and Logic Unit
2. Control Unit
3. Registers (internal memory)

The arithmetic and logic unit (ALU) is the part of CPU where actual computations take place. It consists of circuits which perform arithmetic operations over data received from memory and are capable of comparing two numbers.

The **control unit** directs and controls the activities of the computer system. It interprets the instructions fetched from the main memory of the computer, sends the control signals to the devices involved in the execution of the instructions.

While performing these operations the ALU takes data from the temporary storage area inside the CPU named **registers**. They are high-speed memories which hold data for immediate processing and results of the processing.

Some other parts of the computer that are inside

Hard Disk Drive: The hard disk drive (HDD) of the computer is where permanent information is stored. Documents, databases, spreadsheets, and programs are all stored on the hard disk. The larger the hard disk, the more you can fit on the drive. The size of the HDD does not affect the speed at which a program can run, but the HDD speed can affect how fast you can access your files.

Video Card: The video card is a board that plugs into the PC motherboard to give it display capabilities. New video cards come with their own RAM and processor to help speed up the graphics display. Many computers come with video chips built in. That makes a separate video card unnecessary, unless the computer is going to be used for high-end multimedia work or to play video games.

Sound Card: Like video cards, sound cards are expansion boards used for enabling a computer to manipulate sound. Most sound cards give you the power to plug in speakers and a microphone. Some even give you the jacks for hooking your computer up to a common stereo. As with video cards, many computers come with sound chips, making it unnecessary to buy a separate card, unless you need higher sound quality for your work.

Modem: The modem allows your computer to use a telephone line to communicate and connect to the Internet.

Network Card: A network card allows your computer to be connected either to other computers or to the Internet if you are using a fast Internet connection such as cable or dsl.

Fans: One or more fans inside the computer keep air moving and keep your computer cool.

Cables: Numerous wires and flat, ribbon-like cables provide power and communication to the various parts inside your computer.

2.2.2 Operating System

What is an Operating System?

An Operating System (OS) is a program that acts as an intermediary between the user of a computer and computer hardware. It provides an environment in which other programs can do useful work. It controls execution of programs to prevent errors and improper use of the computer. The OS manages these resources and allocates them to specific programs and users. With the management of the OS, a programmer is rid of difficult hardware considerations.

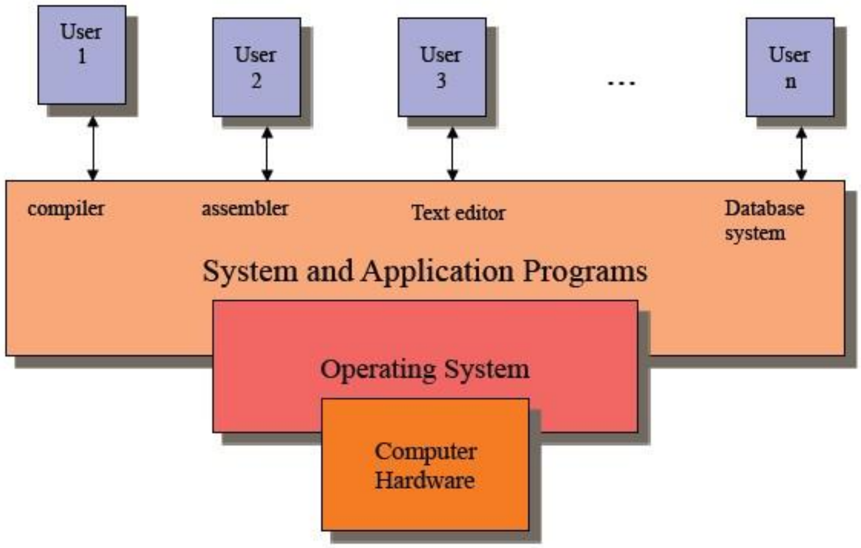


Figure 4: System Units

Functions of an Operating System

1. Simplify the execution of user programs and make solving user problems easier.
2. Allow sharing of hardware and software resources.
3. Make application software portable and versatile.
4. Provide isolation, security and protection among user programs.
5. Improve overall system reliability, fault tolerance, reconfiguration.

Reasons for Studying Operating Systems

a) There is need to understand interaction between the hardware and applications e.g new applications, new hardware.
b) Need to understand basic principles in the design of computer systems for efficient resource management, security, and flexibility.
c) Increasing need for specialized operating systems e.g. embedded operating systems for devices - cell phones, sensors and controllers. Other areas include real-time operating systems such as vehicles, aircraft control, multimedia services.

Operating System services

a) An operating system provides services to programs and to the users of those programs. It provided by one environment for the execution of programs.
b) The common service provided by the operating system is listed below.

i. **Program execution**: Operating system loads a program into memory and executes the program. The program must be able to end its execution, either normally or abnormally.

ii. **Input/output Operation**: I/O means any file or any specific I/O device. Program may require any I/O device while running. So operating system must provide the required I/O.

iii. **File system manipulation**: Program needs to read a file or write a file. The operating system gives the permission to the program for operation on file.

iv. **Communication**: Data transfer between two processes is required for some time. The both processes are on the one computer or on different computer but connected through computer network. Communication may be implemented by two methods:

   a. Shared memory

   b. Message passing.

v. **Error detection**: error may occur in CPU, in I/O devices or in the memory hardware. The operating system constantly needs to be aware of possible errors. It should take the appropriate action to ensure correct and consistent computing.

Batch system

Batch operating system is one where programs and data are collected together in a batch before processing starts. Some computer systems only did one thing at a time. They had a list of the computer system may be dedicated to a single program until its completion, or they may be dynamically reassigned among a collection of active programs in different stages of execution.
Memory is usually divided into two areas in batch system: Operating system and user program area.

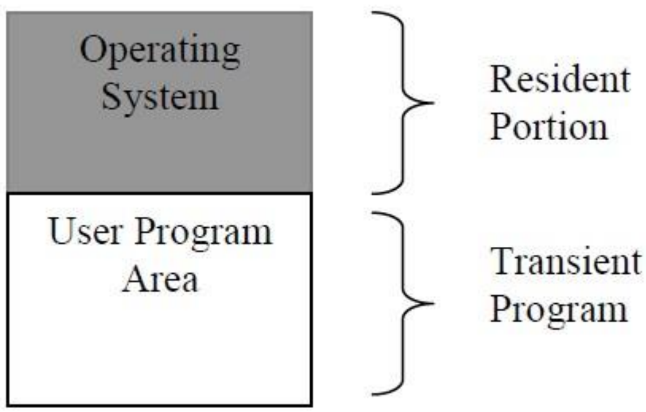


Figure 5: Memory layout of a simple Batch system

Advantages of Batch System

- Move much of the work of the operator to the computer.
- Increased performance since it was possible for job to start as soon as the previous job finished.

Disadvantages of Batch System

- Turn around time can be large from user standpoint.
- Difficult to debug program.
- A job could corrupt the monitor, thus affecting pending jobs.

Time-sharing system
Time-sharing system or multitasking**:** multiple users have *terminals* (not computers) connected to a *main computer* and execute her task in the main computer. It allows many users to share the computer simultaneously, each user is given the impression that she has her own computer, whereas actually one computer is being shared among many users.

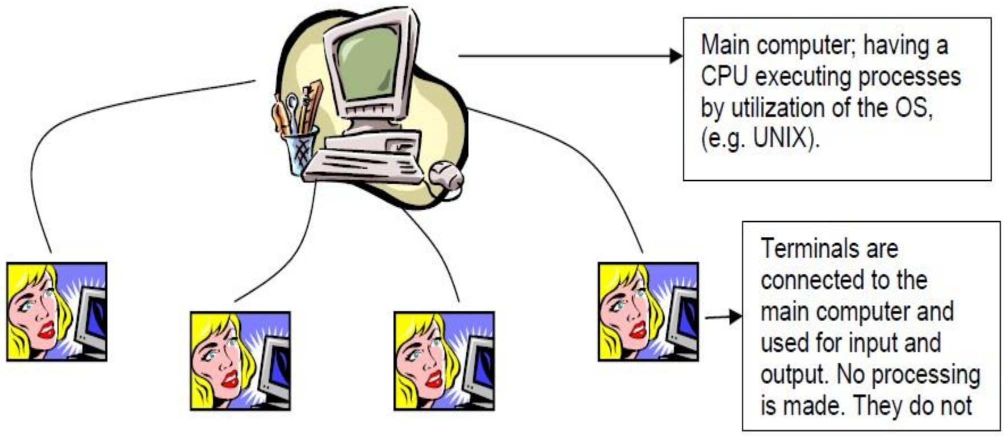


Figure 6: Time-sharing system

Multiprocessor system

A **multiprocessor** is a computer system having two or more processing units (multiple processors) each sharing main memory and peripheral devices, in order to simultaneously process programs. The processors are tightly connected by a –high-speed‖ interconnect.
Examples of multiprocessor Operating System are Solaris, Linux, and Windows 2000.

Multiprogramming system

Multiprogramming: When two or more programs are in memory at the same time, sharing the processor is referred to the multiprogramming operating system. Multiprogramming assumes a single processor that is being shared. It increases CPU utilization by organizing jobs so that the CPU always has one to execute. The operating system keeps several jobs in memory at a time. This set of jobs is a subset of the jobs kept in the job pool. The operating system picks and begins to execute one of the jobs in the memory.

Advantages
1. High CPU utilization.

2. It appears that many programs are allotted CPU almost simultaneously.

Disadvantages
1. CPU scheduling is requires.

2. To accommodate many jobs in memory, memory management is required.

Distributed system
Distributed : Distributes computation among several physical processors. The processors do not share memory or a clock. Instead, each processor has its own local memory. They communicate with each other through various communication lines.

2.2.3 Application Packages

Application packages are bundle of two or more computer programs or packages designed to enable the computer to solve a specific task. For example, the word processor package will enable the user to type, print and store documents in their computer in a manner they appreciate and understand.

Examples of application packages:

Word processing: for writing letters, reports and other documents. Examples: Microsoft Word, Word Perfect. Facilities include: editing of text, font & size changing, find & replace, spell checker, word count, mail merging (*combining data from a database with text in a standard letter to produce customised letters*).

Spreadsheet modeling: for producing invoices and cost plans. It can be used to create models, simulations or expert systems for others to use. Examples: Microsoft Excel, Microsoft Access.
Facilities include: entry of formulas to perform calculations, also ability to display data in graphical and chart form. Acts rather like a multifunction pocket calculator, but once set up for a particular purpose there is no need to remember all the formula and functions each time you use it.

Graphics package: for drawing and painting. Examples: Microsoft Paintbrush, Serif Photoshop.
Facilities include: cropping, resizing, various digital filters, drawing, painting and editing tools.

Presentation software: for demonstrations and lectures to live audiences.
Examples: Microsoft PowerPoint.
Facilities provided to produce and edit on screen multimedia presentations involving text, images, video and sound.

Music (Audio) software: for composing a musical performance.
Example: Sibelius.
Facilities provided to create, edit, store, print and play scripts; to record, process and replay a variety of sounds via input from a music keyboard and other "midi" instruments.

Advantages of application packages

The advantages of application packages are more than the disadvantages as discussed

1. An application package meets the exact needs of the user. Since it is designed specifically with one purpose in mind, the user knows that he has to use one specific package to accomplish his task.
2. The threat of viruses invading custom-made applications is very small, since any business that incorporates it can restrict access and can come up with means to protect their network as well.
3. Licensed application software gets regular updates from the developer for security reasons. Additionally, the developer also regularly sends personnel to correct any problems that may arise from time to time.
4. They are efficient in terms of speed, storage and documentation.
5. They are properly documented.

Disadvantages of application packages

There are certain disadvantages of application packages. Though these are not spoken about very often, nor are they highlighted, the fact is that they do exist and affect certain users. But people have accepted these misgivings and still continue to use such software because their utility and importance is much more profound than their disadvantages.

1. Developing application software designed to meet specific purposes can prove to be quite costly for developers. This can affect their budget and their revenue flow, especially if too much time is spent developing software that is not generally acceptable.
2. Some software that are designed specifically for a certain business, may not be compatible with other general software. This is something that can prove to be a major stumbling block for many corporations.
3. Developing them is something that takes a lot of time, because it needs constant communication between the developer and the customer. This delays the entire production process, which can prove to be harmful in some cases.
4. Application software that is used commonly by many people, and then shared online, carries a very real threat of infection by a computer virus or other malicious programs.
5. If computer virus or other malicious programs enter your whole data then packages will be damaged including computer.

Practice Questions

1. List four main components of a computer system.
2. Explain the following terms. Give examples of each
    - Input unit
    - Output unit
    - Memory unit
3. What is a **bus** in a component of computer system?
4. Differentiate between main memory and hard disk drive (HDD).
5. What are the functions of CPU in a computer?
6. Define Operating System?
7. Explain various function of operating system?

8. Differentiate between Multitasking and Multiprogramming
9. Explain the term multiprocessor.
10. List and explain five operating system serves.
11. List five application programs and give two functions of each.
12. Give four advantages and three disadvantages of application packages.

Section C: Program Development: Algorithm, Pseudocode and Flowchart

Objectives:
Explain the meaning of program
Mention and use programming development tools

3.1 Computer Program

A computer program, or just a program, is a sequence of instructions, written to perform a specified task with a computer. A computer requires programs to function, typically executing the program's instructions in a central processor. Computer programs are written by computer programmer.

Computer programs can be classified into:

Machine Program;

Assembly language program and

High Level program.

Thus there are three levels of programming languages: Machine language, Assembly language and High level language.

Machine language is the fundamental language of the computer's processor, also called Low Level Language; all programs are converted into machine language before they can be executed; it consists of combination of 0's and 1's that represent high and low electrical voltage. Programs written in machine code do not need further conversion. Assembly language is a low level language that is similar to machine language; it uses symbolic operation code to represent the machine operation code; it makes use of an assembler to convert the language code to machine code.

High level language is computer (programming) languages that are easier to learn; uses English like statements. Examples are C ++, Visual Basic, Pascal, Fortran and C# etc. Program written in high level language need to be translated into machine readable code using either compiler or interpreter. That is there are two ways to run programs written in a high-level language. The most common is to compile the program; the other method is to pass the program through an interpreter. An interpreter is a computer program that directly executes, i.e. *performs*, instructions written in a programming or scripting language, without previously compiling them into a machine language program. An interpreter generally uses one of the following strategies for program execution:

1. parse the source code and perform its behavior directly

2. translate source code into some efficient intermediate representation and immediately execute this.
3. explicitly execute stored precompiled code made by a compiler which is part of the interpreter system.

An interpreter translates high-level instructions into an intermediate form, which it then executes. In contrast, a compiler translates high-level instructions directly into machine language. A **compiler** is a computer program (or set of programs) that transforms source code written in a programming language (the source language) into another computer language (the target language, often having a binary form known as object code). The most common reason for converting a source code is to create an executable program. Compiled programs generally run faster than interpreted programs.

The advantage of an interpreter, however, is that it does not need to go through the compilation stage during which machine instructions are generated. This process can be time-consuming if the program is long. The interpreter, on the other hand, can immediately execute high-level programs. For this reason, interpreters are sometimes used during the development of a program, when a programmer wants to add small sections at a time and test them quickly. In addition, interpreters are often used in education because they allow students to program interactively. Both interpreters and compilers are available for most high-level languages. However, BASIC and LISP are especially designed to be executed by an interpreter. In addition, page description languages, such as PostScript, use an interpreter. Every PostScript printer, for example, has a built-in interpreter that executes PostScript instructions.

3.2 Program Development Steps/Stages

Step 1: Understand the Problem
- What is the input?
- What is the output?
- What is the relationship between the input and output? What formulas or techniques do we need?

Step 2: Do a small example by hand
Step 3: Write an algorithm to solve the problem: use pseudocode or flowchart
Step 4: Coding: translate the algorithm into a programming language
Step 5: Test the program. Testing may result in Compilation (parse) errors, Logic errors
Errors and the will require you to return to some step.
Step 6: Implementation of correct running program to solving the required tasks.

Note that in each of the stages above, proper documentation is required with the view of keeping the records and details of activities in each stage. Proper documentation makes it easy for quick understanding of the program details by people that were not involved at the initial development of the program.

3.3 Algorithm

Before writing one piece of computer code, it is important to know what the program is supposed to do. Hence going straight to coding can be very confusing. It is a good idea to write a program in a simple way first to ensure that all requirements are included before writing one line of code in any language. Thus this can be achieved using Algorithm.

Definition: An algorithm is a systematic logical approach used to solve problems in a computer.

It is a finite set of steps defining the solution of a particular problem.
To be an algorithm, a set of rules must be unambiguous and have a clear stopping point. Algorithms can be expressed in any language, from natural languages like English or French to programming languages like FORTRAN, C, Basic etc.

An **algorithm** is procedure consisting of a finite set of unambiguous rules (instructions) which specify a finite sequence of operations that provides the solution to a problem, or to a specific class of problems for any allowable set of input quantities (if there are inputs).

In other word, an algorithm is a step-by-step procedure to solve a given problem.

Alternatively, we can define an algorithm as a set or list of instructions for carrying out some process step by step.

A recipe in a cookbook is an excellent example of an algorithm. The recipe includes the requirements for the cooking or ingredients and the method of cooking them until you end up with a nice cooked dish.

In the same way, algorithms executed by a computer can combine millions of elementary steps, such as additions and subtractions, into a complicated mathematical calculation. Also by means of algorithms, a computer can control a manufacturing process or coordinate the reservations of an airline as they are received from the ticket offices all over the country. Algorithms for such large-scale processes are, of course, very complex, but they are built up from pieces.

3.3.1 Rules for constructing an Algorithm

The following points should be kept in mind when creating algorithms:

a. **Input**: These are data to be supplied for processing.
b. **Output**: At least one result is to be produced.
c. **Definiteness:** Each step must be clear and unambiguous.
d. **Finiteness:** If the steps of an algorithm are traced, then for all cases, the algorithm must terminate after a finite number of steps.
e. **Effectiveness:** Each step must be sufficiently basic that a person using only paper and pencil can in principle carry it out. In addition, not only that each step is definite, it must also be feasible.
f. **Comment Session:** Comment is additional info of program for easy modification. In algorithm comment would be appear between two square bracket

3.3.2 Tools to Represent Algorithm

There are two commonly used tools to help to represent algorithm (or document program logic). These are: **Pseudocode** and **Flowcharts.**

3.4 Pseudocode

Pseudocode is a simple way of writing programming code in English. Pseudocode is not an actual programming language. It uses short phrases to write code for programs before you actually create it in a specific language. Once the objective of a program is known and how it functions, then pseudocode can be used to create statements to achieve the required results for the program.

Pseudocode is a detailed yet readable description of what a computer program or algorithm must do, expressed in a formally-styled natural language rather than in a programming language. Pseudocode is sometimes used as a detailed step in the process of developing a program. It allows designers or lead programmers to express the design in great detail and provides programmers a detailed template for the next step of writing code in a specific programming language.

Because pseudocode is detailed yet readable, it can be inspected by the team of designers and programmers as a way to ensure that actual programming is likely to match design specifications. Catching errors at the pseudocode stage is less costly than catching them later in the development process. Once the pseudocode is accepted, it is rewritten using the vocabulary and syntax of a programming language. Pseudocode is sometimes used in conjunction with computer-aided software engineering-based methodologies.

Examples of pseudocode

Example 1: Write the pseudocode to calculate the sum and average of two numbers.

<u>Solution</u>

```
[pseudocode for calculate sum and average of two numbers]
Step1 : Start
Step2 : Read two numbers n,m
Step3 : Calculate sum=n+m
Step4 : Calculate avg=sum/2
Step5 : Print sum,avg
Step5 : Stop
[End of pseudocode for calculate sum and average of two numbers]
```

Example 2: Write the pseudocode to compute the area of a triangle given the base and the height of the triangle. (Hint: Area = ½ * base * height)

Solution

[pseudocode for calculate area of a triangle]
Step1 : Start
Step2 : Read two numbers base, height
Step3 : Calculate area = ½ * base * height
Step4 : Print area, base , height
Step5 : Stop
[End of pseudocode for calculate sum and average of two numbers]

Example 3. Write the psuedocode to find out number is odd or even?

Solution

```
[psuedocode to find out if a number is odd or even]
step 1 : start
step 2 : input number
step 3 : rem=number mod 2
step 4 : if rem=0 then
            print "number even"
         else
            print "number odd"
         endif
step 5 : stop
[End of pseudocode to find out number is odd or even]
```

Example 4: Sola AD Ltd is into plastic production and the required working hours is between 8.00am to 4.00pm daily. An employee can choose to work extra hours for a minimum of 3 hours and maximum of 5 hours on daily basis in addition to the regular daily working hours. On regular working hour, employee wage per hour is N500.00. On extra hour hours worked, wage per extra hour worked is N50.00. The company is opened for work only from Monday to Friday every week. Write the pseudocode that will accept employee ID number, employee name, daily working hours of employee and help the company to compute the daily wage received by employee

Solution

[psuedocode to compute employee daily wage]
Step 1: Start
Step 2: Read the employee ID Number, employee name, employee daily working hour

Step 3: Test if employee daily working hour exceed 8 hours and calculate the extra hour worked and compute the employee daily wage.
If employee daily working hour > 8 hours then
Employee extra hour = employee daily working hour – 8
Employee daily wage = 8 * 500.00 + (employee extra hour * 50.00)
Otherwise
Employee daily wage = employee daily working hour * 8
End If
Step 5: Output the employee ID number, employee name, employee daily wage
Step 6: Stop
[End of pseudocode to compute employee daily wage]

Example 5 Write the pseudocode that will accept continuous assessment (CA) mark scored by student, examination mark scored by student. CA is a maximum of 30% while examination mark is a maximum of 70%. There are instances where the total marks of CA done by lecturer may be above 30% and also the total marks of examination set be lecturer may be above 70%. The pseudocode should scale down the student's CA and examination mark to 30% and 70% respectively if it happens that the CA and examination marks exceed the 30% and 70% respectively. The sum of the CA and the examination mark is computed. The pseudocode should display whether a student is successful or not. A student is successful if the overall mark (i.e. sum of CA and Examination mark) is greater than or equal to 45%.

<u>Solution</u>

[psuedocode to compute student performance]
Step 1: Start
Step 2: Input values for Total_CA_Score_by_lecturer, Total_Exam_score_from_lecturer, CA_scored_by_student, Exam_Mark_scored_by_student,
Step 3: [Test if both CA and Exam_Mark exceed their respective maximum and scale down where needed]

If CA_scored_by_student > 30 then
CA_scored_by_student = (CA_scored_by_student / Total_CA_Score_by_lecturer) * 30
End if

If Exam_Mark_scored_by_student > 70 then
Exam_Mark_scored_by_student = (Exam_Mark_scored_by_student / Total_Exam_score_from_lecturer) * 70
End if
Step 4: [Compute student overall mark]
Student_overall_mark = CA_scored_by_student + Exam_Mark_scored_by_student
Step 5: [Test to determine if a student is successful or not]

If Student_overall_mark > = 45 then
    Output ―The student is successful‖
Else
    Output ―The student is not successful‖
End if
Step 6: Stop
[End of pseudocode to determine student performance]

3.5 Flowchart

(Dictionary definition): Flowchart is a schematic representation of a sequence of operations, as in a manufacturing process or computer program.

Technically, a flowchart is a graphical representation of the sequence of operations in an information system or program is called a flowchart. Information system flowcharts show how data flows from source documents through the computer to final distribution to users. Program flowcharts show the sequence of instructions in a single program or subroutine. Different symbols are used to draw each type of flowchart.

Flowcharting is a tool developed in the computer industry, for showing the steps involved in a process. A flowchart is a diagram made up of *boxes*, *diamonds* and other shapes, *connected by arrows* - each shape represents a step in the process, and the arrows show the order in which they occur. Flowcharting combines symbols and flow lines, to show figuratively the operation of an algorithm.

Computer program flowcharts are used to show control flow in a computer program. It is sometimes used to show an algorithm without writing the code. Sometimes they are used for training purposes for beginner programmers who don't know programming codes but can understand graphical symbols in flowcharts.
A flowchart is a logic diagram to describe each step that the program must perform to arrive at the solution. A popular logic tool used for showing an algorithm in graphics form.

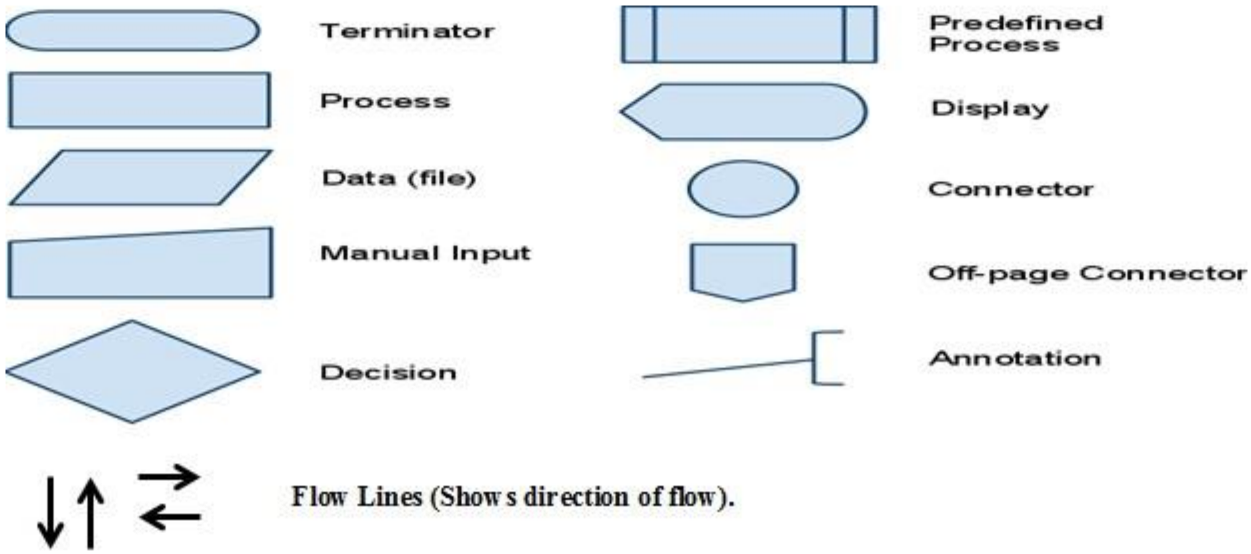
A Flowchart

a. shows logic of an algorithm
b. emphasizes individual steps and their interconnections
c. control flow from one action to the next

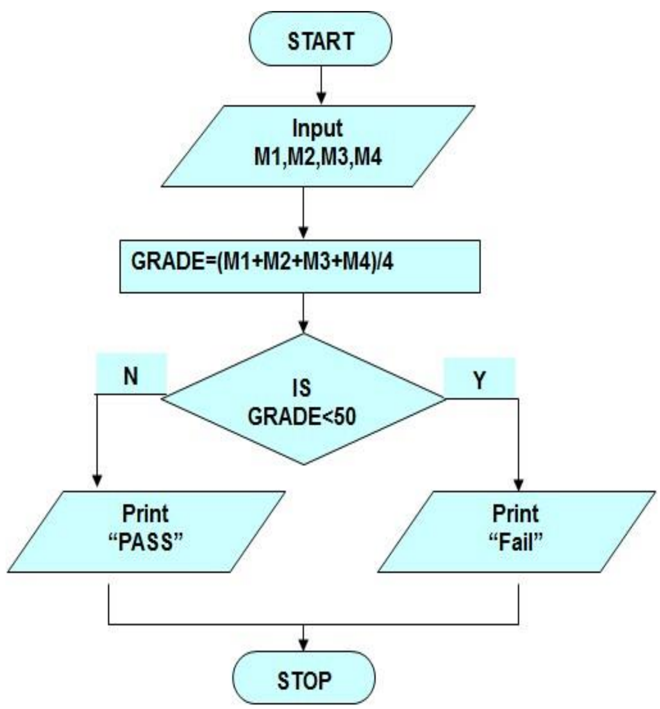
Sometimes flowcharts are partitioned into 4 groups:

a. **Document flowcharts**: showing controls over a document-flow through a system.
b. **Data flowcharts**: showing controls over a data flows in a system.
c. **System flowcharts**: showing controls at a physical or resource level.
d. **Program flowchart**: showing the controls in a program within a system.

Flowchart symbols:



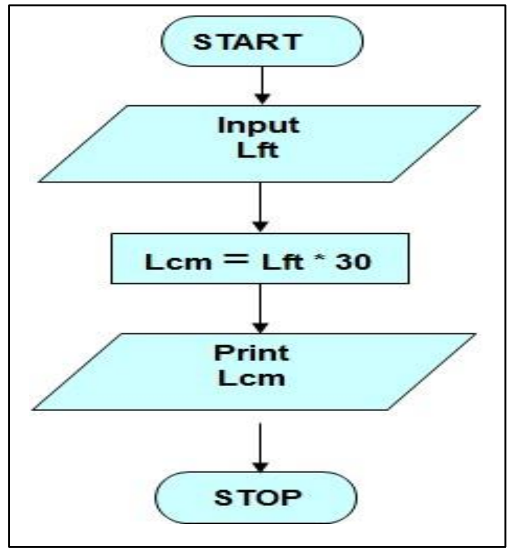
Example 1: Draw the flowchart and write the pseudocode to determine a student's final grade and indicate whether it is passing or failing. The final grade is calculated as the average of four marks.



Step 1 Start
Step 2: Input M1,M2,M3,M4
Step 3: GRADE ← (M1+M2+M3+M4)/4
Step 4: if (GRADE <50) then
    Print "FAIL"
  else
    Print "PASS"
  Endif
Step 5: Stop

Example 2: Draw the flowchart and write the pseudocode to convert the length in feet to centimeter

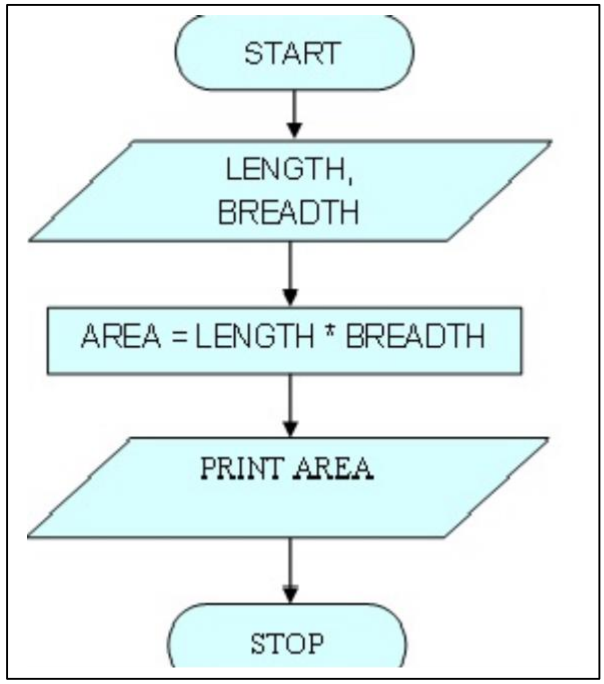
Step 1: Start
Step 2: Read Lft
Step 3: Lcm = Lft *30.48
Step 4: Print Lcm
Step 5: Stop



Example 3: Draw the flowchart and write the pseudocode that will read the two sides of a rectangle and calculate its area.

Pseudocode **Flowchart**

Step 1: Start
Step 2: Read Length, Breadth
Step 3: [Compute Area]
Area = Length * Breadth
Step 4: Print Area
Step 5: Stop

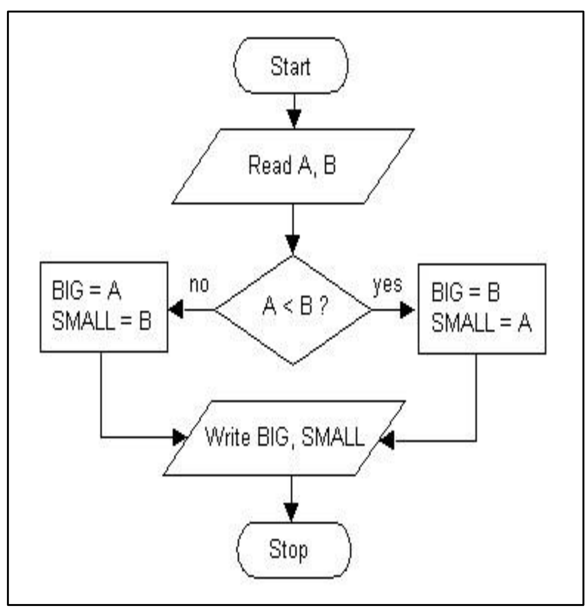


Example 4: Draw the flowchart and write the pseudocode that reads two values, determines the larger value and prints the larger and smaller value with an identifying message.

Pseudocode **Flowchart**

Step 1: Start
Step 2: *Input* A, B
Step 3: *if (A< B) then*
MAX ← B
SMALL ← A
else
MAX ← A
SMALL ← B
endif

Step 4: *Print "The largest value is", MAX, SMALL*
Step 5: Stop



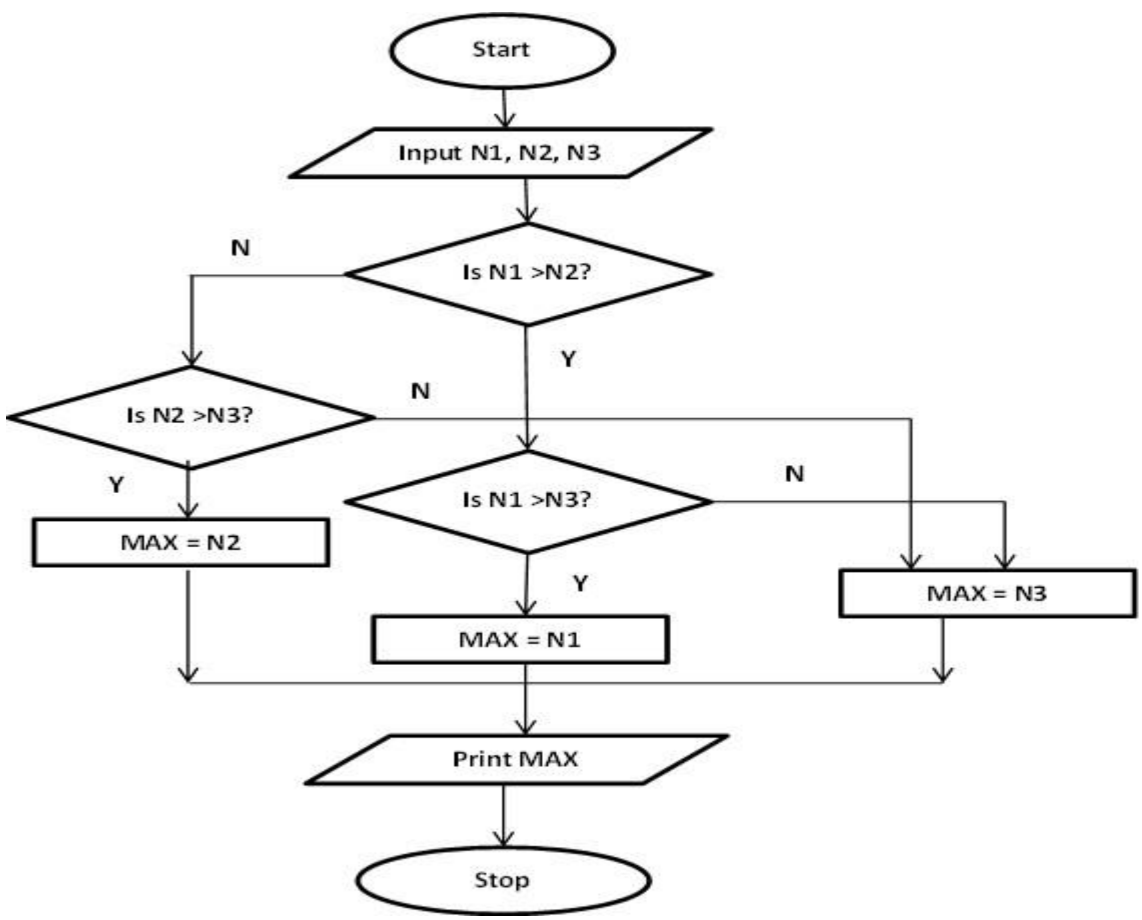
Example 5: Draw the flowchart and write the pseudocode that reads three numbers and prints the value of the largest number.

Pseudocode

Step 1: Start
Step 2: *Input* N1, N2, N3
Step 3: *if (*N1>N2) *then*
        *if (*N1>N3) *then*
                MAX ← N1 [N1>N2, N1>N3]
        else
                MAX ← N3 [N3>N1>N2]
        endif

        *else if (*N2>N3) *then*
                MAX ← N2 [N2>N1, N2>N3]
        else
                MAX ← N3 [N3>N2>N1]
        endif
        endif

Step 4: *Print "The largest number is", MAX*
Step 5: Stop



Section D: Applications of Computing

- Computer application areas and technological trends
- Using personal computers as effective problem solving tools for the present and the future

4.0 Application areas of Computer Science

The applications of computers have been widely accepted and deployed in almost every human endeavours. It is a known requirement for today's professionals to know about computers in other to enhance their on-the-job performance effectively in this information age. The purpose of this section is to:

- introduce the computer applications in various areas
- present the effects of computers on society

4.1.1 Computers in Scientific Applications

Computers are used extensively in science. For example, meteorologists use computers to study the formation of tornadoes. Computers can also be used to simulate automobile accidents on screen. In this unit, we will introduce the use of computers in modeling and simulation, and weather forecasting.

1. Modeling

Computer modeling is the use of computers to create abstract models of real life objects, organisms, situations, or systems. A computer model is not static, you can feed data in and examine how it behaves under certain conditions. E.g. A financial manager can create a spreadsheet to project the profit and loss of his company.

2. Simulation of experiments

A computer simulation refers to the use of computers to execute a model. It is represented by a computer program that gives information about the object, situation or system being examined.

Advantages of computer modeling and simulation:

- It is much ***cheaper*** to use a simulator to train pilots rather than using the real planes or ships.
- Some demonstrations or experiments are too ***dangerous*** to be conducted. A simulation is an alternative.
- Computer simulations can serve as a ***time machine*** for exploring the future. For example, it could take the biologists many years to study whether the rising tiger population in a forest threatens other animals. A computer model of the forest would speed up the biological processes, and the biologists can study their effects over several generations in a few minutes.
- In many cases, the experiments are required to ***repeat*** with different conditions. Replication on a computer model is simple and requires just a matter of changing some input data and running a new simulation.

- In some experiment simulations, users can control the speed of the simulated motion or process. This facilitates users to ***see and understand the relationships***.

3. Weather forecasting

Several government agencies collect a lot of weather data from satellites, weather balloons, airplanes in flight, ground weather stations and overseas reports on a per minute basis every day. It is however, practically cumbersome or impossible for the scientists to process and analyze them manually. Hence, high-speed computers play a significant role in gathering and analyzing these data.

In order to provide more timely and reliable weather forecasts, the Hong Kong Observatory has acquired a CRAY supercomputer. This supercomputer takes less than one hour to produce a 24-hour forecast using a 20 km by 20 km grid high-resolution numerical weather prediction model. Note that the old computer takes more than 5 months to perform the same calculation.

The computers also support scientists to develop new weather models for improving the quality of weather forecast.

4.1.2 Computers in Medicine

4.1.3 Computers in Industrial Applications

Although drafting tables and T-squares are still around, more and more engineers and architects are designing products with computers. In this unit, we will introduce the use of computers in design, manufacturing and transportation.

1. Computer-Aided Design (CAD)

Computer-aided design is a term that refers to the use of computers and graphics-oriented software to aid in the design process. CAD systems allow engineers to create two-dimensional or three-dimensional electronic objects. They also enable the designers to view the objects from different perspectives.

What are the advantages of a CAD system?

- It allows a designer to modify the design more easily than traditional manual drafting.
- It allows a designer to view the object from different perspectives. Hence, the designer does not need to produce a different drawing for each view.
- It allows a designer to change the size of the object.
- It reduces the design time.

2. Computer-Aided Manufacturing (CAM)

Computer-aided manufacturing is a term that refers to the use of computers to control equipment drilling, welding and milling in the manufacturing process.

What are the advantages of CAM?

- The computer-controlled robot can perform tasks with precision and it is more accurate than a human.

- The computer-controlled equipment can perform dangerous and repetitive tasks for humans.
- The computer-controlled equipment reduces production costs because it does not require any annual leave, sick leave and other fringe benefits.

3. Transportation systems

Traffic lights control:- In order to ***optimise a traffic flow***, a computer system can be used to coordinate the signal timings of the adjacent traffic lights in a district. The system can monitor the traffic flows in real time by collecting traffic flow data from different traffic sensors placed at various locations. . Based on the current traffic flow situation, the system will send signal control instructions to the traffic lights to adjust their signal timings in order to minimise delays and reduce stopping time.

To ***flag the possible incidents*** on the road network, the system can also compare the current traffic flow profiles with a typical one. If there are significant differences, the system will give warning signals.

Bus/Train/Airline scheduling:- it is practically impossible to produce an optimised transportation timetable manually due to the complexity in manipulating vehicular, train and aircraft movements. Hence, a computer is used with a timetabling algorithm to generate a travel schedule to dispatch and reverse buses, trains and aircrafts based upon the required headway (time between two successive trips) at different periods in time.

4.1.4 Computers in Education

The capability of interacting with learners makes computers as powerful tools for enhancing the process of learning. In addition, computers also play an important role in searching information and school administration. Computers are used in the educational sector as learning and teaching tools, and as administrative tools.

1. Computer Assisted Learning (CAL)

Computer assisted learning is a term which refers to the use of computers in assisting learning. For example, a teacher may use a graph plotting software to demonstrate the behaviour of different functions in a mathematics lesson; a student may use a drill-and-practice program to practice what he/she has just learnt from a lesson or use a tutorial program to enhance a skill or a subject.

What are the advantages of CAL?

- The multimedia contents, such as special sound effects, animation and video can arouse students' interest in learning.
- Tedious practices in arithmetic and spelling can be turned into entertaining games. This makes learning more exciting and interesting.
- Some CAL softwares include testing and diagnostic features which allow teachers to identify common misconceptions of their students.
- CAL can provide immediate feedback to students.

- The automatic grading of exercises feature frees up teachers' resources that can be used for additional attention toward students.
- Students can learn at their own pace. This alleviates the pressure on the slow learners so that they can keep up with their peers.
- Students are free to make wrong answers because there is no peer group pressure. This encourages them to learn by trials and errors.
- Multimedia contents can help make difficult or abstract concepts simple.

2. Information searching

The World Wide Web is a system of interlinked hypermedia documents that enables users to find and retrieve information by navigating. A hypermedia document is a document that contains text, graphics, sounds, video and animation.

- How does a search engine work?
  Most search engines keep a huge index of the Web pages on the World Wide Web. This index is maintained by software agents, sometimes called spiders or software robots. They automatically search for new information on the Web and update the index. When the search engine receives a search request, it compares the input keywords to the entries in the index, and returns the results.

- Searching information on a CD-ROM
  Dictionaries, encyclopedias, maps and other specialized references are now available in CD-ROMs. Many of them also include multimedia capabilities.

- What are the advantages of the above-mentioned searching of information?
  - The World Wide Web is a tremendous information resource. It is your on-line library and information centre. With the access to this rich resource, you can work faster and smarter.
  - The use of graphics, sound, animation, and video can better explain certain topics or concepts than just using words.

3. Cyber schools (e-learning)

A cyber school is a school that uses the Internet as a delivery tool to offer courses. The hyperlinked multimedia course materials and video lectures are made available on the Web. By utilizing video-conference, tutors can talk to students in various locations and answer their questions in real time. Students can also exchange ideas through interactive discussion groups.

What are the advantages of cyber schools?

- Students can attend classes anytime, anywhere, and anyplace.
- Handicapped students can attend classes without commuting.
- The tuition fee of cyber schools is usually lower than that of the traditional schools.

4. Administrative tools

There quite a number of School Administration and Management Software System which have been implemented to provide administration and management supports for schools. These educational administration software aims to provide a computerized network system to schools for supporting the administrative and management processes, and for transmitting electronically information between schools and the Education and Manpower Bureau.

Some of the major functions of the educational administration software include the followings:

- School management
  - To maintain school information.
  - To collate data for the preparation of statistical reports and forms.

- Students' records and attendances
  - To maintain students' personal, performance and extra-curricular information.
  - To transmit students' information to the Education and Manpower Bureau through an electronic data exchange system.
  - To keep records of students' attendances.

- Students' assessments
  - To print students' assessment reports.
  - To support the operation of the allocation systems with assessment data.

- Staff records and deployments
  - To maintain teachers' and staffs' personal and duty information.

- Staff deployments
  - To keep records of staffs' absences.
  - To automate the process of deploying substitute teachers.
  - To transmit the vacation leave applications and substitute teachers appointment applications to the Education and Manpower Bureau through an electronic data exchange system.

- Timetabling
  - To schedule timetables which show lesson arrangements for classes, teachers and venues respectively.

4.1.5. Computers in Office Applications

The advance of computer technology supports a range of improved office activities. Here we introduced the applications of computers in various general office works.

1. Office automation (OA)

Office automation is the use of hardware, software and networks to enhance general office works such as communication among employees, and documents typing and filing.

2. Software in OA

Word processing software

Suppose your school wants to send a personalized letter to invite all the parents to attend a meeting. The contents of each letter are the same except for the names and addresses of the parents. Since typing individual letters to so many parents is a time-consuming task, with the help of the mail merge function of a word processing software, you can generate these personalized letters in a short time.

- ✓ **Spreadsheet software**

Suppose you want to know the effects of the change of import levy on the balance (surplus or deficit) of the budget. With the spreadsheet software, you only have to enter the new fee and the software will do the recalculation automatically. Without this software, you may have to spend a lot of time recalculating all the data to get to your new budget balance.

- ✓ **Database management software**

Suppose a teacher wants to find out how many students are living in Igbo Elerin. She enters the query into the computer and the database management software will give her the results instantly. Without this database management software, she will have to search the student records from the student files manually.

- ✓ **Presentation software**

Suppose you have to make a project presentation. With the presentation software, you can create all the slides easily with the layout provided by the software. You can also enhance your slides by applying special effects to the slide contents and the transitions between each slide. However, it is difficult to produce these effects manually.

- ✓ **Electronic mail (e-mail)**

Suppose the principal wants to hold an urgent meeting after school. He/She can inform every teacher by just sending one e-mail and the e-mail will be received almost instantly. Without an e-mail facility, he/she may have to circulate a memo among the teachers or post a notice on the notice board of each staff room.

4.1.6 Computers in Business Applications

Computers are widely used in business nowadays. In this subsection, we will introduce their uses in banking, supermarkets and transaction payments.

1. Automatic Teller Machine (ATM)

An ATM is a terminal specially designed for self-service banking. A typical ATM has the following input and output devices.

Input devices:

- A card reader: to capture the account information stored on the magnetic strips of the users' plastic cards.
- A keypad: to allow the users to enter transaction information.

Output devices:

- A monitor: to display information and instructions to users.
- A printer: to print transaction receipts.
- A cash dispenser: to deliver bank notes to users.

Services available on an ATM include

- Cash withdrawal
- Money transfer from one account to another
- Bills payment
- Checking of account balances
  - request cheque books and bank statements
  - change personal identification number

Design Framework for a typical transaction on an ATM

The following steps illustrate how an ATM works when a customer is withdrawing cash from it:

1. The customer inserts his/her plastic card into the card reader in the ATM.
2. The account information such as account number stored on the magnetic strip on the back of the plastic card is captured by the card reader.
3. The ATM will ask for a personal identification number (PIN).
4. Both the account information and the PIN are sent to the bank computer through the telephone network.
5. The bank computer verifies if the PIN is correct.
6. If the account number and PIN are valid, the customer can proceed with the transaction, otherwise, he/she has to re-enter the PIN.
7. The ATM requests the customer to select a type of transaction.
8. The customer selects the withdrawal transaction type and enters the amount to be withdrawn.
9. This information is sent to the bank computer.
10. The bank computer checks if the customer has sufficient balance for withdrawal. If yes, it authorises the ATM to dispense cash.
11. The ATM has a device to count each bank note as it exits the dispenser. The bank note count and all the information relating to the transaction are recorded in a journal. This journal will be referred to whenever the customer has a dispute about the transaction.
12. In addition to the bank note counting device, the ATM has a sensor to measure the thickness of each bank note. If two or more bank notes are stuck together, they will be diverted to a reject bin instead of being dispensed to the customer.

Advantages of an ATM

- It provides routine banking services 24 hours a day, 7 days a week.
- It helps banks save human resources, hence reducing their labour cost.

2. Internet banking

The following services can be accessed via the Internet banking platform of commercial banks:

- Fund transfer from one account to another.
- pay bills now or schedule future payments.
- check account balances and transaction history.
- access previous account statements.
- request cheque books.
- initiate stop payment requests.
- change personal identification number.
- trade stocks, view major indices and get stock quotes.
- view currency exchange and interest rates.
- place fixed-time deposits and change maturity instructions.
- apply for credit cards and various types of loans.
- enroll in insurance plans.

Equipment/Tools required to use Internet Banking services:

- a computer installed with communication device such as a modem.
- a reliable connection to the Internet through an Internet Service Provider.
- a secure browser to send and receive information over the Internet.
- a token

Operational Framework for Internet Banking

The following steps illustrate the operations of Internet banking:

- The customer connects his/her computer to the Internet.
- The customer accesses the homepage for the Internet banking services by typing the bank's URL.
- The customer enters his/her user ID and PIN.
- This information will be encrypted (i.e. coded) and transferred to the bank computer through the Internet.
- When the bank computer receives this encrypted information, it will decrypt (i.e. decode) it. All the information transferred between the customer computer and the bank computer are encrypted. The sender encrypts the information while the receiver decrypts it. This process is required in order to ensure no third party can reveal and use the information.
- The bank computer will check if both the user ID and PIN are valid.
- If so, the customer can proceed with the transaction, otherwise he/she is asked to re-enter the information again.

Advantages of Internet Banking

- It provides an access to a variety of banking services 24 hours a day, 7 days a week.

- The customers can manage their finances anytime, anywhere without visiting the bank in person.
- It helps to save the bank's human resources, hence reducing the operation cost.

3. Supermarket checkout counter

The checkout process in a supermarket involve the use of an Universal Product Code, Barcode Scanner and a Point of Sale terminal.

The ***Universal Product Code (UPC)*** is a system for uniquely identifying different products. Each product has its own unique code number on its label represented by a pattern of light and dark bars.

The ***Point of Sale (POS) terminal*** is a special-function elctornic device used to process card payments at retail outlets. In retail outlets, it is a combination of an electronic cash register, a bar code scanner or reader and software, a A POS terminal generally does the following:

- Reads the information off a customers credit or debit card
- Checks whether the funds in a customer's bank account are sufficient
- Transfer the funds from the customer's account to the seller;s account for the transfer withcredit/debit card network
- Records the transaction and prints a receipt

An E***lectronic Cash Register*** **(ECR)** is an electronic system for registering, calculating and storing sales transactions, and is usually attached to a printer that can print out receipts for record keeping purposes. ECR help large retail outlets to track sales, minimize register errors, collect and collate inventory data, and much more. It typically processed goods by

- Reading the information contained on a UPC using a barcode scanner or reader
- Checking the price database for the price mathing the information in the UPC
- Adding that price to the running total of all products being purchased by a customer
- Sending data to sales and inventory software after the sales transaction is completed
- The sales system is incomplete without other software that turn ECR data into operational signals.

A ***bar code scanner or reader*** (also called a price scanner or point-of-sale (POS) scanner), is a hand-held or stationary input device used to capture and read information contained in a bar code .

A barcode reader consists of a scanner , a decoder (either built-in or external), and a cableused to connect the reader with a computer. Because a barcode reader merely captures and translates the barcode into numbers and/or letters, the data must be sent to a computer so that a software application can make sense of the data.

Barcode scanners can be connected to a computer through a serial port , keyboard port , or an interface device called a wedge . A barcode reader works by directing a beam of light across the bar codeand measuring the amount of light that is reflected back. (The dark bars on a barcode reflect less light than the white spaces between them.) The scanner converts the light energy into electrical energy, which is then converted into data by the decoder and forwarded to a computer.

There are five basic kinds of barcode readers -- pen wands, slot scanners, Charge-Couple Device (CCD) scanners, image scanners, and laser scanners.

- A **pen wand** is the simplest barcode reader. It contains no moving parts and is known for its durability and low cost. A pen wand can present a challenge to the user, however, because it has to remain in direct contact with the bar code, must be held at a certain angle, and has to be moved over the bar code at a certain speed.

- A **slot scanner** remains stationary and the item with the bar code on it is pulled by hand through the slot. Slot scanners are typically used to scan bar codes on identification cards.

- A **CCD scanner** has a better read-range than the pen wand and is often used in retail sales. Typically, a CCD scanner has a "gun" type interface and has to be held no more than one inch from the bar code. Each time the bar code is scanned, several readings are taken to reduce the possibility of errors. A disadvantage of the CCD scanner is that it cannot read a bar code that is wider than its input face.

- An **image scanner**, also called a camera reader, uses a small video camera to capture an image of the bar code and then uses sophisticated digital image processing techniques to decode the bar code. It can read a bar code from about 3 to 9 inches away and generally costs less than a laser scanner.

- A **laser scanner**, either hand-held or stationary, does not have to be close to the bar code in order to do its job. It uses a system of mirrors and lenses to allow the scanner to read the bar code regardless of orientation, and can easily read a bar code up to 24 inches away. To reduce the possibility of errors, a laser scanning may perform up to 500 scans per second. Specialized long-range laser scanners are capable of reading a bar code up to 30 feet away.

Advantages of a computerised checkout system

- Prices retrieved by the computer from the file are more accurate than being retrieved by typing manually.
- It is easier to change prices because only updating the computer file is needed. Without the system, repeatedly restamping the price on each piece of the product is required.
- Checkout is faster.
- The labour cost is reduced.
- The computer can keep track of the quantity of each product left on the shelves and in the warehouse inventory; it can inform the manager when restocking and reordering are necessary.

- The raw sales data collected by the computer can be analysed to discover customer preferences and purchasing habits.

4. Smart cards

A smart card looks like a credit card in size and shape, but instead of a magnetic strip it contains an embedded microprocessor and memory. One popular use of smart cards is its stored value. Each time you use the card, the available of amount of currency (e.g Naira) is reduced.

Other applications of smart cards:

- Smart cards can be used to store personal data and medical information. In case of an emergency, the cardholder can be identified rapidly and doctors or hospitals can then provide improved treatments.
- Smart cards can be used as keys to log on to an online bank.
- Smart cards can be used as identity cards for students and employees. Since the identity with access privileges are stored on them, the cardholders can be granted access to certain departments/offices, facilities, equipment and data according to their status.
- They can also be used to track information such as business transactions or employee attendance.

What are the advantages of a smart card?

- It improves the convenience and security of any transaction.
- It provides reliable and fast payment.
- It eliminates the service provider's need to handle heavy coins. For example, the weight of the coins (bus fares) collected by KMB every day is reduced from 55 tons to 25 tons with Octopus in operation. This also reduces the operation cost.
- It provides a convenient way to carry data between systems.

4.1.7 Computers in Government and Democratic Studies

4.1.8 Computers in Mass Communications

Broadcasting, Journalism, Advertisement, Public Relations, Social Media

4.1.9 Computers in Legal and Jurispudence

4.1.10. Computers in Sports and Recreation

Sports and recreation are another areas area of computer application. You can play electronic golf at home. You can play chess with the computer as your opponent. Some software combine entertainment and education. In this unit, we will describe different types of computer games and explain why they have 'intelligence', edutainment and special movie effects produced by computers.

1. Computer games

Types of computer games:

- Adventure games
  In adventure games, the players become characters in situations they know only a little about. The characters will then encounter different phases of the adventure, and only successful problem solvings with the given resources and information will move them one step ahead to accomplish the required mission.
- Arcade games
  Arcade games are similar to games such as pinball and darts found in an amusement arcade.
- Strategy games
  Strategy games require the players to use strategies to win. They are often implemented as board games such as chess and backgammon.
- Simulation games
  Simulation games allow players to explore artificial environments, imaginary or based on the real world. The players can experience the consequences of their actions.
- Role-play games
  Role-play games assume the player the guise of a character and acts out that role.
- Psychomotor games
  Psychomotor games require intellectual and motor skills. Joysticks or game paddles are often used for input. For example, space games and computer-simulated sports games.
- Combat games
  Combat games require players pitting against each other until there is a clear winner.

2. Edutainment

Edutainment comes from two words: ***EDUcation and EnterTAINMENT.*** It means the combination of education with entertainment. Most of the edutainment software use multimedia elements to entertain users while they learn.

General ***guidelines*** for selecting educational software:

- **Aims and objectives:-** Does the software meet its stated aims and objectives? Does the software meet your instructional aims?

- **Subject content:-** Is the content appropriate to the curriculum? Is the content accurate? Is the content free of spelling, grammar and punctuation errors? Is the content free of racial and gender discrimination and other bias? Is the content free of violence?

- **Presentation:-** Is the presentation interesting? Is the sequence of presentation appropriate?
  Does the presentation encourage a high degree of learner involvement?

- **Surface features:-** Is the use of colours effective? Is the use of graphics and/or animations effective?Is the use of sound effective? Is the text easily readable on the screen?

- **Feedback:-** Does the software present effective feedback for correct responses? Does the software present effective feedback for incorrect responses? Does the software provide learners with a summary of performance?

- **Language:-** Is the readability of text appropriate for intended learners? Are the technical terms and jargon relevant?

- **Ease of use:-** Is minimum computer skills needed to use the software? Is the user interface easy to use? Are potential errors trapped? Does the software provide helpful messages to correct learner errors?

- **Student control:-** Can the learners control the rate of presentation? Can the learners control the sequence of learning? Can the learners control the time allowed for responding? Can the learners control the level of difficulty? Can the learners temporarily suspend the learning and resume it from the point of suspension? Can the learners review previous information?

- **Documentation:-** Are the user manual and installation guide included? Are the instructions clear and easy to understand? Are the aims and objectives clearly stated? Are the intended learners clearly stated? Are suggested ways to use included? Are other resource materials included?

4.2 Effects of Computers on Society

Even if you never touch a computer, computer technology still has an impact on your life. For example, your student record is kept on a computer, your bank statement is printed by a computer, the special effects in movies and TV commercials are produced by computers, and so on.

4.2.1 Information privacy

Information privacy refers to one's right to restrict or deny the collection and use of one's personal information.

Examples of ***ways personal information are collected*** through the Internet

- Many web sites send cookies (a small file that allows a web site to record users' data) to the user browsers to collect personal information such as users' interests, preferences, and surfing patterns on the web sites.
- In order to establish an e-mail account or become a member of a web site, you have to do a registration. In the registration process, you need to complete a questionnaire from which your personal information such as name, postal and e-mail addresses, telephone number and so on are gathered by the web site.

The misuse of personal information

New technology sometimes is not accepted by everybody. One may refuse to use e-mail or a credit card. The most common reason cited for this attitude is the fear of one's personal information being misused. Here are some examples of misuse of personal information:

- A magazine publisher may sell subscriber lists to direct marketers, fund-raisers, and others.
- An employee of a telephone company may be bribed by a loan collection company to provide addresses and telephone numbers of loan borrowers by performing computer searches.
- A company may send employees to the Registrar of Marriages offices to gather publicly accessible information about people who will marry in the next few weeks. Then, this information is sold to restaurants, bridal photography salons, travel agencies, real-estate agencies and so on so that they can market their business.

Guidelines for the collection and dissemination of personal information

- Individuals must be made aware of the organisation's policy on privacy information prior to the collection of their personal information.
- Individuals must be made aware of their choices as to how their personal information may be used. For example, individuals may have the option of not receiving any direct-mail advertisements.
- Information collected should be limited to what is required to fullfill the original stated purpose.
- There is a method of enforcement restricting the access to the information to those staffs who need it to perform their duties.
- Individuals must be assured that the information is accurate and secure.
- Individuals must have the opportunity to access their personal information and determine the accuracy of the data.

4.2.2. Computer crimes

i. **Theft by computers:-** Computers are being used to steal money, information, goods and computer services. Here are two examples:

   - A programmer in a bank modified a program to bypass the checking of the overdraft limit on his account. He then drew money from his account without a limit being imposed.
   - A student stole her teacher's computer account password by spying. She then made a copy of the examination questions file from her teacher's computer account.

ii. **Computer viruses:-** A computer virus is a piece of software written with a malicious intent to cause the computer to be infected and change its behaviour unexpectedly without the user's permission. Viruses are often designed to spread to other computers automatically. They can be transmitted by downloading infected game programs or files from other sites, sending them as e-mail attachments, or being present on a diskette.

Some viruses are activated as soon as the infected programs or files are used; other viruses lie dormant until certain conditions, such as a specific date or time, cause their code to be executed. Some viruses do nothing, displaying some unexpected messages on the screen, but some do destroy data on a disk or reformat a hard disk. Since many data are stored on computers today, loss of them by virus attacks will cost work time and financial loss.

4.2.3 Intellectual property

In order to combat intellectual property copyright infringements, the Intellectual Property (Miscellaneous Amendments) Ordinance 2000 was enacted by the Legislative Council in June 2000. The amended law came into operation on April 1, 2001.

a. Software acquisition:- Software licence: when a buyer is purchasing a software, he/she is not actually purchasing the software, but the licence to use the software on a computer. The licencing agreement specifies how the software should be used. For example, the number of copies users are allowed to make.

- ***Site licence:*** it is an agreement that grants the buyer of the software the right to use that software on a given number of computers. The price is less than that of buying a separate copy for each computer.
- ***Network version:*** it permits the buyer to purchase just one copy of the software (in network version) that can legally load into his/her network server.
- ***Shareware:*** it is a software distributed free for a trial period. If the user wants to use it regularly, he/she should pay for it on a honour system.
- ***Freeware:*** it is a software that is provided to users at no cost, but it is still copyrighted. It means resale of it is not allowed.

b. **Public-domain software:-** it is a freeware with no copyright restrictions.

Here are two **examples of** committing a **criminal offence** after the amended law t akes effect:

- An IT training instructor buys one copy of a software which is licenced for use in one computer only. But he installs this software in all the computers in the computer laboratory.
- An IT manager of a trading company buys one copy of an accounting software which is licenced for use in one computer only. But he asks his subordinate to install it in a LAN server for shared use by all the employees in the accounting department.

4.2.4 Ethical issues:- Ethics deals with what is considered right or wrong. In theory, one can distinguish between illegal acts and unethical acts. An illegal act breaks the law, but an unethical act may not break the law. In many cases, illegal acts are unethical as well.
Examples of ethical issues

- A teacher reads a student's e-mail.
- A student forwards an e-mail message to the whole class without permission from the e-mail sender.
- Your friend, who is not studying in your school, asks you to borrow your password to get access to your school computer system.
- The use of computers monitors the job performance of employees. For example, a computer program is used to monitor the typing speed of typists without the knowing of the typists.

4.2.5 Employment trends:- Computer usage can lead to displacement of some jobs which are formerly performed by humans, but it also creates new job opportunities. Somebody has to be employed to develop software, operate and repair computers and their peripherals, market computers and software and so on. The followings are some of the typical jobs generated by computers:

- Computer operators
- System analysts
- Application programmers
- System programmers
- Database administrators
- Network administrators
- Customer service engineers
- Web masters
- Computer instructors

Change of job skills

As the use of computers continues to grow in our society, jobs in every profession are being redefined. For example, twenty years ago the use of typewriters is a necessary skill for applying the post of secretary. Today, secretaries are required to know word processing software, e-mail and so on.

Here are ***some of other professions*** that might ***require computer knowledge***:

- Real-estate agents, lawyers, researchers and teachers need to use computers to search information.
- Reporters and writers need to use word processing software to write and change documents.
- Accountants, budget controllers, stockbrokers and insurance agents need to use spreadsheet software to analyse data.
- Engineers and architects need to use CAD software to design products or buildings.

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