1

Key concepts

- **Data and Information**
- **Data processing**
- **Functional units of a computer**
- **Computer as a data processor**
  - Characteristics of computer
- **Number system**
  - Decimal
  - Binary
  - Octal
  - Hexadecimal
- **Number conversions**
  - Decimal to binary
  - Decimal to octal
  - Decimal to hexadecimal
  - Binary to decimal
  - Octal to decimal
  - Hexadecimal to decimal
  - Octal to binary
  - Hexadecimal to binary
  - Octal to hexadecimal
- **Binary addition**
- **Data representation**
  - Representation of numbers
  - Representation of characters
  - Representation of audio, image and video

Fundamentals of Computer

Computers have now become an integral part of our daily life. People use computers for a variety of reasons and purposes. Be it education, business, entertainment, communication, government service or transportation, computers are inevitable today. As far as students are concerned, computers are used for learning different subjects effectively and for carrying out learning activities apart from their primary functions of computing. Try to recollect the situations where we used computers and identify the benefits you got from it. Therefore it is essential to know more about computers and its applications. This chapter presents the concepts of data processing and functional units of computer. Different data representation methods used in computers are also discussed in this chapter.

1.1 Data and Information

Many of us are familiar with the terms - data and information. We often use these terms interchangeably in our daily life. But there exists fundamental differences between these two. As part of our attempt to explore the field of computers, it is very essential to distinguish between these two terms.

Figure 1.1 shows a portion of the class diary of a teacher. Can you make out the words and numbers? Since it is a teacher's diary, these

can be the names of some students. What do the numbers mean? One cannot be sure. It can be the marks scored by students in tests, their attendance for some months, or something similar. We call these facts and figures data, because they do not give a complete idea. **Data** denotes raw facts and figures such as numbers, words, amount, quantity etc. that can be processed or manipulated.

Fig. 1.1 : Sample data

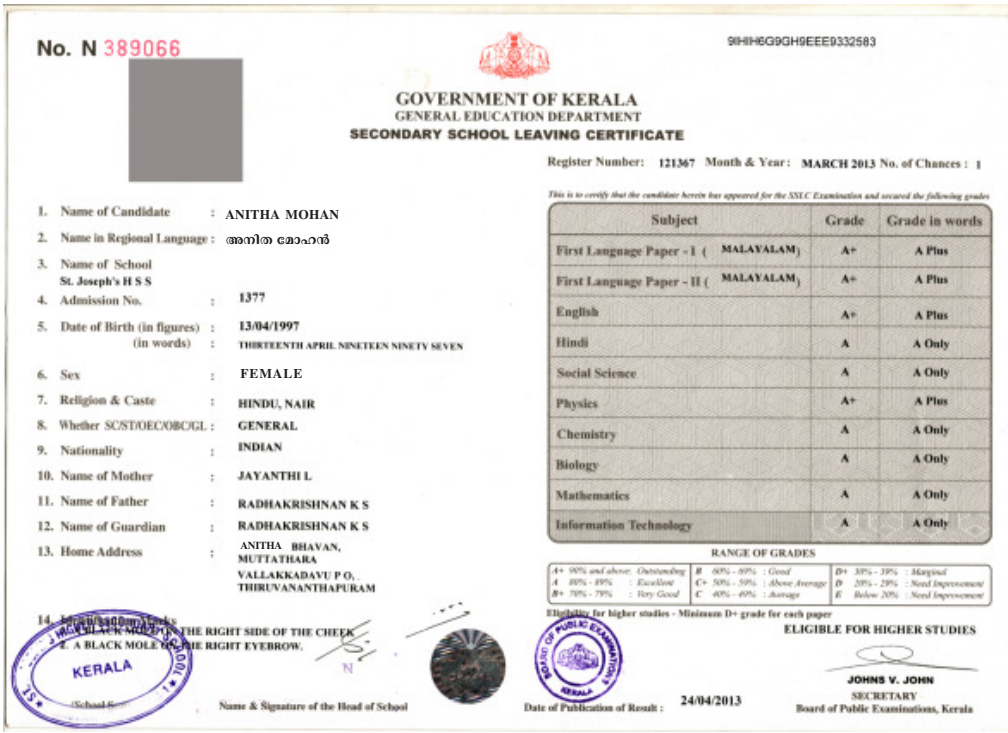
If these facts and figures were written as shown in Figure 1.2, there would be no confusion as to what they mean. It is clear that the figures show the scores obtained by students in Continuous Evaluation (CE) activities. We can see that when the data is arranged in a meaningful way, we get a clear-cut idea about these facts and figures. This is known as **information**. It is a meaningful and processed form of data.

Roll	Name	Scores out of 20			
		Asgmt	Test	Sem	Project
1	Anitha	19	19	20	19
2	Adarsh	20	18	18	19

Fig. 1.2 : Sample information

Information may also act as data in other contexts. In our example of preparation of CE scores of students, the teacher converts these numbers into a consolidated score out of 10. Similarly, after the evaluation of answer scripts of the public examination, each of these students will be awarded a score out of 40. During the preparation of results of examination, the scores of all the subjects are collected and corresponding grades are granted. The personal details and grades are put in an appropriate format with suitable labels and it becomes the mark sheet of the student, which is again information.

Figure 1.3 shows the score sheet of a student issued after the public examination. It contains personal details of the student and the grades obtained in each subject. The personal details like Anitha Mohan, Female, 13/04/1997, etc. are printed against proper labels such as Name, Sex, Date of Birth, etc. Here the facts and figures that represent the personal details and grades are the data. When these data are specified with suitable labels, it becomes information about that student. Thus we can say that the score sheet contains the information about the performance of a student in an examination. This information adds to our knowledge about the level of achievement of the students in various subjects. It also helps them to take decisions about their higher studies or to plan their future.



No. N 389066

9IHIH6G9GH9EEE9332583

GOVERNMENT OF KERALA
GENERAL EDUCATION DEPARTMENT
SECONDARY SCHOOL LEAVING CERTIFICATE

Register Number: 121367 Month & Year: MARCH 2013 No. of Chances : 1

1. Name of Candidate : ANITHA MOHAN
2. Name in Regional Language : അനിത മോഹൻ
3. Name of School : St. Joseph's H S S
4. Admission No. : 1377
5. Date of Birth (in figures) : 13/04/1997
(in words) : THIRTEENTH APRIL NINETEEN NINETY SEVEN
6. Sex : FEMALE
7. Religion & Caste : HINDU, NAIR
8. Whether SC/ST/OEC/OBC/GL : GENERAL
9. Nationality : INDIAN
10. Name of Mother : JAYANTHI L
11. Name of Father : RADHAKRISHNAN K S
12. Name of Guardian : RADHAKRISHNAN K S
13. Home Address : ANITHA BHAVAN, MUTTATHARA, VALLAKKADAVU P O, THIRUVANANTHAPURAM
14. Identification Marks : 1. A BLACK MOLE ON THE RIGHT SIDE OF THE CHEEK 2. A BLACK MOLE ON THE RIGHT EYEBROW.

This is to certify that the candidate herein has appeared for the SSLC Examination and secured the following grades

Subject	Grade	Grade in words
First Language Paper - I (MALAYALAM)	A+	A Plus
First Language Paper - II (MALAYALAM)	A+	A Plus
English	A+	A Plus
Hindi	A	A Only
Social Science	A	A Only
Physics	A+	A Plus
Chemistry	A	A Only
Biology	A	A Only
Mathematics	A	A Only
Information Technology	A	A Only

RANGE OF GRADES

A+ 90% and above : Outstanding	B 80% - 89% : Good
A 80% - 89% : Excellent	C+ 50% - 59% : Above Average
B+ 70% - 79% : Very Good	C 40% - 49% : Average
D+ 30% - 39% : Marginal	
D 20% - 29% : Need Improvement	
E Below 20% : Need Improvement	

Eligibility for higher studies - Minimum D+ grade for each paper

ELIGIBLE FOR HIGHER STUDIES

KERALA

Name & Signature of the Head of School

Date of Publication of Result : 24/04/2013

JOHNS V. JOHN
SECRETARY
Board of Public Examinations, Kerala

Fig. 1.3 : SSLC score sheet

Information is always generated by performing some operations on data. In other words, data is like raw material to generate information. Now let us try to distinguish between these two terms. Table 1.1 summarises the comparison between data and information.

Data	Information
• Raw facts and figures	• Processed data
• Similar to raw material	• Similar to the finished product
• Cannot be directly used	• Adds to knowledge and helps in taking decisions
• Does not give precise and clear sense	• Clear and meaningful

Table 1.1 : Comparison between data and information

As we know, information always adds to knowledge. One can apply this knowledge to solve problems or in decision making. Generally, the ability to draw useful inferences from the acquired knowledge is known as intelligence. It depends on how we process knowledge and apply it in various situations. Recent advancement in Computer Science and technology have attempted to make computers do things, which at the moment people do better, incorporating knowledge and intelligence. This is referred to as artificial intelligence.

Let us do

- *Examine a telephone bill, electricity bill or water bill and identify the data contained in it.*
- *Think of the purchase of some items from a shop. Identify the data involved and see how it is converted into information.*
- *Identify data and information in any real life situation. Make sure that you can clearly distinguish them.*

1.2 Data processing

In the case of preparation of the score sheet mentioned in the previous section, the scores given to each subject as part of Continuous Evaluation (CE) and Terminal Evaluation (TE) are added together, and grades are determined based on some predefined criteria. The activities or operations to generate information can collectively be termed as process. **Data processing** refers to the operations or activities performed on data to generate information. So we can say that information is the result of data processing.

As shown in Figure 1.4, data is supplied for processing and information is obtained after processing. In other words, data is the input to the process and information is the output from the process.

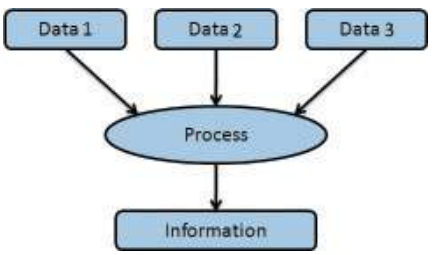


Fig. 1.4 : Data processing

Let us consider the case of the Single Window System (*Ekajaalakam*) - the admission procedure for higher secondary courses in Kerala. We can briefly list out its activities as follows:

1. The authority collects the data from applicants through application forms, in which score sheet of Class X examination will be referenced to furnish the required details. Note that in this context the facts and figures in the score sheet become the data.
2. The collected data is then fed to the computer.
3. The input data is stored and will later be retrieved for processing.
4. The data within the computer is used for performing operations such as calculations, comparisons, categorisation, sorting, filtering, etc.
5. The allotment slips for candidates and allotment lists for schools are generated. The slips and lists are printed and may be stored for later reference. It may be used as data to generate information in some other situation.
6. The slips are distributed to the applicants and lists are forwarded to schools.

Thus it is clear that data processing proceeds through six stages, as listed below:

(a) Capturing data
(b) Input of data
(c) Storage of data
(d) Processing / manipulating data
(e) Output of information
(f) Distribution of information

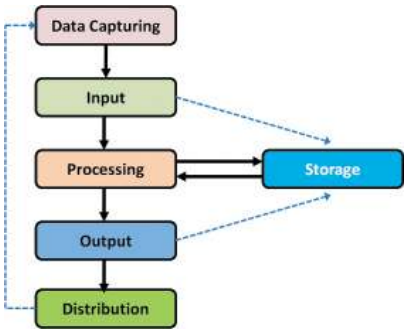


Fig. 1.5 : Stages of data processing

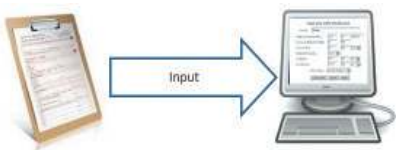
The thick arrow marks in Figure 1.5 indicate the flow of the activities in data processing and the dotted lines specify the flow of activities that are optional. Let us take a close look at these stages.

a. Capturing data

When we apply for admission to the higher secondary course, we usually provide details through a prescribed application form. The authority is actually collecting the required data for the admission process through the proforma. This is the first stage in data processing. The proforma, also known as the source document, is so designed that all relevant data to be recorded in proper order and format. Thus, preparation of hard copy of source document and data collection are the activities that take place in this stage. Today, prescribed application forms are not used for collecting data. Instead, data are directly entered through on-line facility.

b. Input

In the case of seeking admission, we submit the filled up application form to the school. There the data is extracted and fed into the computer. Sometimes, we may enter these details directly into the computer. Feeding data to the computer for processing is known as input. The input data is usually stored in computers before it is processed.



c. Storage

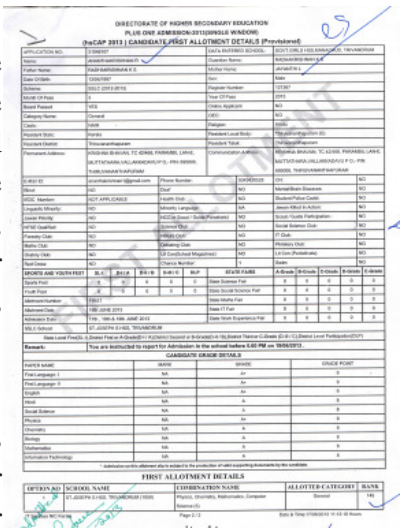
In many cases, the amount of data given to the computers will be large. Besides, the data entry may not be completed in a single session or a day. In the case of admissions, the data of lakhs of applicants is input to the computer. It usually takes a few weeks to complete the data entry. So the data input at different times should be stored then and there. The processing will start only after the entire data is stored. The information obtained as a result of processing is also stored in the computer. This stored data and information can be used in future for various purposes.

d. Process

The data stored in computers is retrieved for processing. Various operations like calculation, classification, comparison, sorting, filtering, summarising etc. are carried out as part of processing. In the case of admission to the higher secondary course, Weighted Grade Point Average (WGPA) of each applicant is calculated. Then the applicants are listed under various categories based on the descending order of WGPA. Here, school of choice, course, and performance in various co-curricular activities are considered. Finally, allotment lists for schools and allotment slips for applicants are prepared.

e. Output

The information obtained after processing will be available in this stage. Output stage should provide the information in such a form that the beneficiary should be able to take decision or solve the problem. In the case of admission to the higher secondary course, allotment slip for the applicant and allotment list for the school are generated in the desired format as outputs.



f. Distribution of information

The information obtained in the output stage is distributed to the beneficiaries. They take decisions or solve problems according to the information. For example in higher secondary admission, the allotment slips are distributed to applicants for joining the school allotted and allotment lists are issued to the schools for admitting the eligible applicants. The allotment slips may be used to prepare admission register or roll list of classes. The allotment lists may be used to prepare nominal roll for registering the students for public examination.

Let us do

- *Identify and write the data processing activities in (i) opening an account in a bank and (ii) applying for scholarships*
- *Identify data processing cases in any other real life situations and write the activities performed in each stage.*

Check yourself

1. Raw facts and figures are known as _____ .
2. Processed data is known as _____.
3. Which of the following helps us to take decisions?

   (a) data (b) information (c) knowledge (d) intelligence
4. Manipulation of data to get information is known as _____.
5. Arrange the following in proper order:

   Process, Output, Storage, Distribution, Data Capture, Input
6. Pick the odd one out and give reason:

   (a) Calculation (b) Storage (c) Comparison (d) Categorization
7. Why do we store information?
8. Information may act as data. State True or False.
9. Which is the final stage in data processing?
10. What is a source document?

1.3 Functional units of a computer

Even though computers differ in size, shape, performance and cost over the years, the basic organisation of a computer is the same. It is based on a model proposed by John Von Neumann, a mathematician and a computer scientist. It consists of some functional units namely Input Unit, Central Processing Unit (CPU), Storage Unit and Output Unit. Each of these units is assigned to perform a particular task. Let us discuss the functions of these units. Figure 1.7 shows the basic functional units of a computer.

Fig. 1.6 : John Von Neumann (1903 - 1957)

1. Input unit

The collected data and the instructions for their processing are entered into the computer through the input unit. They are stored in the memory (storage unit). The data may be in different forms like number, text, image, audio, video, etc. A variety of devices are

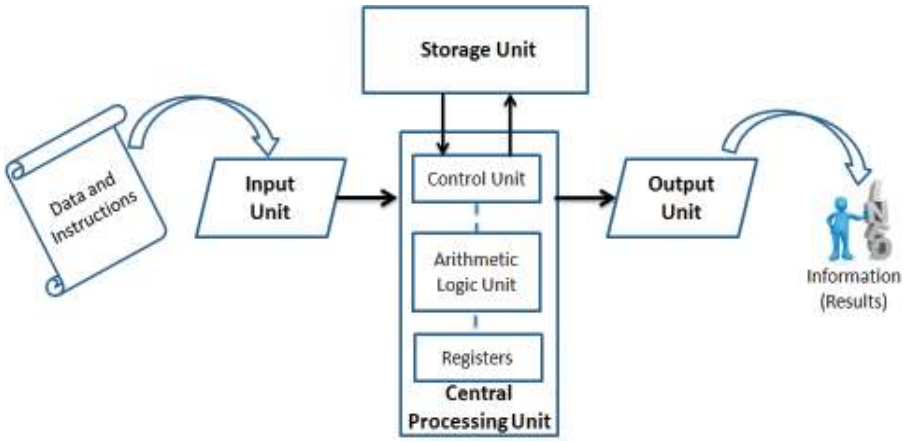


Fig. 1.7 : Functional units of a computer

available to input the data depending on its nature. Keyboard, mouse, scanner, mic, digital camera, etc. are some commonly used input devices. In short, the functions performed by input unit are as follows:

1. Accepts instructions and data from the outside world.
2. Converts these instructions and data to a form acceptable to the computer.
3. Supplies the converted instructions and data to the computer for processing.

2. Central Processing Unit (CPU)

The CPU is the brain of the computer. In a human body, all major decisions are taken by the brain and other parts of the body function as directed by the brain. Similarly, in a computer system, all major computations and comparisons are made inside the CPU. It is also responsible for activating and controlling the operations of other units of the computer. The functions of CPU are performed by three components - Arithmetic Logic Unit (ALU), Control Unit (CU) and registers.

a. Arithmetic Logic Unit (ALU)

The actual operations specified in the instructions are carried out in the Arithmetic Logic Unit (ALU). It performs calculations and logical operations such as comparisons and decision making. The data and instructions stored in the storage unit are transferred to the ALU and the processing takes place in it. Intermediate results produced by the ALU are temporarily transferred back to the storage and are retrieved later when needed for further processing. Thus there is a data flow between the storage and the ALU many times before the entire processing is completed.

b. Control Unit (CU)

Each of the functional units has its own function, but none of these will perform the function until it is asked to. This task is assigned to the control unit. It invokes the other units to take charge of the operation they are associated with. It is the central nervous system that manages and co-ordinates all other units of the computer. It obtains instructions from the program stored in the memory, interprets the operation and issues signals to the unit concerned in the system to execute them.

c. Registers

These are temporary storage elements that facilitate the functions of CPU. There are variety of registers; each designated to store unique items like data, instruction, memory address, results, etc.

3. Storage unit

The data and instructions entered in the computer through input unit are stored inside the computer before actual processing starts. Similarly, the information or results produced after processing are also stored inside the computer, before transferring to the output unit. Moreover, the intermediate results, if any, must also be stored for further processing. The storage unit of a computer serves all these purposes. In short, the specific functions of storage unit are to hold or store:

1. data and instructions required for processing.
2. intermediate results for ongoing processing.
3. final results of processing, before releasing to the output unit.

The storage unit comprises of two types as detailed below:

Primary storage: It is also known as main memory. It is again divided into two - Random Access Memory (RAM) and Read Only Memory (ROM). RAM holds instructions, data and intermediate results of processing. It also holds the recently produced results of the job done by the computer. ROM contains instructions for the start up procedure of the computer. The Central Processing Unit can directly access the main memory at a very high speed. But it is costly and has limited storage capacity.

Secondary storage: It is also known as auxiliary storage and it takes care of the limitations of primary storage. It has a huge storage capacity and the storage is permanent. Usually we store data, programs and information in the secondary storage, but we have to give instruction explicitly for this. Hard disk, CDs, DVDs, memory sticks, etc. are some examples.

4. Output unit

The information obtained after data processing is supplied to the outside world through the output unit in a human-readable form. Monitor and printer are the commonly used output devices. The functions performed by output unit can be concluded as follows:

1. Receives the results produced by the CPU in coded form.
2. Converts these coded results to human-readable form.
3. Supplies the results to the outside world.

Let us do

Fill up the following table by comparing human beings and the computer in the context of data processing. In the case of operations, the organs or components may be specified and for characteristics, performance may be indicated. You can also add more features.

Features	Human being	Computer
Operations		
Input	*Eyes, Ears*	*Keyboard, Mouse*
Output		
Calculation & Comparison		
Temporary Storage		
Permanent Storage		
Controlling		
Characteristics		
Speed		
Accuracy		
Reliability		
•		
•		

1.4 Computer - as a data processor

We have seen the activities involved in data processing and identified the different stages in data processing. Imagine the situation where humans are involved in these stages for performing the operations. It is sure that we will not get the information always in time and without any error all the time. We always need accurate, comprehensive, reliable and timely information in proper format and media so that it can be applied to the

context concerned to formulate knowledge. Only then problems can be solved and/or decisions be made appropriately. From the discussions we had so far, computers can be considered as the best data processing machine. In short, **computer** may be defined as an electronic machine designed to accept the data and instructions, performs arithmetic and logical operations on the data according to a set of instructions and output the results or information.

1.4.1 Characteristics of computers

We have already recognized some of the characteristics of computers by performing the learning activity of filling the comparison table given in the Let us do box. As we know, computers can execute millions of instructions in a second. The results produced after processing the data are very accurate, but computers do not have adequate knowledge or intelligence to interpret the results. They only carry out instructions like an obedient servant. The computer gives correct results only if the data and instructions given are correct. The term Garbage In Garbage Out (GIGO) is used to mean this feature. That is, if a wrong input is given to the computer, it will give a wrong output. Look at Table 1.2 and identify the advantages and limitations of computer.

Computers	
Advantages	**Limitations**
Speed: A computer can perform millions of operations in a second or in fraction of second. It can do in a minute, as much work as a man do taking months and years. ***Accuracy***: A computer can perform arithmetic operations with a very high degree of accuracy. By accuracy, we mean fewer errors in the output and precision with which computations are performed. ***Diligence***: Since computer is a machine, it can operate for long hours untiringly. Unlike human beings, it will not show any emotion or disobey you. Hence computers are best suited for routine jobs. ***Versatility***: Computer can be used to perform many different kinds of processing tasks. It is a general purpose data processing machine. ***Huge memory***: Computer has enormous memory capacity. Huge volume of data can be stored in its memory for processing. The storage capacity can also be increased as per requirement.	***Lack of IQ***: Many people think that computer has super human capabilities. However this is not true. A computer does not have natural intelligence as humans have. ***Lack of decision making power***: Computer cannot decide on its own and it does not possess intuitive capabilities like human beings.

Table 1.2 : Advantages and limitations of computers