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The Computer: Its Role in Research

INTRODUCTION

Problem solving is an age old activity. The development of electronic devices, specially the computers, has given added impetus to this activity. Problems which could not be solved earlier due to sheer amount of computations involved can now be tackled with the aid of computers accurately and rapidly. Computer is certainly one of the most versatile and ingenious developments of the modern technological age. Today people use computers in almost every walk of life. No longer are they just big boxes with flashing lights whose sole purpose is to do arithmetic at high speed but they make use of studies in philosophy, psychology, mathematics and linguistics to produce output that mimics the human mind. The sophistication in computer technology has reached the stage that it will not be longer before it is impossible to tell whether you are talking to man or machine. Indeed, the advancement in computers is astonishing.

To the researcher, the use of computer to analyse complex data has made complicated research designs practical. Electronic computers have by now become an indispensable part of research students in the physical and behavioural sciences as well as in the humanities. The research student, in this age of computer technology, must be exposed to the methods and use of computers. A basic understanding of the manner in which a computer works helps a person to appreciate the utility of this powerful tool. Keeping all this in view, the present chapter introduces the basics of computers, especially it. answers questions like: What is a computer? How does it function? How does one communicate with it? How does it help in analysing data?

THE COMPUTER AND COMPUTER TECHNOLOGY

A computer, as the name indicates, is nothing but a device that computes. In this sense, any device, however crude or sophisticated, that enables one to carry out mathematical manipulations becomes a computer. But what has made this term conspicuous today and, what we normally imply when we speak of computers, are electronically operating machines which are used to carry out computations.

In brief, computer is a machine capable of receiving, storing, manipulating and yielding information such as numbers, words, pictures.

The computer can be a digital computer or it can be a analogue computer. A *digital computer* is one which operates essentially by counting (using information, including letters and symbols, in coded form) where as *the analogue computer* operates by measuring rather than counting. Digital computer handles information as strings of binary numbers i.e., zeros and ones, with the help of counting process but analogue computer converts varying quantities such as temperature and pressure into corresponding electrical voltages and then performs specified functions on the given signals. Thus, analogue computers are used for certain specialised engineering and scientific applications. Most computers are digital, so much so that the word computer is generally accepted as being synonymous with the term 'digital computer'.

Computer technology has undergone a significant change over a period of four decades. The present day microcomputer is far more powerful and costs very little, compared to the world's first electronic computer viz. Electronic Numerical Integrator and Calculator (ENIAC) completed in 1946. The microcomputer works many times faster, is thousands of times more reliable and has a large memory.

The advances in computer technology are usually talked in terms of 'generations'.* Today we have the fourth generation computer in service and efforts are being made to develop the fifth generation computer, which is expected to be ready by 1990. *The first generation computer* started in 1945 contained 18000 small bottle-sized valves which constituted its central processing unit (CPU). This machine did not have any facility for storing programs and the instructions had to be fed into it by a readjustment of switches and wires. *The second generation computer* found the way for development with the invention of the transistor in 1947. The transistor replaced the valve in all electronic devices and made them much smaller and more reliable. Such computers appeared in the market in the early sixties. *The third generation computer* followed the invention of integrated circuit (IC) in 1959. Such machines, with their CPU and main store made of IC chips, appeared in the market in the second half of the sixties. *The fourth generation computers* owe their birth to the advent of microprocessor—the king of chips—in 1972. The use of microprocessor as CPU in a computer has made real the dream of 'computer for the masses'. This device has enabled the development of microcomputers, personal computers, portable computers and the like. *The fifth generation computer,* which is presently in the developing stage, may use new switch (such as the High Electron Mobility Transistor) instead of the present one and it may herald the era of superconducting computer. It is said that fifth generation computer will be 50 times or so more faster than the present day superfast machines.

So far as input devices in computers are concerned, the card or tape-based data entry system has almost been replaced by direct entry devices, such as Visual Display Unit (VDU) which consist of a TV-like screen and a typewriter-like key board which is used for feeding data into the computer. Regarding output devices, the teleprinter has been substituted by various types of low-cost high speed printers. VDU is also used as an output device. For storing data, the magnetic tapes and discs

* (i) First generation computers were those produced between 1945–60 such as IBM 650, IBM 701.
(ii) Second generation computers were those produced between 1960–65 such as IBM 1401 Honeywell 40.
(iii) Third generation computers were those produced between 1965–70 such as IBM System 360, 370.
(iv) Fourth generation computers are those produced between 1971 to this date such as IBM 3033, HP 3000, Burroughs B 7700.

are being replaced by devices such as bubble memories and optical video discs. In brief, computer technology has become highly sophisticated and is being developed further at a very rapid speed.

THE COMPUTER SYSTEM

In general, all computer systems can be described as containing some kind of input devices, the CPU and some kind of output devices. Figure 15.1 depicts the components of a computer system and their inter-relationship:

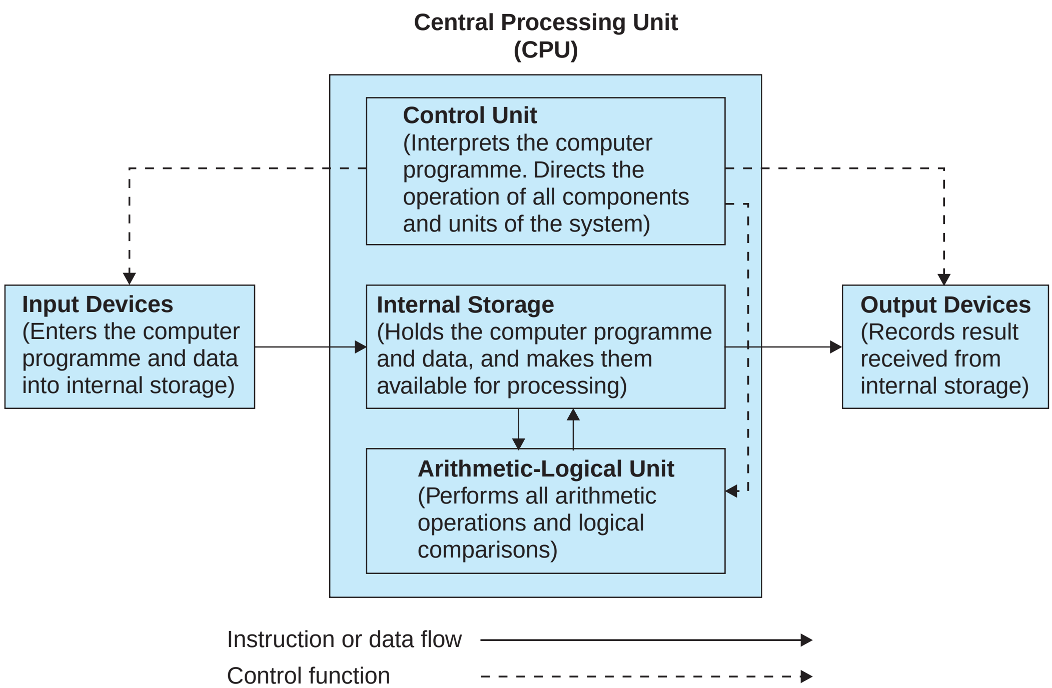

Fig. 15.1

The function of the input-output devices is to get information into, and out of, the CPU. The input devices translate the characters into binary, understandable by the CPU, and the output devices retranslate them back into the familiar character i.e., in a human readable form. In other words, the purpose of the input-output devices is to act as translating devices between our external world and the internal world of the CPU i.e., they act as an interface between man and the machine. So far as CPU is concerned, it has three segments viz. (i) internal storage, (ii) control unit, and (iii) arithmetic logical unit. When a computer program or data is input into the CPU, it is in fact input into the internal storage of the CPU. The control unit serves to direct the sequence of computer system operation. Its function extends to the input and output devices as well and does not just remain confined to the sequence of operation within the CPU. The arithmetic logical unit is concerned with performing the arithmetic operations and logical comparisons designated in the computer program.

In terms of overall sequence of events, a computer program is input into the internal storage and then transmitted to the control unit, where it becomes the basis for overall sequencing and control of computer system operations. Data that is input into the internal storage of the CPU is available for processing by the arithmetic logical unit, which conveys the result of the calculations and comparisons back to the internal storage. After the designated calculations and comparisons have been completed, output is obtained from the internal storage of the CPU.

It would be appropriate to become familiar with the following terms as well in context of computers:

(a) *Hardware:* All the physical components (such as CPU, Input-output devices, storage devices, etc.) of computer are collectively called hardware.

(b) *Software:* It consists of computer programs written by the user which allow the computer to execute instructions.

(c) *Firmware:* It is that software which is incorporated by the manufacturer into the electronic circuitry of computer.

(d) *System software:* It is that program which tells the computer how to function. It is also known as operating software and is normally supplied by the computer manufacturer.

(e) *Application software:* It is that program which tells the computer how to perform specific tasks such as preparation of company pay roll or inventory management. This software is either written by the user himself or supplied by 'software houses', the companies whose business is to produce and sell software.

(f) *Integrated circuit (IC):* It is a complete electronic circuit fabricated on a single piece of pure silicon. Silicon is the most commonly used semiconductor—a material which is neither a good conductor of electricity nor a bad one. An IC may be small-scale, medium-scale or a large-scale depending upon the number of electronic components fabricated on the chip.

(g) *Memory chips:* These ICs form the secondary memory or storage of the computer. They hold data and instructions not needed immediately by the main memory contained in the CPU.

(h) *Two-state devices:* The transistors on an IC Chip take only two states—they are either on or off, conducting or non-conducting. The on-state is represented by 1 and the off-state by zero. These two binary digits are called bits. A string of eight bits is termed byte and a group of bits constitute a word. A chip is called 8-bit, 16-bit, 32-bit and so on, depending on the number of bits contained in its standard word.

IMPORTANT CHARACTERISTICS

The following characteristics of computers are note worthy:

(i) *Speed:* Computers can perform calculations in just a few seconds that human beings would need weeks to do by hand. This has led to many scientific projects which were previously impossible.

(ii) *Diligence:* Being a machine, a computer does not suffer from the human traits of tireness and lack of concentration. If two million calculations have to be performed, it will perform the two millionth with exactly the same accuracy and speed as the first.

(iii) *Storage:* Although the storage capacity of the present day computer is much more than its earlier counterpart but even then the internal memory of the CPU is only large enough to retain a certain amount of information just as the human brain selects and retains what it feels to be important and relegates unimportant details to the back of the mind or just forgets them. Hence, it is impossible to store all types of information inside the computer records. If need be, all unimportant information/data can be stored in auxiliary storage devices and the same may be brought into the main internal memory of the computer, as and when required for processing.

(iv) *Accuracy:* The computer's accuracy is consistently high. Errors in the machinery can occur but, due to increased efficiency in error-detecting techniques, these seldom lead to false results. Almost without exception, the errors in computing are due to human rather than to technological weaknesses, i.e., due to imprecise thinking by the programmer or due to inaccurate data or due to poorly designed systems.

(v) *Automation:* Once a program is in the computer's memory, all that is needed is the individual instructions to it which are transferred one after the other, to the control unit for execution. The CPU follows these instructions until it meets a last instruction which says 'stop program execution'.

(vi) *Binary digits:* Computers use only the binary number system (a system in which all the numbers are represented by a combination of two digits—one and zero) and thus operates to the base of two, compared to the ordinary decimal arithmetic which operates on a base of ten. (Binary system has been described in further details under separate heading in this chapter.) Computers use binary system because the electrical devices can understand only 'on' (1) or 'off' (0).

THE BINARY NUMBER SYSTEM

An arithmetic concept which uses two levels, instead of ten, but operates on the same logic is called the binary system. The binary system uses two symbols '0' and '1', known as bits, to form numbers. The base of this number system is 2. The system is called binary because it allows only two symbols for the formation of numbers. Binary numbers can be constructed just like decimal numbers except that the base is 2 instead of 10.

For example,

$$523 \text{ (decimal)} = 5 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$$

Similarly,

$$111 \text{ (binary)} = 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 7 \text{ (decimal)}$$

Thus, in the example, we see that in the decimal system, the first place is for 1s, 2nd place is for 10s and the 3rd place is for 100. On the other hand, in the binary system, the factor being 2 instead of 10, the first place is still for 1s but the 2nd place is for 2s, the 3rd for 4s, the 4th for 8s and so on.

Decimal to Binary Conversion: A positive decimal integer can be easily converted to equivalent binary form by repeated division by 2. The method works as follows:

Start by dividing the given decimal integer by 2. Let R_1 be the remainder and q_1 the quotient. Next, divide q_1 by 2 and let R_2 and q_2 be the remainder and quotient respectively. Continue this process of division by 2 until a 0 is obtained as quotient. The equivalent binary number can be formed by arranging the remainders as

$$R_k\, R_{k-1} \ldots R_1$$

where R_k and R_1 are the last and the first remainders respectively, obtained by the division process.

Illustration 1

Find the binary equivalents of 26 and 45.

Solution: Table for conversion of 26 into its Binary equivalent:

Number to be divided by 2	*Quotient*	*Remainder*
26	13	0
13	6	1
6	3	0
3	1	1
1	0	1

Collecting the remainders obtained in the above table we find that

26(decimal) =11010 (binary)

or $(26)_{10} = (11010)_2$

Similarly, we can find the binary equivalent of 45 as under:

Table 15.1

Number to be divided by 2	*Quotient*	*Remainder*
45	22	1
22	11	0
11	5	1
5	2	1
2	1	0
1	0	1

Thus, we have $(45)_{10} = (101101)_2$
i.e., the binary equivalent of 45 is 101101.

Alternative method: Another simple method for decimal to binary conversion is to first express the given integer as a sum of powers of 2, written in ascending order. For example,

$$26 = 16 + 8 + 0 + 2 + 0 = 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$$

Then collect the multipliers of the powers to form the binary equivalent. For 26, we get, from the above mentioned expansion 11010 as the binary equivalent. This alternative method is convenient for converting small decimal integers by hand.

Binary to Decimal Conversion: A simple method for converting a binary number to its decimal equivalent is known as double-babble method. This can be described as follows:

Begin the conversion process by doubling the leftmost bit of the given number and add to it the bit at its right. Then again double the sum and add to it the third bit from the left. Proceed in this manner till all the bits have been considered. The final sum obtained by repeated doubling and adding is the desired decimal equivalent.

Illustration 2

Convert 1101 to its decimal equivalent using the double-babble method.

Solution:

1. Doubling the leftmost bit we get 2.
2. Adding to it the bit on its right we get 2 + 1 = 3
3. Doubling again the number obtained we get 6
4. Adding to it the next bit we get 6 + 0 = 6
5. Again doubling we get 12
6. Finally adding the last bit we get 12 + 1 = 13

Thus, we have $(1101)_2 = (13)_{10}$

In other words, the decimal equivalent of binary 1101 is 13.

(Conversion of real number to binary number is also possible but it involves little bit more complicated conversion process. Those interested may read any binary system book.)

Computations in Binary System

(a) *Binary addition:* Binary addition is just like decimal addition except that the rules are much simpler. The binary addition rules are as shown below:

0	0	1	1
+ 0	+ 1	+ 0	+ 1
0	1	1	10

Note that sum of 1 and 1 is written as '10' (a zero sum with a 1 carry) which is the equivalent of decimal digit '2'. We can now look at two examples of binary additions which make use of the above rules.

Illustration 3

Add 1010 and 101.

Solution:

Binary	Decimal equivalent
1010	(10)
+101	+(5)
1111	(15)

Illustration 4

Add 10111000 and 111011.

Solution:

Carry 111	Carry 11
10111000	184
+ 111011	+ 59
11110011	243

In Illustration 4, we find a new situation (1 + 1 + 1) brought about by the 1 carry. However, we can still handle this by using the four combinations already mentioned. We add the digits in turn. 1 + 1 = 10 (a zero sum with a 1 carry). The third 1 is now added to this result to obtain 11 (a 1 sum with a 1 carry).

The computer performs all the other arithmetical operations (viz. ×, –, +) by a form of addition. This is easily seen in the case of multiplication, e.g., 6 × 8 may be thought of as essentially being determined by evaluating, with necessary carry overs, 8 + 8 + 8 + 8 + 8 + 8. This idea of repeated addition may seem to be a longer way of doing things, but remember that computer is well suited to carry out the operation at great speed. Subtraction and division are handled essentially by addition using the principle of complementing.

(b) *Complementary subtraction:* Three steps are involved in this method:

Step 1. Find the ones complement of the number you are subtracting;

Step 2. Add this to number from which you are taking away;

Step 3. If there is a carry of 1 add it to obtain the result; if there is no carry, add 0, recomplement and attach a negative sign to obtain the result.

Following two examples illustrate this method.

Illustration 5

Subtract 10 from 25.

Solution:

Decimal number	Binary number		According to complementary method	
25	11001		11001	
Subtract 10	01010	Step 1	+ 10101	(Ones complement of 01010)
15		Step 2	101110	
		Step 3	→ 1	(add the carry of 1)
		Result	1111	Its decimal equivalent is 15.

Illustration 6

Subtract 72 from 14.

Solution:

Decimal number	Binary number		According to complementary method	
14	0001110		0001110	
Subtract 72	1001000	Step 1.	+ 0110111	(ones complement of 1001000)
–58		Step 2.	01000101	
		Step 3.	0	(add 0 as no carry)
			1000101	
		Result	– 0111010	(recomplement and attach a negative sign). Its decimal equivalent is –58.

The computer performs the division operation essentially by repeating this complementary subtraction method. For example, 45 ÷ 9 may be thought of as 45 – 9 = 36 – 9 = 27 – 9 = 18 – 9 = 9 – 9 = 0 (minus 9 five times).

Binary Fractions

Just as we use a decimal point to separate the whole and decimal fraction parts of a decimal number, we can use a binary point in binary numbers to separate the whole and fractional parts. The binary fraction can be converted into decimal fraction as shown below:

$$\begin{aligned} 0.101 \text{ (binary)} &= (1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3}) \\ &= 0.5 + 0.0 + 0.125 \\ &= 0.625 \text{ (decimal)} \end{aligned}$$

To convert the decimal fraction to binary fraction, the following rules are applied:

(i) Multiply the decimal fraction repeatedly by 2. The whole number part of the first multiplication gives the first 1 or 0 of the binary fraction;

(ii) The fractional part of the result is carried over and multiplied by 2;

(iii) The whole number part of the result gives the second 1 or 0 and so on.

Illustration 7

Convert 0.625 into its equivalent binary fraction.

Solution:

Applying the above rules, this can be done as under:

$$\begin{aligned} 0.625 \times 2 &= 1.250 \rightarrow 1 \\ 0.250 \times 2 &= 0.500 \rightarrow 0 \\ 0.500 \times 2 &= 1.000 \rightarrow 1 \end{aligned}$$

Hence, 0.101 is the required binary equivalent.

Illustration 8

Convert 3.375 into its equivalent binary number.

Solution:

This can be done in two stages. First $(3)_{10} = (11)_2$ as shown earlier. Secondly, $(0.375)_{10} = (0.011)_2$ as shown above. Hence, the required binary equivalent is 11.011.

From all this above description we find how computer arithmetic is based on addition. Exactly how this simplifies matters can only be understood in the context of binary (not in decimal). The number of individual steps may indeed be increased because all computer arithmetic is reduced to addition, but the computer can carry out binary additions at such great speed that this is not a disadvantage.

COMPUTER APPLICATIONS

At present, computers are widely used for varied purposes. Educational, commercial, industrial, administrative, transport, medical, social financial and several other organisations are increasingly depending upon the help of computers to some degree or the other. Even if our work does not involve the use of computers in our everyday work, as individuals, we are affected by them. "The motorists, the air passenger, hospital patients and those working in large departmental stores, are some of the people for whom computers process information. Everyone who pays for electricity or telephone has their bills processed by computers. Many people who are working in major organisations and receive monthly salary have their salary slips prepared by computers. Thus, it is difficult to find anyone who in some way or the other does not have some information concerning them processed by computer".[1] "Computers can be used by just about anyone: doctors, policemen, pilots, scientists, engineers and recently even house-wives. Computers are used not only in numeric applications but also in non-numeric applications such as proving theorems, playing chess, preparing menu, matrimonial match-making and so on. Without computers we might not have achieved a number of things. For example, man could not have landed on the moon nor could he have launched satellites. We might not have built 100 storied buildings or high speed trains and planes."[2]

The following table depicts some of the important applications and uses of computers:

Table 15.2

Applications in	*Some of the various uses*
1. Education	(i) Provide a large data bank of information; (ii) Aid to time-tabling; (iii) Carry out lengthy or complex calculations; (iv) Assist teaching and learning processes; (v) Provide students' profiles; (vi) Assist in career guidance.

Contd.

[1] N. Subramanian, "*Introduction to Computers*", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1986, p. 192.

[2] *Ibid.*, p. 192–93.

Applications in		*Some of the various uses*
2. Commerce	(i)	Assist the production of text material (known as word processing) such as reports, letters, circulars etc.
	(ii)	Handle payroll of personnel, office accounts, invoicing, records keeping, sales analysis, stock control and financial forecasting.
3. Banks and Financial institutions	(i)	Cheque handling;
	(ii)	Updating of accounts;
	(iii)	Printing of customer statements;
	(iv)	Interest calculations.
4. Management	(i)	Planning of new enterprises;
	(ii)	Finding the best solution from several options;
	(iii)	Helpful in inventory management, sales forecasting and production planning;
	(iv)	Useful in scheduling of projects.
5. Industry	(i)	In process control;
	(ii)	In production control;
	(iii)	Used for load control by electricity authorities;
	(iv)	Computer aided designs to develop new products.
6. Communications and Transportation	(i)	Helpful in electronic mail;
	(ii)	Useful in aviation: Training of pilots, seat reservations, provide information to pilots about weather conditions;
	(iii)	Facilitate routine jobs such as crew schedules, time-tables, maintenance schedules, safety systems, etc.;
	(iv)	Helpful to railways, shipping companies;
	(v)	Used in traffic control and also in space flight.
7. Scientific Research	(i)	Model processing;
	(ii)	Performing computations;
	(iii)	Research and data analysis.
8. The homes	(i)	Used for playing games such as chess, draughts, etc.;
	(ii)	Can be used as an educational aid;
	(iii)	Home management is facilitated.

COMPUTERS AND RESEARCHERS

Performing calculations almost at the speed of light, the computer has become one of the most useful research tools in modern times. Computers are ideally suited for data analysis concerning large research projects. Researchers are essentially concerned with huge storage of data, their faster retrieval when required and processing of data with the aid of various techniques. In all these operations, computers are of great help. Their use, apart expediting the research work, has reduced human drudgery and added to the quality of research activity.

Researchers in economics and other social sciences have found, by now, electronic computers to constitute an indispensable part of their research equipment. The computers can perform many statistical calculations easily and quickly. Computation of means, standard deviations, correlation coefficients, 't' tests, analysis of variance, analysis of covariance, multiple regression, factor analysis and various nonparametric analyses are just a few of the programs and subprograms that are available at almost all computer centres. Similarly, canned programs for linear programming, multivariate analysis, monte carlo simulation etc. are also available in the market. In brief, software packages are readily available for the various simple and complicated analytical and quantitative techniques of which researchers generally make use of. The only work a researcher has to do is to feed in the data he/she gathered after loading the operating system and particular software package on the computer. The output, or to say the result, will be ready within seconds or minutes depending upon the quantum of work.

Techniques involving trial and error process are quite frequently employed in research methodology. This involves lot of calculations and work of repetitive nature. Computer is best suited for such techniques, thus reducing the drudgery of researchers on the one hand and producing the final result rapidly on the other. Thus. different scenarios are made available to researchers by computers in no time which otherwise might have taken days or even months.

The storage facility which the computers provide is of immense help to a researcher for he can make use of stored up data whenever he requires to do so.

Thus, computers do facilitate the research work. Innumerable data can be processed and analyzed with greater ease and speed. Moreover, the results obtained are generally correct and reliable. Not only this, even the design, pictorial graphing and report are being developed with the help of computers. Hence, researchers should be given computer education and be trained in the line so that they can use computers for their research work.

Researchers interested in developing skills in computer data analysis, while consulting the computer centers and reading the relevant literature, must be aware of the following steps:

(i) data organisation and coding;
(ii) storing the data in the computer;
(iii) selection of appropriate statistical measures/techniques;
(iv) selection of appropriate software package;
(v) execution of the computer program.

A brief mention about each of the above steps is appropriate and can be stated as under:

First of all, researcher must pay attention toward data organisation and coding prior to the input stage of data analysis. If data are not properly organised, the researcher may face difficulty while analysing their meaning later on. For this purpose the data must be coded. Categorical data need to be given a number to represent them. For instance, regarding sex, we may give number 1 for male and 2 for female; regarding occupation, numbers 1, 2, and 3 may represent Farmer, Service and Professional respectively. The researcher may as well code interval or ratio data. For instance, I.Q. Level with marks 120 and above may be given number 1, 90–119 number 2, 60–89 number 3, 30–59 number 4 and 29 and below number 5. Similarly, the income data classified in class intervals such as Rs. 4000 and above, Rs. 3000–3999, Rs. 2000–2999 and below Rs. 2000 may respectively be represented or coded as 1, 2, 3 and 4. The coded data are to be put in coding forms (most systems call for a maximum of 80 columns per line in such forms) at the appropriate space meant for each variable. Once the researcher knows how many spaces each variable will occupy, the variables can be assigned to their column numbers (from 1 to 80). If more than 80 spaces are required for each subject, then two or more lines will need to be assigned. The first few columns are generally devoted for subject identity number. Remaining columns are used for variables. When large number of variables are used in a study, separating the variables with spaces make the data easier to comprehend and easier for use with other programs.

Once the data is coded, it is ready to be stored in the computer. Input devices may be used for the purpose. After this, the researcher must decide the appropriate statistical measure(s) he will use to analyse the data. He will also have to select the appropriate program to be used. Most researchers prefer one of the canned programs easily available but others may manage to develop it with the help of some specialised agency. Finally, the computer may be operated to execute instructions.

The above description indicates clearly the usefulness of computers to researchers in data analysis. Researchers, using computers, can carry on their task at faster speed and with greater reliability. The developments now taking place in computer technology will further enhance and facilitate the use of computers for researchers. Programming knowledge would no longer remain an obstacle in the use of a computer.

In spite of all this sophistication we should not forget that basically computers are machines that only compute, they do not think. The human brain remains supreme and will continue to be so for all times. As such, researchers should be fully aware about the following limitations of computer-based analysis:

1. Computerised analysis requires setting up of an elaborate system of monitoring, collection and feeding of data. All these require time, effort and money. Hence, computer based analysis may not prove economical in case of small projects.
2. Various items of detail which are not being specifically fed to computer may get lost sight of.
3. The computer does not think; it can only execute the instructions of a thinking person. If poor data or faulty programs are introduced into the computer, the data analysis would not be worthwhile. The expression "garbage in, garbage out" describes this limitation very well.

Questions

1. What is a computer? Point out the difference between a digital computer and analogue computer.
2. How are computers used as a tool in research? Explain giving examples.
3. Explain the meaning of the following terms in context of computers:
   (a) Hardware and Software
   (b) The binary number system
   (c) Computer generations
   (d) Central Processing Unit.
4. Describe some of the important applications and uses of computers in present times.

5. "The advancement in computers is astonishing". Do you agree? Answer pointing out the various characteristics of computers.
6. Write a note on "Computers and Researchers".
7. "Inspite of the sophistication achieved in computer technology, one should not forget that basically computers are machines that only compute, they do not think". Comment.
8. Add 110011 and 1011. State the decimal equivalent of the sum you arrive at.
9. Explain the method of complementary subtraction.

   Subtract 15 from 45 and 85 from 68 through this method using the binary equivalents of the given decimal numbers.
10. Workout the decimal equivalents of the following binary numbers:

    (a) 111.110

    (b) 0.111

    and binary equivalents of the following decimal numbers:

    (a) 4.210

    (b) 0.745
11. Convert 842 to binary and 10010101001 to decimal. Why binary system is being used in computer?
12. What do you understand by storage in a computer and how is that related to the generations?