UNIT 13 SEQUENCING, FLOW CHARTING AND COMPUTING

Structure

13.1 INTRODUCTION

Everywhere we see the use of computers. The reservations for train or air journey is done through computers. The accounts of big establishments and business houses are maintained by computers. It is an age of computers. Computers are practically entering in every activity of human life. Thus, we can say that invention of the computer is one of the greatest scientific achievements of the present century. It is, therefore, necessary that everyone has some idea of what computers are, how they work, and how should we use them.

13.2 OBJECTIVES

At the end of this unit, you should be able to:

- explain the usefulness of computers in solving problems;
- demonstrate the need of sequential steps in problem solving;
- explain and illustrate that algorithm is a step by step procedure of solving a problem;
- to develop algorithm for mathematical and non-mathematical problems;
- understand and explain the importance of iterative procedures;
- write a flow chart from algorithm; and
- apply an algorithm to specific problems.

13.3 MATHS AND COMPUTERS

Main Teaching Point

The need of sequential steps in problem solving.

Teaching Learning Process

There is a great contribution of the Mathematicians in some development of computers. These Mathematicians are Charles Babbage (1791-1871); and John Von Neumann (1903-1953). The development of computers owes a lot to mathematics and logic. It is quite interesting to study how

mathematics or analytical thinking plays its part in computer science. A computer, as the name suggests performs computation that is calculation. As we shall see, this computation may be numeric or non-numeric. The computer simply carries out the given instructions. It is quite different from solving a problem by an expert who may think intuitively, discover patterns, apply inductive procedures or deduce results. A computer may be able to solve a problem only if the various steps in solving a problem have been sequentially structured from beginning to end.

A computer is an electronic machine. It can neither think nor make decisions on its own. However each computer has a set of instructions which it can carry out. Solving a problem using a computer involves two steps:

i) Break-up the solution of a problem into a sequential step by step procedure. The end-result of this exercise is called an algorithm. Thus, a sequential step by step procedure to solve a problem is called an algorithm.

ii) Using the algorithm as a basis or reference, write a program. Program is a set of instructions which the computer understands. The language used to write a program is called machine language. Different kinds of requirements have given rise to different languages such as Cobol, Fortran, D'base and C etc. More and more languages are coming up.

Let us now study how we can write an algorithm for solving a problem.

Methodology used: Lecture method.

13.4 ALGORITHM

Main Teaching Point

To develop algorithm for solving a problem.

Teaching Learning Process

The technical term for a step-by-step procedure is algorithm. Thus, an algorithm describes a method by which a given task is accomplished. In other words, an algorithm specifies a sequence of steps which, when faithfully carried out will result in a task or a job being completed.

Here are a few terms used equivalently for an algorithm in everyday activities:

Task	Common name used for a step-by-step procedure i.e., algorithm
Manufacturing a machine	Assembly instructions
Preparing a uniform	Uniform pattern
Preparing a dish	Recipe

To emphasize the importance of a sequential step by step procedure the teacher will do well to take up the boat problem which runs as below:

"Three adults want to cross a river which has no bridge." There is a small boat and two boys. The boat can carry either one adult or the two boys. Assuming that each adult and the boys can row the boat, develop a procedure to cross the river.

Ask: Who shall first go across the river? Let students suggest, discuss, argue and eliminate the following options:

i) Adult going across (because he then returns with the boat making his trip infructuous).

ii) An adult and a boy (because b it cannot carry the two).

1. Hence the first step is that the two boys go first. One of them stays across, the other brings the boat back.

2 Next an adult goes across, second boy returns with the boat. The end result of first two steps is that one adult is across the river.

Ask: If we have to send two more adults in this manner, what should we do next? Let students

come to a conclusion that the same steps have to be repeated twice. State that this is called 'iteration'.

Students enjoy these type of problems. Present them with another. A man has a goat, a dog and a load of grass with him. He wants to cross a stream. If he is not there, dog will bite the goat or goat will eat away the grass. He can wade through with one thing at a time. Plan a procedure to cross the stream.

Having discussed a few non numerical examples, the teacher may then discuss a few numerical examples. Here is an example using ' BODMAS '.

Example 1

Evaluate : $28 - 120 \div 5 \times 47 - 16 \div 4 - (-5)$

Let us try to solve it step-by-step.

Step I : Locate the different terms in the problem. They are 28, $-120 \div 5$, 5×47, $-(16 \div 4)$, and $-(-5)$.

Step II : First of all we take first two factor term involving division. Replace the term $(16 \div 4)$ by its value namely -4. So the given expression become 28 – 120 + 5 47 – 4 – (–5).

Step III : Again we take two-factor term involving multiplication replacing it by its value 235, the expression becomes 28 – 120 + 235 – 4 – (–5)

Step IV : Remove all the brackets in the expression taking care of signs we get 28 - 120 + 235 – 4 + 5.

Step V : Add all the terms with positive sign i.e. 28, 235, 5. The sum is 268. The value is positive.

Step VI : Add all the terms with negative sign i.e. – 120, – 4. Their sum is – 124. This value is negative.

Step VII : If the sum of positive terms i.e. value obtained in step V is **greater than or equal** to the absolute value of sum of negative terms **i.e. value obtained in step VI, then** subtract absolute value of step VI from **the result of** step V, otherwise subtract the result of step V from absolute value of step VI and attach the negative sign to the difference obtained. In this case the answer is 268–124 = 144.

In this procedure we have written the steps in a sequence to solve the problem. As the students if they can first eliminate the bracket and then two factor terms.

Example 2

Let us consider a general problem in which the above example can be considered as a particular case.

Evaluate . $p \times q - (r) + m \div n + (-t)$.

The method of evaluating the expression is the same as in the above example. We shall present the step-by-step procedure in the form of a diagram.

Start

Step I : Identify the terms of given expression.

Step II : Find the value of first two-factor term and replace the term by its value.

Step III : Find the value of the other two-factor term and replace the term by its value.

Step IV : Remove all the brackets in the expression taking care of signs of the term.

Step V : Add all the terms having plus sign. Denote this sum by P.

Step VI : Add all the terms having minus sign. Denote the sum by N. Let absolute value of N be $|N|$.

Step VII : Is $P = |N|$?

Step VIII : If yes write answer zero. Go to stop

Else, Is P > |N|?

Step IX : If yes, subtract |N| from P i.e., find P – |N| call it A.

Else, Subtract P from |N| i.e. find |N| – P, attach a minus sign and call it A.

Step X : Write A as the answer.

Step XI : Stop

Example 3

Write an algorithm to find the smaller of two given numbers:

1. Write the numbers A and B.
2. Find A – B, call the difference D.
3. If D = 0 state that two given numbers are equal and stop.
4. If D is positive declare 'B is smaller of the two given numbers' and stop.
5. Otherwise declare 'A is smaller' and stop. The algorithm can also be written in the form of a flow-chart.

Example 4

Construct a flow chart to find gain or loss if cost price and selling price of an article are given (cost price ≠ selling price).

Algorithm is as follows:

1. Write CP and SP as given
2. IF SP > CP
3. Find SP – CP call it G
4. Write the value of G as gain
5. If CP > SP
6. Find CP – SP. Call it L
7. Write the value of L as loss.

Thus we see that designing an algorithm is a very important activity for the solution of a problem. Underlying this activity of preparing an algorithm lies a thinking process. Thus developing an algorithm requires decision on steps that need to be carried out in a sequential order to be able to arrive at a solution of the problem. This process has been in use since long, more specially in the field of solving or proving problems in geometry but it has gained further momentum because of the use of computers in modern times. After a algorithm has been developed, it is necessary that one should also be able to communicate it to the computer. Basic, Fortron, Cobol, Pascal are some of the languages that are used while working with computers. **An algorithm written in such a language is called a program.**

Methodology used: Lecture method combined with discussion to write the steps in proper sequence.

13.5 FLOW CHART

Main Teaching Point

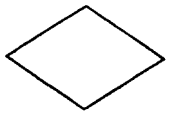
To draw a flow chart corresponding to an algorithm.

Teaching Learning Process

The pictorial representation of an algorithm is called a flow chart. It consists of instructions placed in boxes of different types according to the nature of the instruction. The boxes are connected by

arrows to indicate the sequence of instructions. Four types of boxes are used. Their names are as follows:

Rectangular box



Rhombus-shaped
or
Diamond-shaped box

Terminal box

Input-output box

When we draw a flow chart, the action to be carried out is mentioned in each box. Arrows on lines connecting the boxes indicate the flow or direction in which we should proceed from the terminal box containing the word 'start'. Hence the diagram or pictorial representation of the chart is given the name flow chart or flow diagram.

If we go as indicated by the arrow we will reach the step in which the answer is obtained. At the end comes another terminal box in which the word 'stop' is written. The box indicates that we have reached the end of computation.

The answer to a problem can be considered as output of the action carried out as per the flow in the flow chart. In order to write output or the answer, a separate box called the **input-output box** is used.

A **rectangular box** is used for indicating some computation or action which cannot have two or more possible out comes, but has a single definite result.

The rhombus shaped box is called the **decision box.** It contains a question for which the answer would be yes or no. At this point the flow chart branches into two directions – one along the **yes** line, and the other along the **no** line. Thus, this box decides the direction or path to be followed.

The parallelogram shaped box is used to indicate the input and the output and is termed as the input-output box.

The arrows in the flow chart tell us the direction and sequence in which the instructions are carried out.

Iteration: consider a problem "Find the sum of first ten multiples of 3."

If you were asked to solve this problem, you would probably proceed as below:

$3 + 6 + 9 + 12 + 15 + 18 + 21 + 24 + 27 + 30 = 165$

The computer will however take its instructions differently. It will add only two numbers at a time.

If we denote the number of multiples added by n and the corresponding sum by S then.

$n = 1, t_1 = 3, S = 3$

$n = 2, t_2 = 3 + 3 = 6, S = 3 + 6 = 9$

$n = 3, t_3 = 6 + 3 = 9, S = 9 + 9 = 18$

$n = 10, t_{10} = 27 + 3 = 30, S = 135 + 30 = 165$

Ask : Students to state what they observe in the above procedure of addition. There is repeated addition. Each time n goes on increasing.

With each increase of value of n, the term increases by 3.

The sum increases over the preceding sum by the value of the new term.

Explain: This repeated addition is termed as 'iteration'. In a flow chart this is denoted by a loop.

To write a program involving a loop we have to answer a few questions initially.

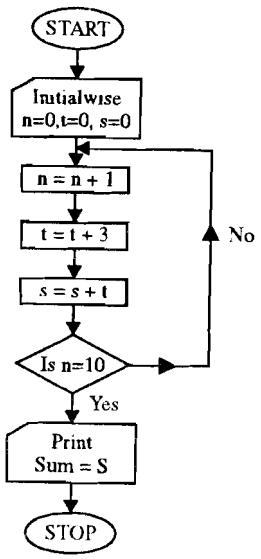
From where do we start?

When do we stop?

We use 'n' as a counter to let us know when we have added 10 terms. Term t is assigned an initial value and sum S is assigned an initial value.

Generally we start with n = 0, t = 0 and S = 0

The flow chart will look something like this.



Methodology used: Students should be encouraged to first write the algorithm and then put it in the form of a flow chart.

Explain

1. In the computation box n = n + 1 left hand side n is called the new value of n and right hand side n is called the old value of n.

   The statement is read as :

   (New value of n) **becomes** (the old value of n) + 1. Similarly t = t + 3 stands for (new value of t) becomes (old value of t) + 3 and so on.

2. So long as the value fo n does not reach 10, the decision from box 6 will be 'no' and the computer will follow the route given by 'No'. It will go back to box No. 3. Computations shown by boxes 3, 4, 5 will be repeated.

3. This movement in a loop will continue and stop only when n = 10. Then the computer will follow the route 'Yes', come to box 7, Print the sum and stop.

Ask: If initial value of n in box 2 is taken as 1, what will be corresponding initial values of t and S?

Ask: If the decision box contains the question 'Is n <10', what should be the decision 'Yes' or 'No' to continue in the loop?

Check Your Progress

Notes: a) Write your answer in the space given below.
b) Compare your answer with the one given at the end of the unit.

Write an algorithm and draw a flow chart for the following problems:

1. To find whether the quadratic equation $ax^2 + bx + c = 0$ has real roots or not.

2. To find the sum of first 20 natural numbers without using the formula.

13.6 EXECUTION OF AN ALGORITHM

Main Teaching Point

To check the flow chart for correctness by putting known values of the unknowns.

Teaching Learning Process

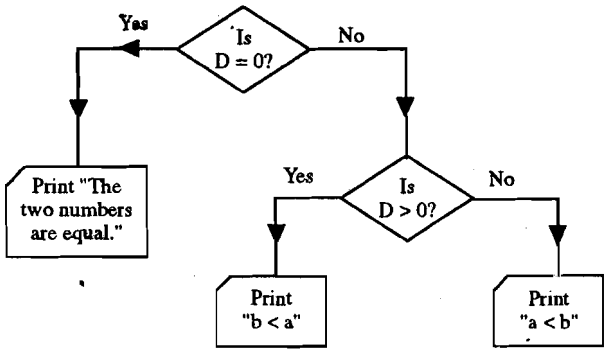
Execution of an algorithm involves carrying out instructions sequentially as given in the boxes. Execution will take place only along one branch after each decision box.

If after a decision box, more than two options are available, then more than one decision box have to be used. e.g. "out of two given numbers a, b, find the one that is smaller".

There are three possibilities namely:

$a = b$ or $a > b$ or $a < b$

We use two decisions boxes as below. Let us denote $a - b$ by D.



In executing a program for two given values of a and b, only one route will be used.

If a = 12, b = 12, we go to box 2 from box 1; If a = 12, b = 16, we follow the route along boxes 1, 3 and 4 or 5.

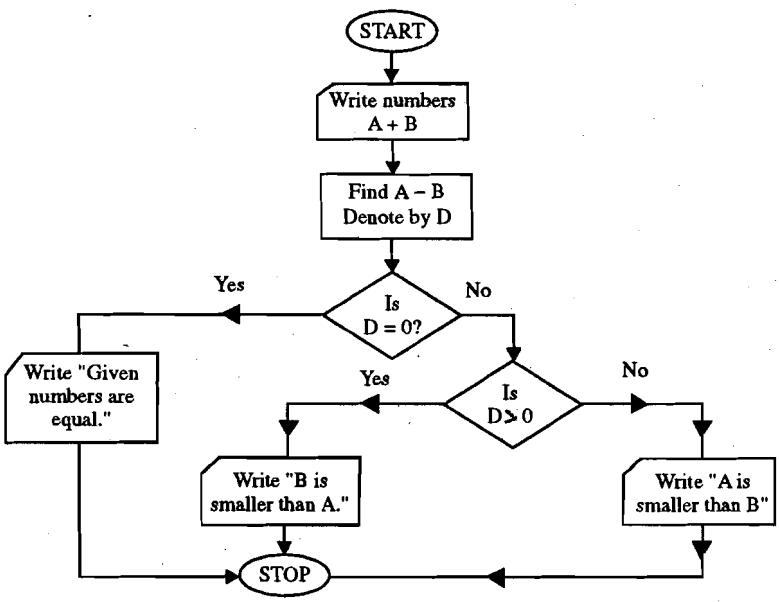
Consider a few examples.

Example 5

Write an algorithm to find the smaller of two given numbers A and B. Construct a flow chart and execute the program for A = 20, B = 30.

1. Write the numbers A and B.
2. Find A – B, call the difference D.
3. If D = 0 state that two given numbers are equal and stop.
4. If D is positive declare 'B is smaller of the two given numbers' and stop.
5. Otherwise declare 'A is smaller' and stop.

Flow chart for the above algorithm will appear as below:



Execution of a flowchart with respect to a particular numerical data depends upon the actual numerical values.

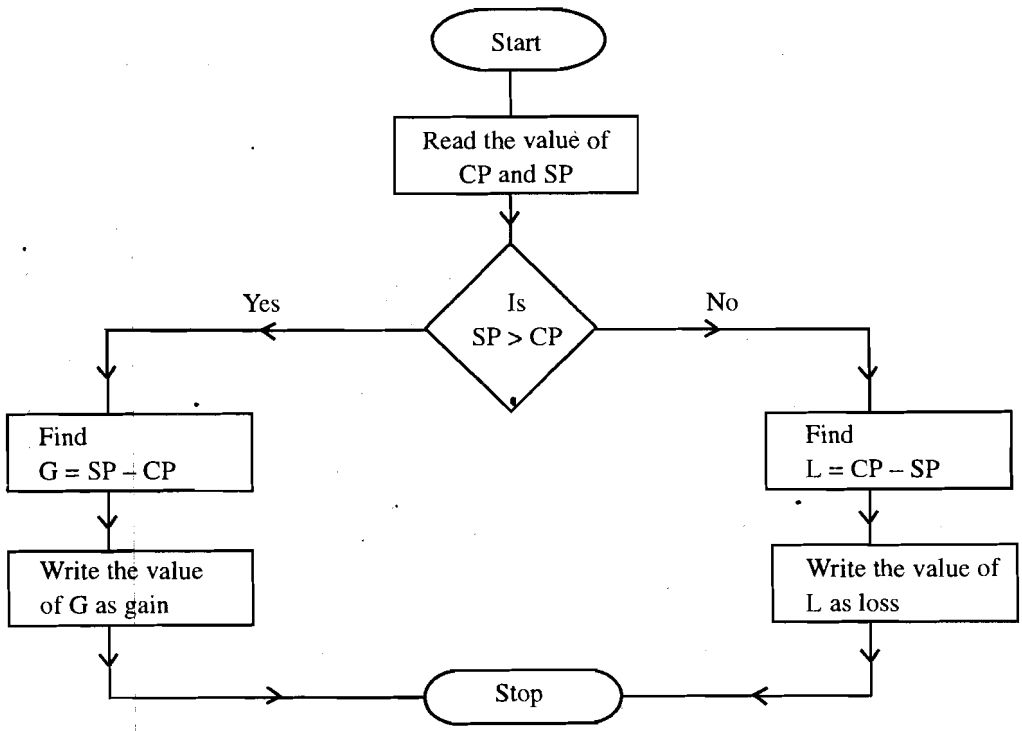
Box number to which arrow leads us	Type of box	Result of action performed
1.	start	algorithm execution starts
2.	input	A = 20, B = 30
3.	computation	D = 20 – 30 = –10
4.	decision	no
6.	decision	no
8.	output	answer "A is less than B"
9.	stop	algorithm execution completes

Example 6

Construct a flow chart to find gain or loss if cost price and selling price of an article are given (cost price & selling price). Execute the algorithm for S. P = Rs. 375, C. P. = Rs. 300.

The algorithm is as follows:

1. Read CP and SP as given
2. IF SP > CP
3. Find SP – CP call it G
4. Write the value of G as gain
5. If CP > SP
6. Find CP – SP call it L
7. Write the value of L as loss.



Box No. which arrow leads us	Type of box	Result of action performed
1.	start	algorithm execution starts
2.	input	SP = Rs. 375, C.P. = Rs. 300
3.	decision	Yes
4.	computation	G = Rs. 75
5.	output	Gain = Rs. 75
6	stop	execution of algorithm completes

Methodology used: Lecture method is used to illustrate the process through several examples.

13.7 LET US SUM UP

You as a teacher, are now in a position to explain the relation between computing and Mathematics. You can help students write algorithm for a problem. You understand and are able to explain how a program is written. More specifically you are able to communicate to the students the manner in which a computer can be used to solve a problem.

13.8 UNIT-END ACTIVITIES

1 Construct a flow chart to find nature of roots of a Quardratic Equation $ax^2 + bx + c = 0$ ($a = 0$).

2. To find LCM of two numbers a and b if HCF is given.

3. Construct a flow chart to find the amount A for a given sum P for 7 years at R% per annum at simple interest.

4. Construct a flow chart to find the average of four numbers a, b, c, d.

5. Construct a flow chart to find the greatest prime number smaller than the given positive number.

6. Construct a flow chart to find if the given number is divisible by 4 or not.

7. Construct a flow chart to find the first prime number greater than the given number.

8. Write an algorithm to find out the possibility of construction of a triangle out of 10 different sets of line segments a, b, c where a, b, c, are sides of a triangle.

9 Write an algorithm to find if the roots of equation $Ax^2 + Bx + C = 0$ are equal for 20 different sets of values of A, B, C.

10. Write an algorithm to find the compound interest on a sum of Rs. P at R% per annum for 5 years. The interest is compounded annually.

13.9 ANSWERS TO CHECK YOUR PROGRESS

1. Step 1 : Read the values of a, b, c

   Step 2 : Compute $D = b^2 - 4ac$

   Step 3 : If $D \geq 0$, write 'Equation has real roots. Else, write Equation does not have real roots.

   Step 4 : Stop

2. Step 1 : Set N = 0, S = 0

   Step 2 . Calculate N = N + 1

   Step 3 : Calculate S = S + N

   Step 4 : If N = 20, write S and stop, else go to step 2.

13.10 SUGGESTED READINGS

Jain, Satish; *Introduction to Computer Science and Basic Programming,* B.P. B Publications, New Delhi.

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