Problem and Problem Solving

People in their day to day life solve lot of problems. Let us discuss one such process, consider that you are playing 'Hide and seek' with your friends. In this game our problem is to find the location where our friend has hidden. This can only be done only if we can predict the place of his/her hiding.

Let us take another problem, assume that we have to solve a mathematical equation to find the value of x, if we have been given equation $2x + 4 = 0$. To solve this problem we need to rearrange the equation as $2x = -4$, and then say that $x = -4/2$, the answer here is -2.

Let us take another example. We want to find the meaning of the word "Eloquent". We will need an English Language dictionary for the same. A dictionary contains thousands of words and its meaning. We are still able to find the desired meaning very quickly. Have you ever thought how we are able to do it so fast? We actually take advantage of the sequential order of words given in dictionary. We quickly eliminate the options that do not start with alphabet "E" and start looking for the words that start with alphabet "E"; we again use this elimination method to find words with second alphabet as "l". This elimination method is continued till we find the exact word that we are looking for.

The above example gave us a hint of what a problem can be? Problem solving can be a mental or machine (any systemic procedure) process that leads to the desired outcome required by the user. The examples discussed above also indicate that result of some problems is exactly predictable while for others predicting exact outcome may become difficult. Thus the problems can be classified into two types; well defined and ill-defined problems. In the above cases problem 2 and 3 are well defined problems, while problem number 1 is ill-defined. Note that well defined problems have clear goals and hence we can clearly define solution steps. It is fact that computers solve well defined problems only and therefore we will discuss only well defined problems in this chapter.

In the field of computers, solution of a given problem is a sequence of instructions given to a computer. Computer can solve variety of problems from the easiest to the most complex ones. To solve a problem it needs to be given a complete set of instructions. These instructions tell the computer what is to be done at every step. Remember one thing, computer does not solve a problem; it merely assists in solving the problem. We can solve any problem using the steps mentioned:

1. Define the problem.
2. Identify the input, output and constraint of the problem.
3. Identify different alternatives of solving the problem.
4. Choose the best possible alternative from the above list.
5. Prepare detailed stepwise instruction set of the identified alternative.
6. Compute results using this instruction set.
7. Check correctness of the answer obtained.

Steps 1 to 5 are performed by person who needs the solution, while step 6 and 7 are performed by a computer.

Assume that we need to find whether a given number is odd or even. The following set of instructions can be used to solve this problem.

1. Accept the number
2. Divide the number by 2 and find the remainder
3. If the remainder is 1, the given number is odd otherwise the number is even

The generalized solution to the problem is obtained using three different techniques mentioned below.

1. Pseudo code
2. Flowchart
3. Algorithm

The three steps given for finding whether a number is odd or even is known as Pseudo code. Pseudo means fake or simulated, we should consider the second meaning as it is more appropriate in our context. We can say that the steps mentioned to solve the problem is simulated code. Let us now discuss the other two techniques.

Flowchart

A flowchart is a technique in which we use pictorial representation of every action that we perform within the machine process that solves a problem. A set of symbols, showing different actions, is used to represent a flowchart. The symbols are also called components of flowcharts. We have a unique symbol corresponding to each action within a process. Let us discuss some commonly used components and its associated symbols.

Start and End : The Start and End components are used to show the beginning and the end of a flowchart. It is represented by an oval shape as shown in figure 9.1. The symbol is also called terminal symbol.

Figure 9.1 : Terminal Symbol

This symbol is used twice in a flowchart as it is used in the beginning as well as at the end of a flowchart.

Input-Output : Every problem needs an input, it then processes this input and generates an output. Consider the problem number 3 discussed above, here we need to input one number, dividing this number by 2 and finding the remainder is the process and the decision whether the given number is odd or even is our output. Thus we need one symbol to show the input and one to show the output. The input and output in flowchart is represented by a parallelogram as shown in figure 9.2.

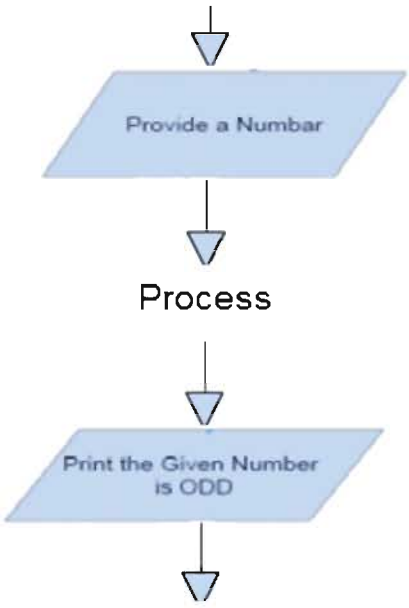


Figure 9.2 : Input-Output Symbol

Arrow : Observe that in both figure 9.1 and 9.2 we have shown arrows coming in and going out of the symbols. An arrow is used to show the sequence of the actions that are to be performed. It generally starts at one symbol and ends at another symbol. Thus there will be one arrow coming into the symbol and one arrow going out from the symbol.

Note that the start symbol will only have arrow going out, while the end symbol will have arrows coming in.

Process : Process is the core part of any solution procedure. A process is actually, a sequence of actions. To represent a process we use rectangle symbol as shown in figure 9.3.

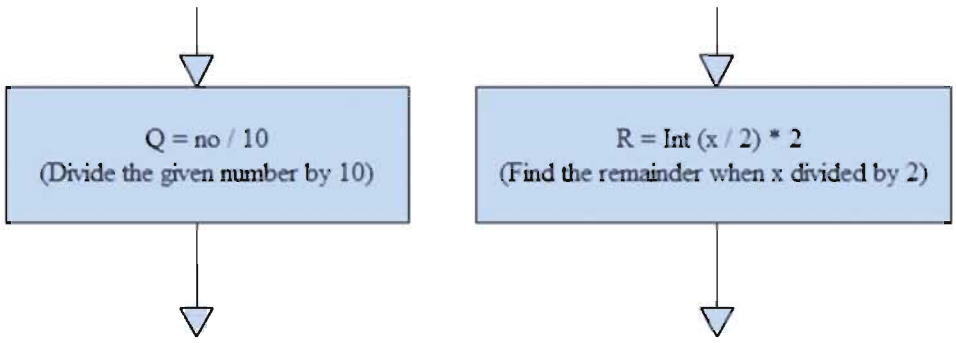


Figure 9.3 : Process Symbol

Normally a process in computers is either arithmetic or logical operation. The arithmetic operation we mean addition, subtraction, multiplication or division. Logical operations generally help in decision making, when used it answers in the form of true or false. For example we may ask a question such as is 10 greater than 5? The answer to this question is yes or true.

Decision : A logical decision of a process is represented by a diamond shaped symbol as shown in figure 9.4. It is also called a test symbol. A decision box is used when we want to alter the normal sequence of the solution (see in figure 9.4) or when a specific statement needs to be executed based on the result of decision.(See figure 9.5).

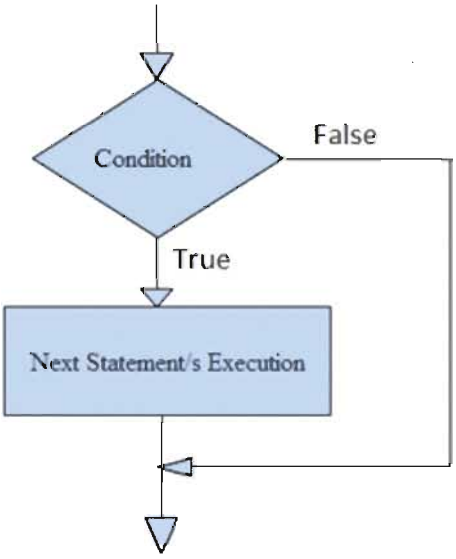


Figure 9.4 : Decision Symbol

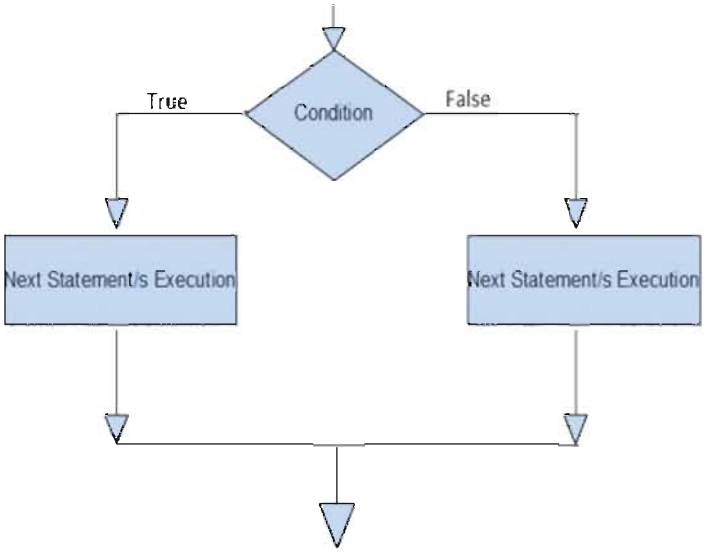


Figure 9.5 : Execution of different results

Sometimes we may require more than two alternatives to take a decision. In such a situation more than one decision box can be combined to form the required alternatives as shown in figure 9.6.

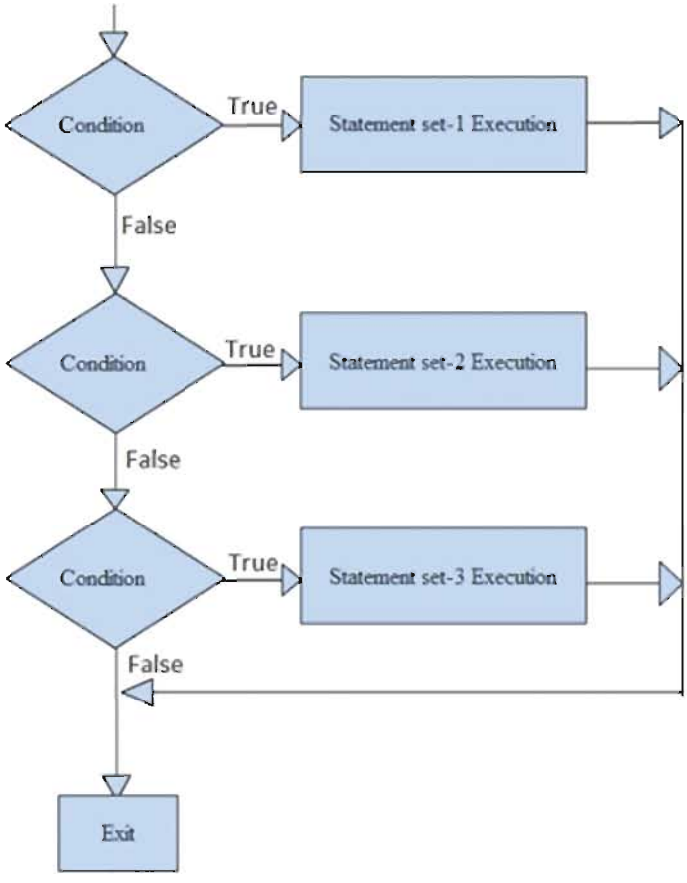


Figure 9.6 : Combining more than one decisions

As shown in the figure 9.6 first the condition will be checked; if it results into true, then first set of statements will be executed. In case of result being false next condition will be checked. This process will be repeated for all the given conditions. Note that when any condition results into true, the conditions following it will not be checked.

Connector: A circle symbol is used to represent a connector. At times it is possible that a flowchart becomes to large to fit into a single page or it may not be possible to use an arrow to link two processes. In such cases a connector can be used to join the two parts. Minimum two circles are required for a connection; one with an arrow coming into a circle and other with an arrow going out of the circle as shown in figure 9.7. To distinguish different connectors, different characters are used with a same character (alphabet) in a pair.

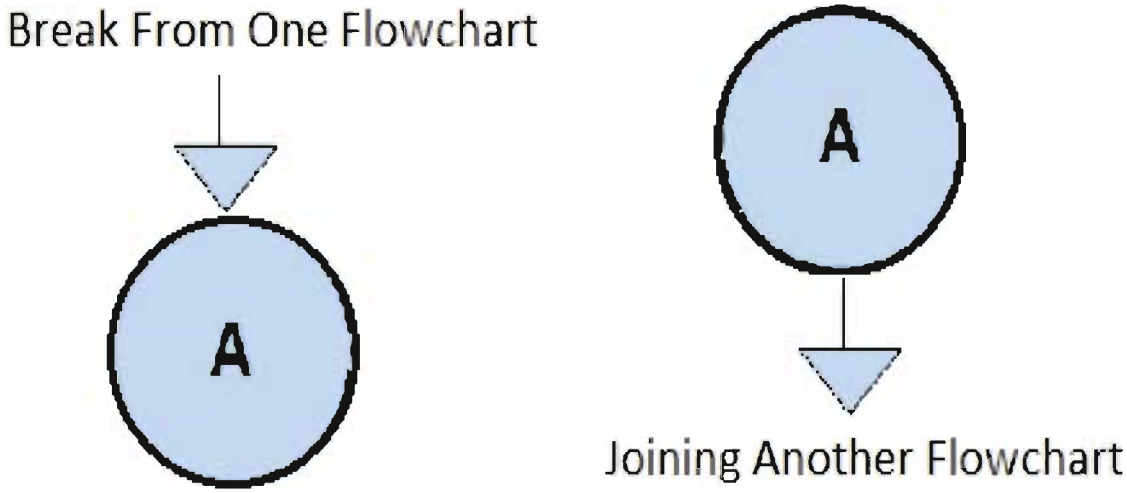


Figure 9.7 : Connector

Examples of Flowchart

Till now we have learnt what a flowchart is and also looked at some of the symbols used in it. Let us now solve some problems by creating flowcharts.

Problem 1 : The fitting charge of tiles is Rs. 10 per square feet. Now assume that the problem is to find the total cost of fitting tiles on the rectangular shaped town hall floor.

Solution :

To find the total cost of fitting the tiles we have to first need to find the area of the floor. Area of a rectangle, as we know, is product of length and breadth. Hence if we know the length and breadth we can find the area of a rectangle. The formula to compute area of the floor can be given as Area = Length * Breadth.

Next to find the total cost of fitting the tiles we multiple cost of fitting per square fit of tiles with the area of the floor. The formula to compute total cost thus is Cost = Area * 10.

To solve this problem we require four variables Area, Length, Breadth and Cost. Before we continue further let us first define the term variable as it will be used in all flowcharts.

Variable : An entity whose value can be assigned and changed during the execution of the process.

The flowchart to find cost of fitting the tiles on the floor is shown in figure 9.8.

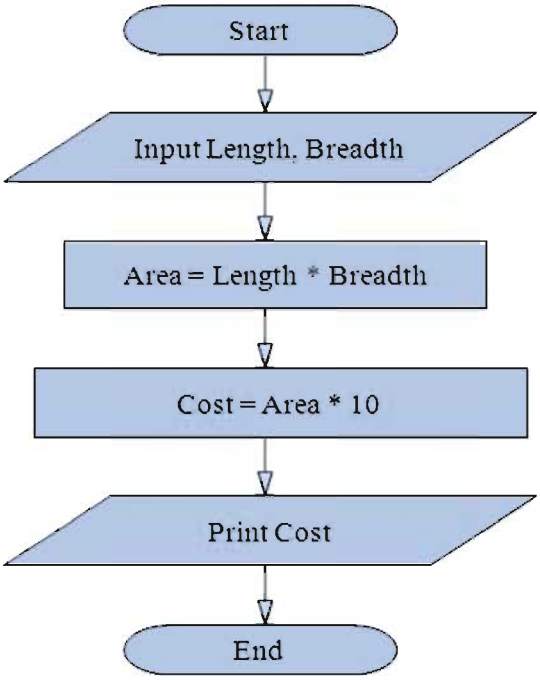


Figure 9.8 : Flowchart to find cost of tiles

Observe the value 10 in expression Cost = Area * 10, Here 10 is known as a constant. It is an entity whose value once assigned remains fixed and cannot be changed during the entire process. The solution that we have created in flowchart shown in figure 9.8 can only be used in the cases where the cost of fitting one square feet tile is Rs. 10. If the cost of fitting the tile changes, the above solution will not work. A generalized solution the above problem is given in figure 9.9.

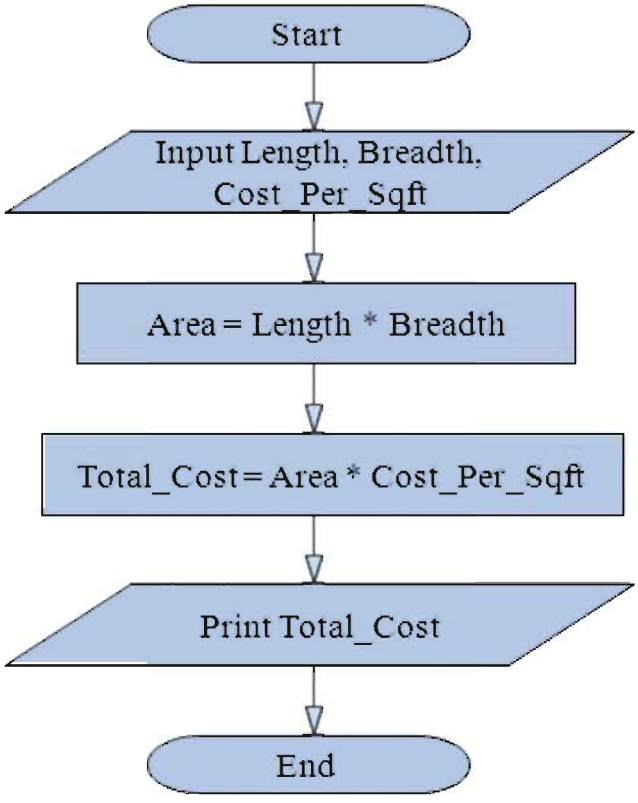


Figure 9.9 : Modified flowchart to find cost of fitting tiles

Observe the flowchart in figure 9.9; here we have used five variables instead of three. The variable Cost_Per_Sqft is now used to store the value of cost for fitting one square feet of tiles. With every run now we may change the value, and we will now be able to get the output. Table 9.1 lists some such outputs.

Length	Breadth	Area=Length*Breadth	Cost_Per_Sqft	Total_Cost=Area*Cost_Per_Sqft
50	50	2500	10	25000
25	75	1875	10	18750
45	35	1575	20	31500

Table 9.1 : Output of flowchart shown in figure 9.9

Problem 2 :

Suppose you have a very nice and round cricket ground at the city sports center. The authority wants to make fencing surrounding this ground. They also want to cover the total surface with a lawn. The authority wants to know how many meters the total fencing will run into? They also want to know the total surface area of the ground that needs to be covered with lawn.

Solution :

To solve this problem we need to find out the area and perimeter of the ground. The formula to find area of the circular ground is Area = II * R2, similarly Perimeter = 2 * II * R (here value of II is 3.14 and R refers to radius of the ground).

Thus to solve this problem we need three variable Radius, Area and Perimeter. The formula that we will use in the flowchart to calculate area and perimeter are given below:

Area = 3.14 * Radius * Radius, Perimeter = 2 * 3.14 * Radius

The flowchart for the said problem is shown in figure 9.10.

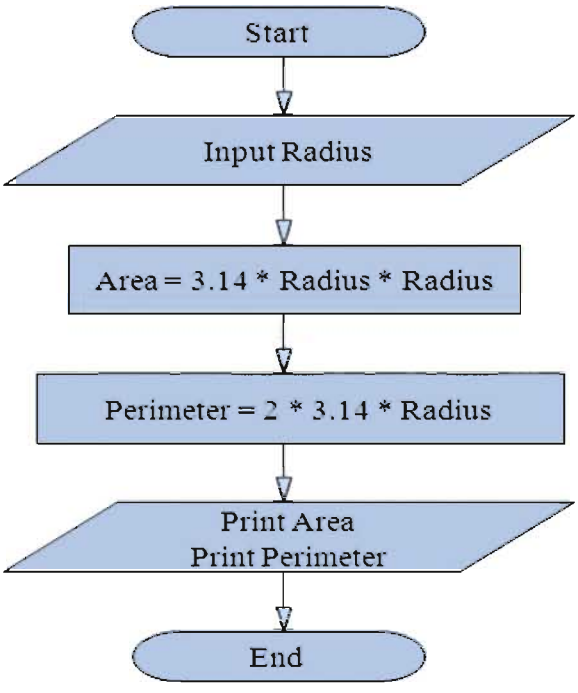


Figure 9.10 : Flowchart to find area and perimeter of a circle

Problem 3 : Ms. Jhanavi has borrowed a loan of Rs. 35,000 at the rate of 11.5 percent from a bank for 6 years. Calculate the simple interest that she will have to pay to the bank.

Solution :

The formula to compute simple interest 'I' on a loan of principle amount 'P' at an interest rate of 'R' for 'N' years is given as **I = (P*R*N)/100.**

To solve this problem we require four variables I, P, R, N and a constant value 100. Figure 9.11 shows the flowchart to solve the problem.

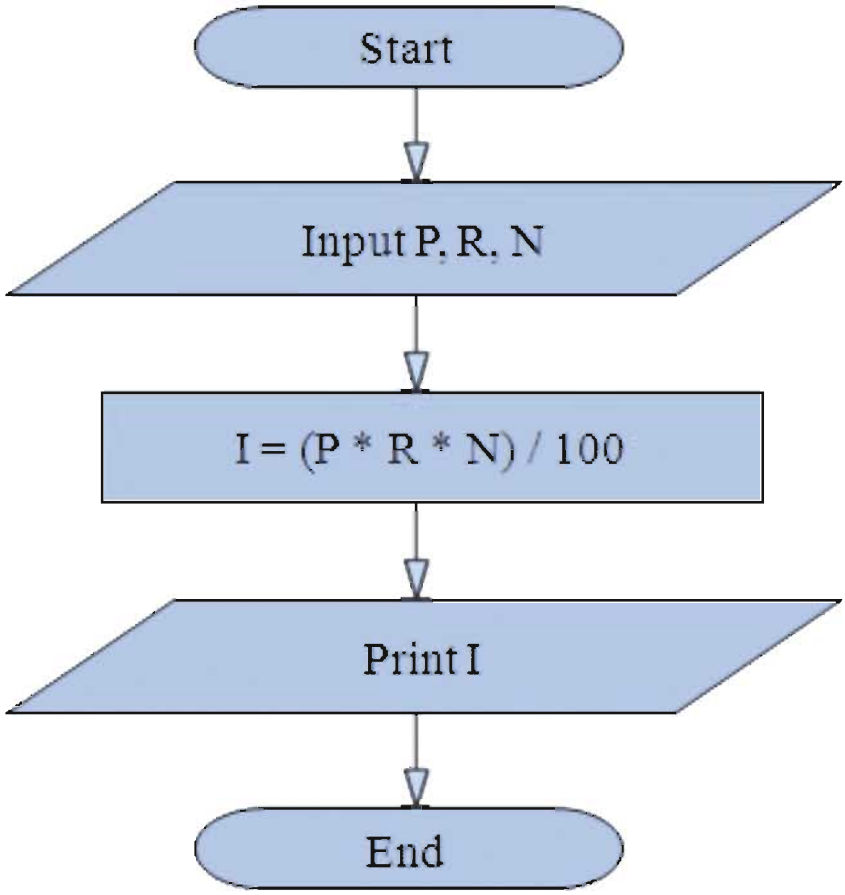


Figure 9.11 : Flowchart to find simple interest

Problem 4 : Assume that you want to find out the youngest student amongst two students. The input in this case will be the age of the student.

Solution :

The solution to the problem can be obtained by performing the steps mentioned below :

Take the ages of both the students; let it be assigned to variables Age_1 and Age_2. Now compare the value of Age_1 with Age_2. If both values are same, then we have two students with same age, hence both can be considered as youngest. If the value of Age_1 is less than Age_2 then first student is youngest. Otherwise second student is youngest. Figure 9.12 shows the flowchart to solve this problem.

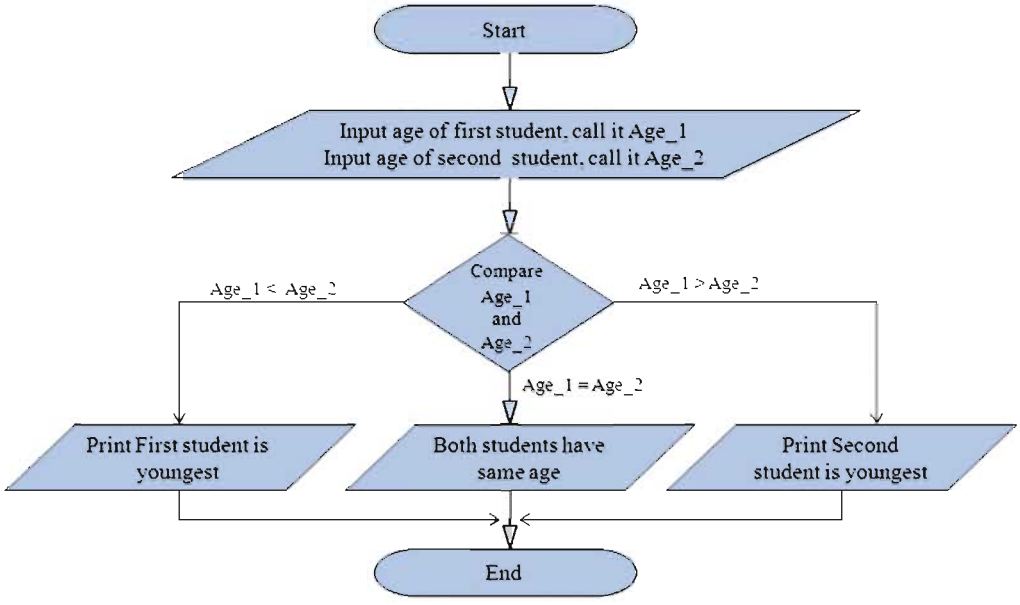


Figure 9.12 : Flowchart to find youngest of two students

Problem 5 : Let us now try to find youngest amongst three students.

Solution :

Take the ages of three students; let it be assigned to variables Age_1, Age_2 and Age_3. Now compare the value of Age_1, Age_2 and Age_3. If value of all the ages is same then, we have three equal aged students. Hence we can assign all three as youngest.

Otherwise compare Age_1 and Age_2. If the value of Age_1 is less than Age_2; then compare Age_1 and Age_3 if still Age_1 is less than Age_3, Then first student is youngest.

In the comparison made above, if Age_2 is less than Age_1, then compare Age_2 and Age_3 if still Age_2 is less than Age_3, Then second student is youngest. Otherwise third student is youngest. Figure 9.13 shows the flowchart to solve this problem.

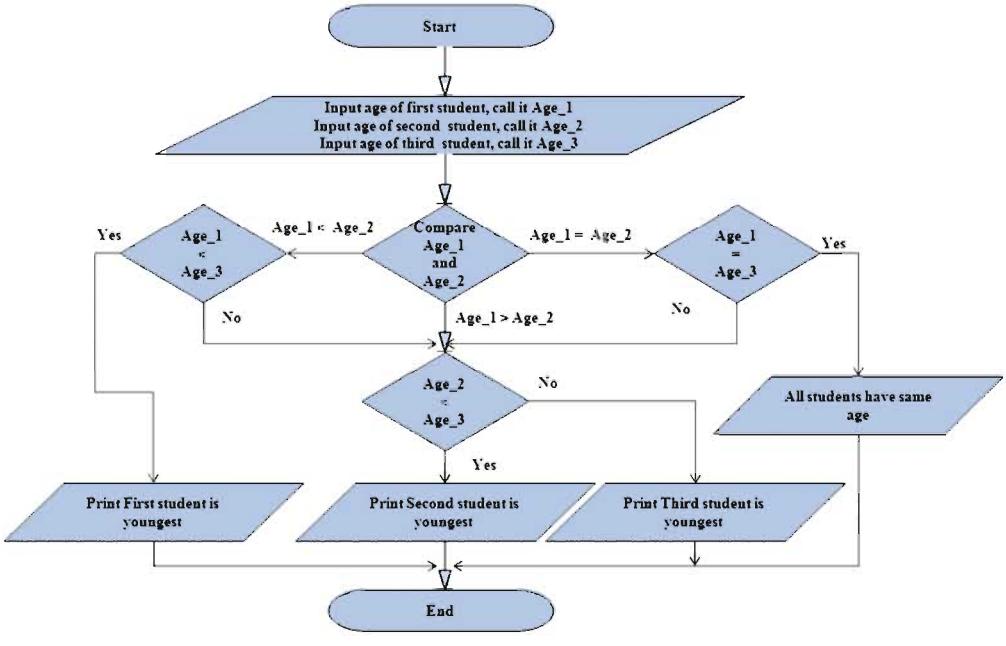


Figure 9.13 : Flowchart to find youngest of three students

Problem 6 : Let us further modify problem 5 to find the out youngest student from a class with any number of students in it. The steps mentioned below can be used to solve our problem.

Step 1: Choose first student, whatever his age, assume that it is MINIMUM.

Step 2 : Now choose another student and compare his/her age with the one that has been mentioned as having minimum age.

Step 3: If new student chosen is younger, we now make his/her age as MINIMUM and discard the old student's age.

Step 4: If both the students have same age then we discard the new student's age and assume that old student's age is still MINIMUM.

Step 5: We repeat step 3 and step 4 till we get the student that has youngest age. When we repeat the same set of statements for more than one time, it is called loop.

Figure 9.14 shows the flowchart to solve this problem.

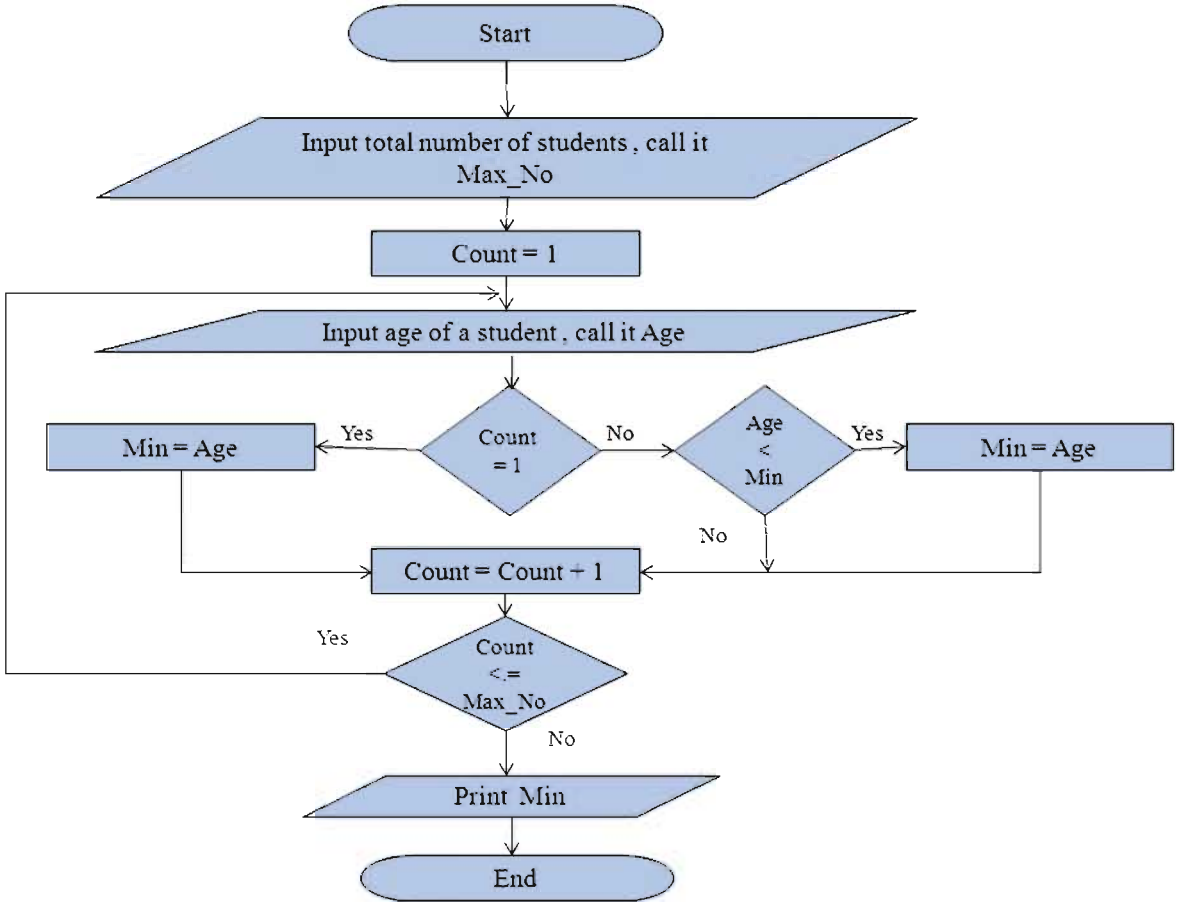


Figure 9.14 : Flowchart to find youngest of any number of students

Problem 7 : Let us now solve one mathematical problem. Assume that we want to find out sum of first 50 odd numbers. That is we want to calculate the sum of 1 + 3 + 5 + 7 + …….. + 99.

Solution :

Assume that you have two boxes, one in your left hand and other in your right hand. Now put one marble in the left box, and then empty it in the box of your right hand. Now again put three marbles in box in your left hand and transfer the marbles in the box of your right hand. What will

happen ? The box in your right hand contains a total of 1 + 3 marbles. If we repeat this process with 5, 7, ... 99 marbles. We will get sum of 1 + 3 + 5 + 7 + ... + 99 marbles. Note that we had assumed that the box in our right hand was initially empty.

With similar analogy, we have taken two variables, numb and sum. The variable numb is initialized with value 1 and the variable sum is initialized with 0 (similar to an empty box). The variable numb is incremented by 2, at iteration of the loop, and is added to sum. Thus the value of variable numb becomes 1, 3, 5, ... till 99. The statement sum = sum + numb keeps on adding the values of variable numb into sum till the loop ends. Figure 9.15 shows the flowchart of the problem.

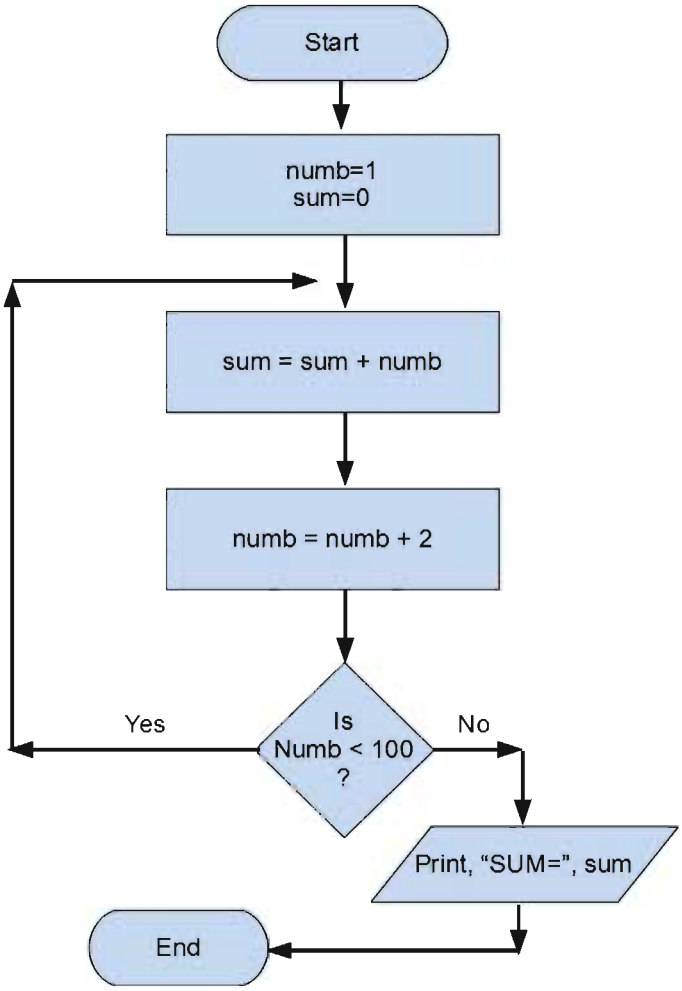


Figure 9.15 : Flowchart to sum of odd numbers till 99

Problem 8 : Let us now have a look at two different ways of exchanging values of two variables.

Solution :

Take two variables say A and B. If we replace the value of either A or B by any other value, the original value stored in them will be lost. Therefore we have used an extra variable C. To make sure that value of A is retained we first transfer it to C. Then value of B is transferred to A and then saved value of A (saved in C) is transferred to B. Figure 9.16 shows the flowchart of this solution.

Figure 9.17 gives a flowchart of the same problem, but it does not use an additional variable. Rather it performs addition and subtraction to interchange the values.

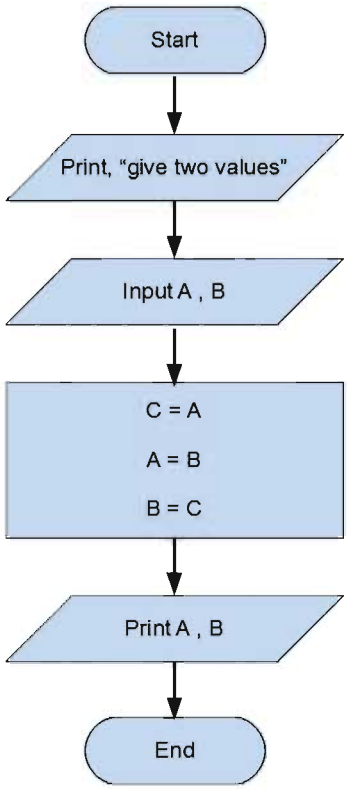


Figure 9.16 : Swapping with extra variable

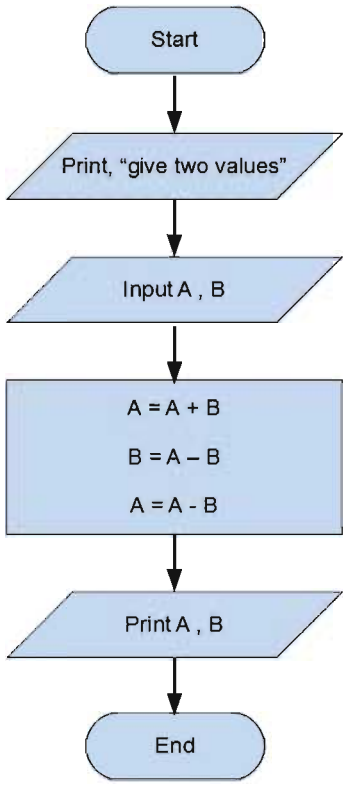


Figure 9.17 : Swapping without extra variable

Advantages and Disadvantages of Flowchart

Whatever tools we use they have some advantages and disadvantages. Flowchart is also not an exception. It also has some benefits and drawbacks.

Advantages of Flowchart :

1. As it provides pictorial representation of the problem solution, it is easy to understand.
2. It provides a convenient aid for writing computer instructions.
3. It assists the programmer in reviewing and correcting the solution steps.
4. It helps in discussion of different methods for solving a problem. This in turn provides us a facility to compare them accurately.

Disadvantages of Flowchart :

1. Drawing a flowchart for a large and complex problem is time consuming and laborious.
2. As flowchart consists of symbols, any changes or modification in the program logic will most of the times require a new flowchart to be drawn.
3. There are no standards specifying the details of data that should be shown in a flowchart. Hence flowchart for a given problem although with similar logic may vary in terms of data shown.

Algorithm

Your friend has reached your home and is now interested in coming to your school. He/She calls you and asks for directions to reach your school. To instruct him/her on how to reach the school you will first need to have some route locations in mind. Assume that you have a route map as shown in figure 9.18 to assist you.

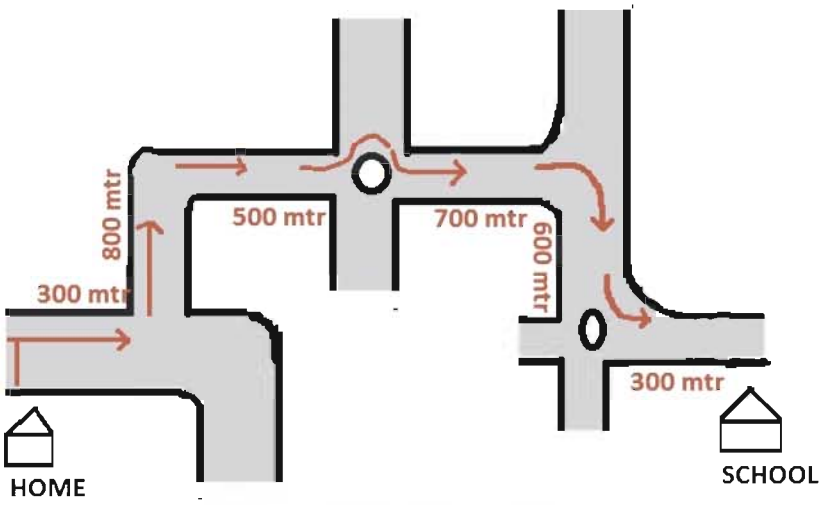


Figure 9.18 : Route Map

Solution :

Using the route map given in figure 9.18, you will be able to guide your friend step by step as mentioned below:

Step-1 : Start from my home and take right and go for 300 meters.

Step-2 : Now take a left turn and go straight for another 800 meters.

Step-3 : Take a right turn and walk for 500 meters, you will encounter a four cross roads with a circle.

Step-4 : Do not take turn at circle; instead keep on walking in the direction you were walking till another 700 meters.

Step-5 : Now take a right turn; after 600 meters you will reach another cross roads with an oval shaped fountain in the middle of cross roads.

Step-6 : Take a left turn from at this junction and walk for 300 meters.

Step-7 : You will be able to see my school on the right side of the street.

From the above example we can say that the problem of reaching your school is solved by following a sequence of steps. In computer science, an algorithm refers to a step by step procedure for solving a particular problem. An algorithm is written in a natural language like English. Algorithms once written then can be easily converted into computer programs. Let us now learn to write some algorithms.

Problem 1 :

Write an algorithm to find summation of numbers divisible by 11 within the range of 1 to 100.

Algorithm :

Step-1 : Start

Step-2 : Take two variable Num and Sum.

Step-3 : Initialize Num = 1 and Sum = 0.

Step-4 : Check whether Num is divisible by 11? To do this we have to find remainder when Num is divided by 11. Store the remainder in another variable say R.

```
R = Num - int(Num/11) * 11
```

Step-5 : If R is not equal to 0 go to Step-7.

Step-6 : Sum = Sum + Num

Step-7 : Num = Num + 1

Step-8 : If Num < 100 go to Step-4.

Step-9 : Print Sum

Step-10 : End

Explanation :

To find the remainder, we first divide the number stored in Num by 11 and then we take its integer part. For example if the value of Num is 39 then dividing it by 11, we will get 3.54545455. If we take its integer part, it will be only 3. The portion after decimal point will be removed. When the integer part is multiplied by 11, we will get 33. If this 33 is subtracted from the original number that is 39, we will get a value 6. This value is the remainder. Note that we have assumed a process called int which gives integer part of the number.

Step number 1 to 4 is self explanatory. Step-5 checks the remainder using the technique mentioned above. If the remainder is not equal to 0, it means that Num is not divisible by 11and we will proceed to take the next number. If Num is divisible by 11, we will jump to step-6. We add the value of Num to Sum and then proceed to step-8. In step-8 we check whether Num is less than 100 or not. This check is used to exit from the loop. We will thus continue till value of Num is less than 100. Finally we will print the value of Sum.

Problem 2 :

Write an algorithm to find compound interest for given, principal amount, time period and rate of interest, when interest is calculated every year.

Algorithm :

We know that the compound interest can be calculated using the formula

$$CI = P * (1 + R/100)N - P$$

Here P is Principal Amount, R is rate of interest and N is time period in years.

Step-1 : Start

Step-2 : Take four variables P, N, R and CI.

Step-3 : Assign values to P, N and R.

Step-4 : Calculate compound interest using $CI = P * (1 + R/100)^N - P$

Step-5 : Print value stored in CI

Step-6 : End

Problem 3 :

Find out the total weekly pay to be given to an employee based on the number of hours he/she has worked. To get a solution here we need to know the pay per hour that is to be given to the employee.

Algorithm :

We want to find weekly pay, for this we need two inputs, number of hours worked and salary per hour.

Step-1 : Start

Step-2 : Take three variables No_Of_Hrs_Worked, Pay_Per_Hour and Weekly_Pay.

Step-3 : Assign values to No_Of_Hrs_Worked and Pay_Per_Hour.

Step-4 : Calculate weekly pay using formula

Weekly_Pay = No_Of_Hrs_Worked * Pay_Per_Hour

Step-5 : Print value stored in Weekly_Pay

Step-6 : End

Summary

In this chapter, we have learnt about the two most used techniques of problem solving, namely, flowchart and algorithm. We saw different symbols that can be used to draw a flowchart. The user needs to decide between using either a flowchart or an algorithm to solve a problem.

EXERCISE

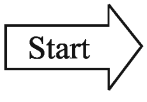
1. Which are the basic components of a flowchart ?
2. Which kind of problem is solved by computers ?
3. Which types of operations are parts of the computer process ?
4. Which are the operations constitute Arithmetic operation ?
5. Decision box is used for which type of operation ?
6. How do you define a variable ?
7. What do you understand by algorithm ? How it is differ from flowchart ?
8. Choose the correct option from the following :

   (1) Which of the following symbol is used to begin a flow chart ?

   (a) 

   (b) 

   (c) 

   (d) 

(2) Which of the following refers to a list of instructions in a proper order to solve a problem called ?

(a) Algorithm (b) Flowchart (c) Sequence (d) Roadmap

(3) Which of the following symbol is used to test conditions in a flowchart ?

(a) Diamond (b) Circle (c) Arrow (d) Square

(4) Which of the following symbol is used to represent output in a flowchart ?

(a) Square (b) Circle (c) Parallelogram (d) Triangle

(5) Which of the following is the standard terminal symbol for a flowchart ?

(a) Circle (b) Diamond

(c) Rounded Rectangle (d) Square

(6) Which of the following refers to the purpose of Algorithm and Flowchart ?

(a) Know the memory capacity

(b) Identify the base of the number system

(c) Direct the output to the printer

(d) Specify the problem completely and clearly

(7) Which of the following is not a problem solving technique ?

(a) Pseudo code (b) Flowchart (c) Algorithm (d) Sequence

(8) Which of the following is a pictorial representation of a problem solving technique ?

(a) Pseudo code (b) Flowchart

(c) Algorithm (d) Computer program

(9) An arrow symbol in flowchart is used to show

(a) The flow of an action

(b) The sequence of action

(c) The start of actions

(d) The completion of an action

(10) Which of the following refers to the core part of any solution ?

(a) Input (b) Output (c) Process (d) Algorithm

(11) Which of the following symbol represents a Process ?

(a) Rectangle (b) Square (c) Circle (d) Diamond

(12) Which of the following is used to distinguish different connector pairs in flowchart ?

(a) Arrows are used

(b) Alphabets or other characters are used

(c) Circles are used

(d) Diamonds are used

LABORATORY EXERCISE

Draw a flowchart and write and algorithm to perform the following operations :

1. Convert the given meters into centimeters.
2. Convert the given centigrade to Fahrenheit.
3. Find minimum of the given two numbers.
4. Find minimum of the given two numbers and check whether the minimum number is odd or even.
5. Find minimum of the given three numbers.
6. Check whether a given number is divisible by other given number.
7. Find average of three numbers.
8. Given total marks of student find whether the student has passed or failed. (If total marks are less than 35 then the student is declared as fail.)
9. Given total marks of student find what grade the student has obtained. (If total marks are less than 35 then the student gets D grade. If total marks are between 35 and 60 then C grade, if total marks between 60 and 70 then B grade, above 70 A grade)
10. Calculate the compound interest on a loan amount of Rs. X taken a t the rate of R% for N years.
11. Find the summation of digits of a given number. For example if the given number is 8327 the output will be 20 (8 + 3 + 2 + 7)