

Problem

- Problem is a puzzle that requires logical thought and /or mathematics to solve.
- A puzzle could be a set of questions on a scenario which consists of ***description of reality*** and **set of constraints about the scenario**.

A milkman has two empty jugs: a three litre jug and a five litre jug. How can he measure exactly one litre without wasting any milk?

You are in the dark, and on the floor there are six shoes of three colors, and a heap of twenty-four socks, black and brown. How many socks and shoes must you take into the light to be certain that you have a matching pair of socks and a matching pair of shoes?

Example Scenario: VIT Vellore campus has a library. The librarian issues books only to VIT employees.

Careful observation suggests...

Description of reality : There is a library in VIT Vellore campus and there is a librarian in the library.

Problem

- **Constraint** : Librarian issues books only to VIT employees

Questions about the scenario:

- 1 How many books are there in the library?
- 2 How many books can be issued to an employee?
3. Does the librarian issue a book to himself? etc

Case study

Consider a bigger scenario...

A Retail Shop

Demand Planning
Inventory Control



Billing
Pricing
Promotions

Store layout
Item Management

Have you ever observed this scenario?

Yes!!! What are the problems in the scenario?

Types of Problems

- All Problems do not have a straightforward solutions.
- Some problems, such as balancing a checkbook or baking a cake, can be solved with a series of actions.
- These solutions are called **algorithmic solutions**.
- There may be more than one solution for a problem
- Identify all possible ways to solve a problem and choose one among them

Types of Problems

- The solutions of other problems, such as how to buy the best stock or whether to expand the company, are not so straightforward.
- These solutions require reasoning built on knowledge and experience, and a process of trial and error.
- Solutions that cannot be reached through a direct set of steps are called **heuristic solution**

- At a café, there are 3-legged stools and 4-legged stools for customers to sit on.
Ram counts 15 stools with a total of 50 legs altogether.
How many 3-legged stools are there in the café?

3-legged stools	4-legged stools	Total number of legs	Check
8 x 3 = 24	7 x 4 = 28	24 + 28 = 52	x
9 x 3 = 27	6 x 4 = 24	27 + 24 = 51	x
10 x 3 = 30	5 x 4 = 20	30 + 20 = 50	✓

Problem Solving with Computers

- Computers are built to solve problems with algorithmic solutions, which are often difficult or very time consuming when input is large
- Solving a complicated calculus problem or alphabetizing 10,000 names is an easy task for the computer
- So the basis for solving any problem through computers is by developing an algorithm

- Field of computers that deals with heuristic types of problems is called Artificial Intelligence (AI)
- Artificial intelligence enables a computer to do things like human by building its own knowledge bank
- As a result, the computer's problem-solving abilities are similar to those of a human being.
- Artificial intelligence is an expanding computer field, especially with the increased use of Robotics.

Computational Problems

- Computation is the process of evolution from one **state to** another in accordance with some **rules**.

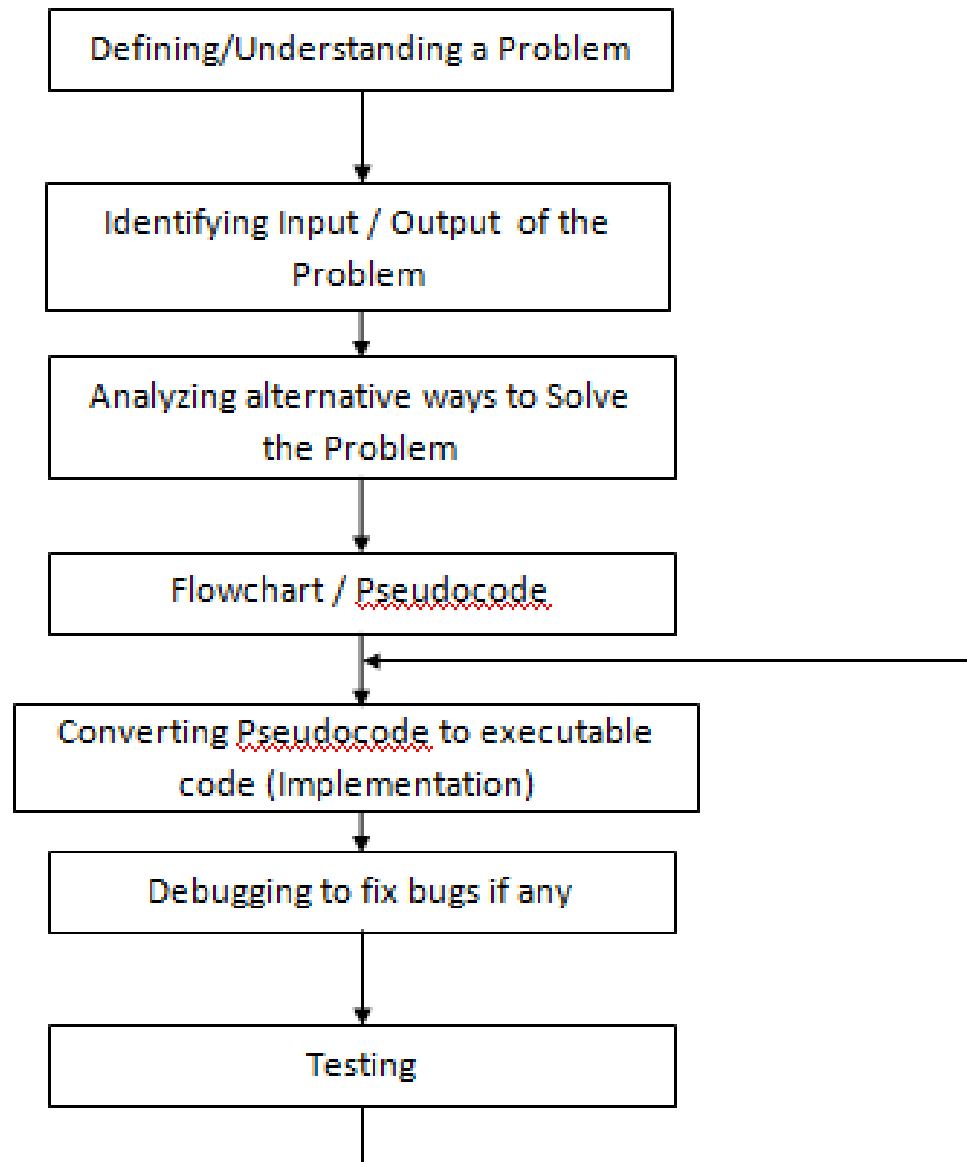
Types of Computational Problems



Problem Solving Life Cycle



For any problem solving strategy logic is prerequisite.



Logic – Basis for solving any problem

- **Definition : A method of human thought that involves thinking in a linear, step by step manner about how a problem can be solved**
- Logic is a language for reasoning.
- It is a collection of rules we use when doing reasoning.
- Eg: John's mum has four children.
- The first child is called April.
- The second May.
- The third June.
- What is the name of the fourth child?

What Problem Can Be Solved By Computer

- Solving problem by computer undergo two phases:
 - Phase 1:
 - Organizing the problem or pre-programming phase.
 - Phase 2:
 - Programming phase.

PRE-PROGRAMMING PHASE

- **Analyzing The Problem**
 - Understand and analyze the problem to determine whether it can be solved by a computer.
 - Analyze the requirements of the problem.
 - Identify the following:
 - Data requirement.
 - Processing requirement or procedures that will be needed to solve the problem.
 - The output.

PRE-PROGRAMMING PHASE

- All these requirements can be presented in a Problem Analysis Chart (PAC)

Data	Processing	Output	Solution Alternatives
given in the problem or provided by the user	List of processing required or procedures.	Output requirement.	List of ideas for the solution of the problem.

PRE-PROGRAMMING PHASE

- **Payroll Problem**

- Calculate the salary of an employee who works by hourly basis. The formula to be used is

$$\text{Salary} = \text{Hour works} * \text{Pay rate}$$

Data	Processing	Output	Solution Alternatives
Hours work, Pay rate	Salary = Hours work * payrate	Salary	1. Define the hours worked and pay rate as constants. *2. Define the hours worked and pay rate as input values.

Miles to Km

Write a Problem Analysis Chart (PAC) to convert the distance in miles to kilometers where 1.609 kilometers per mile.

Data	Processing	Output	Solution Alternatives
Distance in miles	Kilometers = 1.609 x miles	Distance in kilometers	1. Define the miles as constants. *2. Define the miles as input values.

Importance of Logic in problem solving

Determine whether a given number is prime or not?

Data	Processing	Output	Solution Alternatives
Number, N	Check if there is a factor for N	Print Prime or Not Prime	<p>1. Divide N by numbers from 2 to N and if for all the division operations, the remainder is non zero, the number is prime otherwise it is not prime</p> <p>2. Same as 1 but divide the N from 2 to $N/2$</p> <p>3. Same as Logic 1 but divide N from 2 to square root of N</p>

Importance of Logic in problem solving

In a fun game, $M \times M$ grid is given with full of coins. The player has to give a number 'N' of his choice. If N is lesser than M then he is out of game and doesn't gain any points. Otherwise he has to place all coins in the $M \times M$ grid in the $N \times N$ grid and he gains points equal to the number of free cells in the $N \times N$ grid.

Data	Processing	Output	Solution Alternatives
Numbers M and N	<p>If N is less than M Points = 0</p> <p>Otherwise Compute Points as $N^2 - M^2$</p>	Number of points gained	<p>1. Compute $N^2 - M^2$ as $N \times N - M \times M$</p> <p>2. Compute $(N + M)$ $\times (N - M)$ (Number of multiplication is reduced)</p>

Problem 2

- Write a Problem Analysis Chart (PAC) to find an area of a circle where $\text{area} = \pi * \text{radius} * \text{radius}$

Data	Processing	Output
radius	$\text{area} = 3.14 \times \text{radius} \times \text{radius}$	area

Problem 3

- Write a Problem Analysis Chart (PAC) to compute and display the temperature inside the earth in Celsius and Fahrenheit.
- The relevant formulas are
$$\text{Celsius} = 10 \times (\text{depth}) + 20$$
$$\text{Fahrenheit} = 1.8 \times (\text{Celsius}) + 32$$

Data	Processing	Output
depth	$\text{celsius} = 10 \times (\text{depth}) + 20$ $\text{fahrenheit} = 1.8 \times (\text{celsius}) + 32$	Display celsius, Display fahrenheit

Problem 4

Given the distance of a trip in kms, kms per litre by the car that is used in the trip and the current price of one litre of petrol, write a program to determine the fuel required for the trip and the cost spent on the fuel.

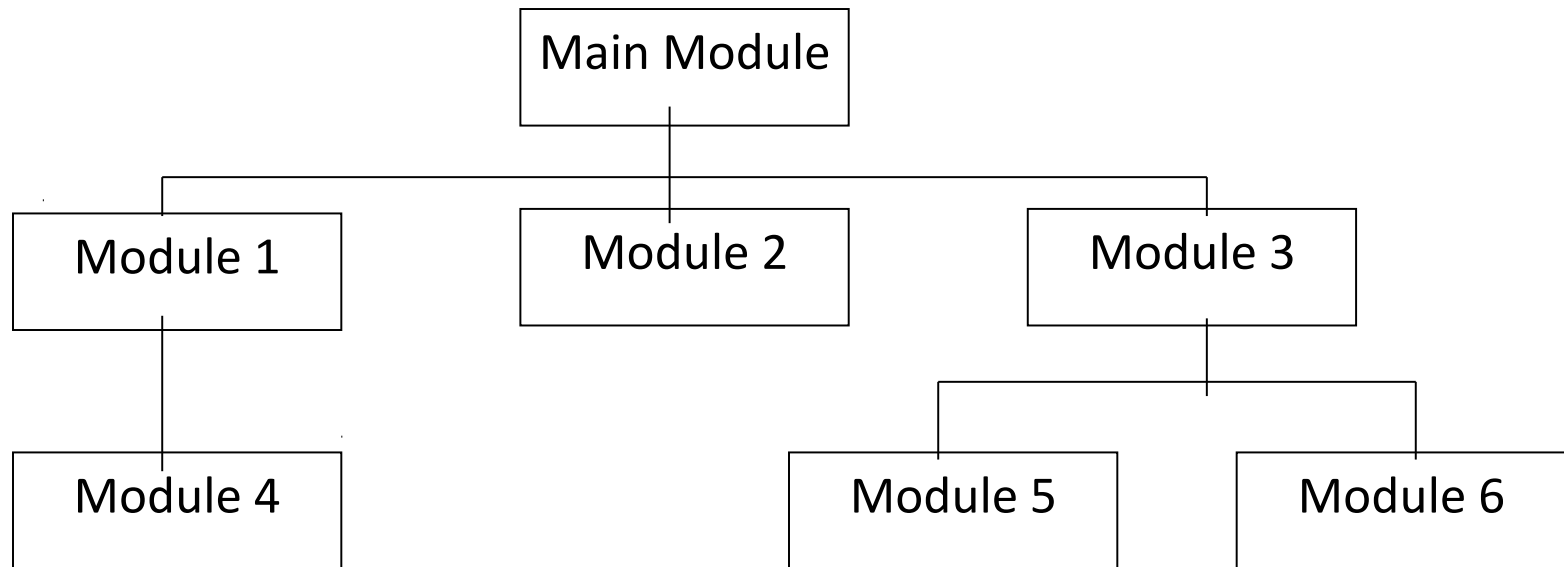
Input	Processing	Output
Distance in kms, Kms per litre, cost per litre	Fuel needed = distance / kms per litre. estimated cost = cost per litre x fuel needed	Display fuel needed Display estimated cost

HIPO Chart

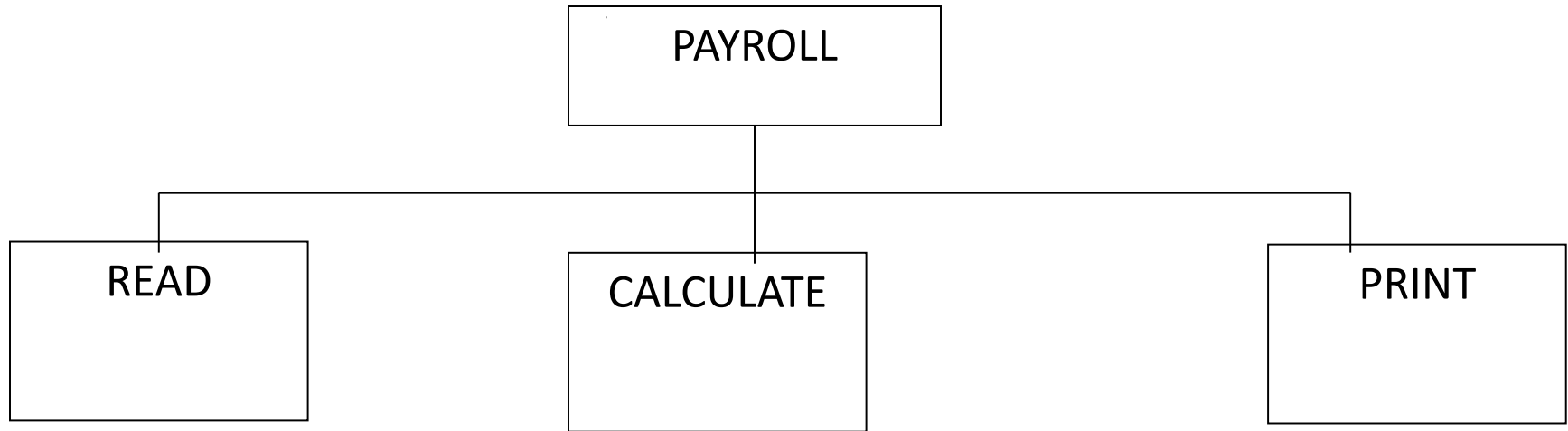
- **Developing the Hierarchy Input Process Output (HIPO) or Interactivity Chart**
 - When problem is normally big and complex.
 - Processing can be divided into subtasks called modules
 - Each module accomplishes one function
 - These modules are connected to each other to show the interaction of processing between the modules

HIPO Chart

- Programming which use this approach (problem is divided into subtasks) is called *Structured Programming*



HIPO Chart for Payroll Problem



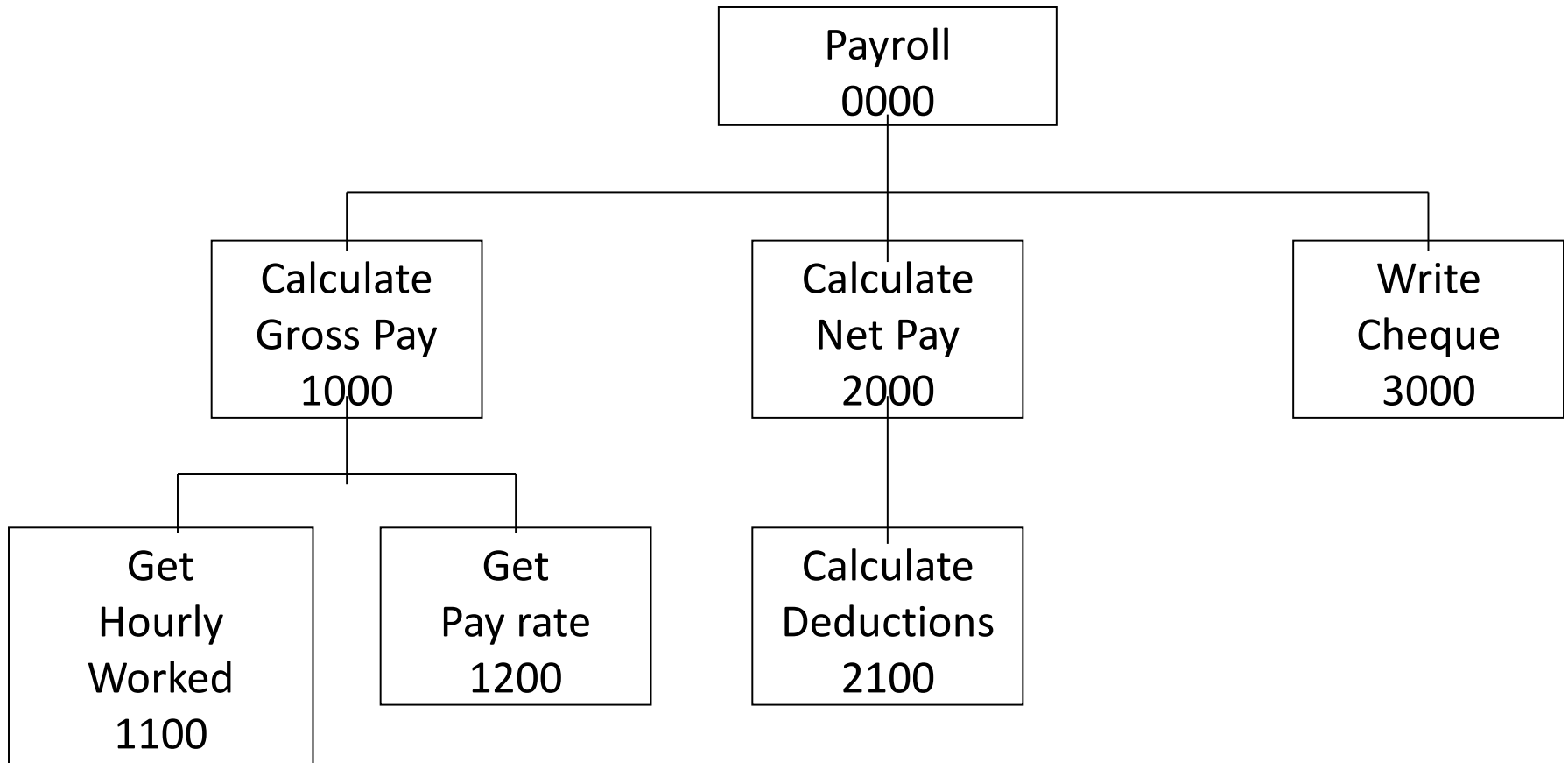
Extended Payroll Problem

- You are required to write a program to calculate both the gross pay and the net pay of every employee of your company. Use the following formulae for calculation:
 - Gross pay = number of hours worked * pay rate
 - Net pay = gross pay – deductions
- The program should also print the cheque that tells the total net pay.

PAC for Extended Payroll Problem

Input	Processing	Output
Number of hours worked, pay rate, deductions	Gross pay = number of hours * pay rate Net pay = Gross pay – deductions	Net pay and write net pay in cheque

HIPO Chart

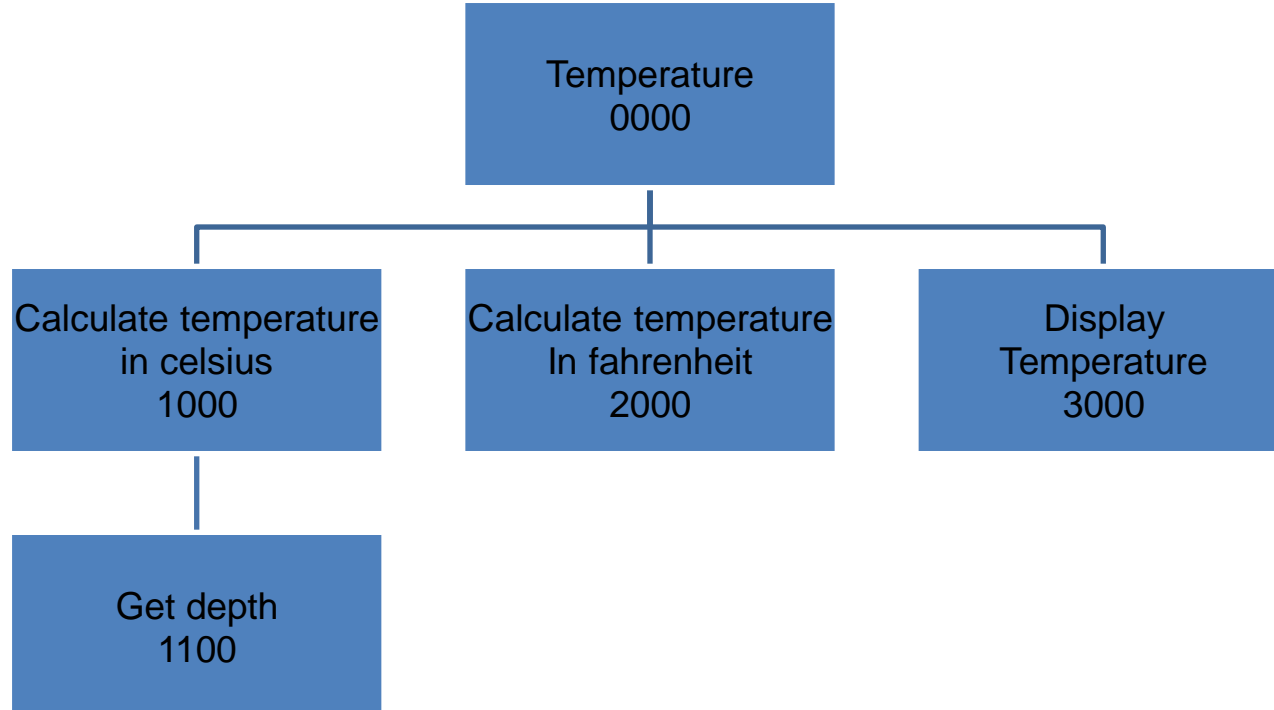


Temperature of Earth

- Write a Hierarchy Input Process Output (HIPO) to compute and display the temperature inside the earth in Celsius and Fahrenheit. The relevant formulas are

$$\text{Celsius} = 10 \times (\text{depth}) + 20$$

$$\text{Fahrenheit} = 1.8 \times (\text{Celsius}) + 32$$



Algorithm

- Step by step procedure to solve a problem
- 'In Computer Science following notations are used to represent algorithm
- Flowchart: This is a graphical representation of computation
- Pseudo code: They usually look like English statements but have additional qualities

Heat oven to 325°F



Gather the ingredients



Mix ingredients thoroughly
in a bowl



Pour the mixture into a
baking pan



Bake in the oven
50 minutes



Repeat

Bake 5 minutes more

Until cake top springs back when touched in the center

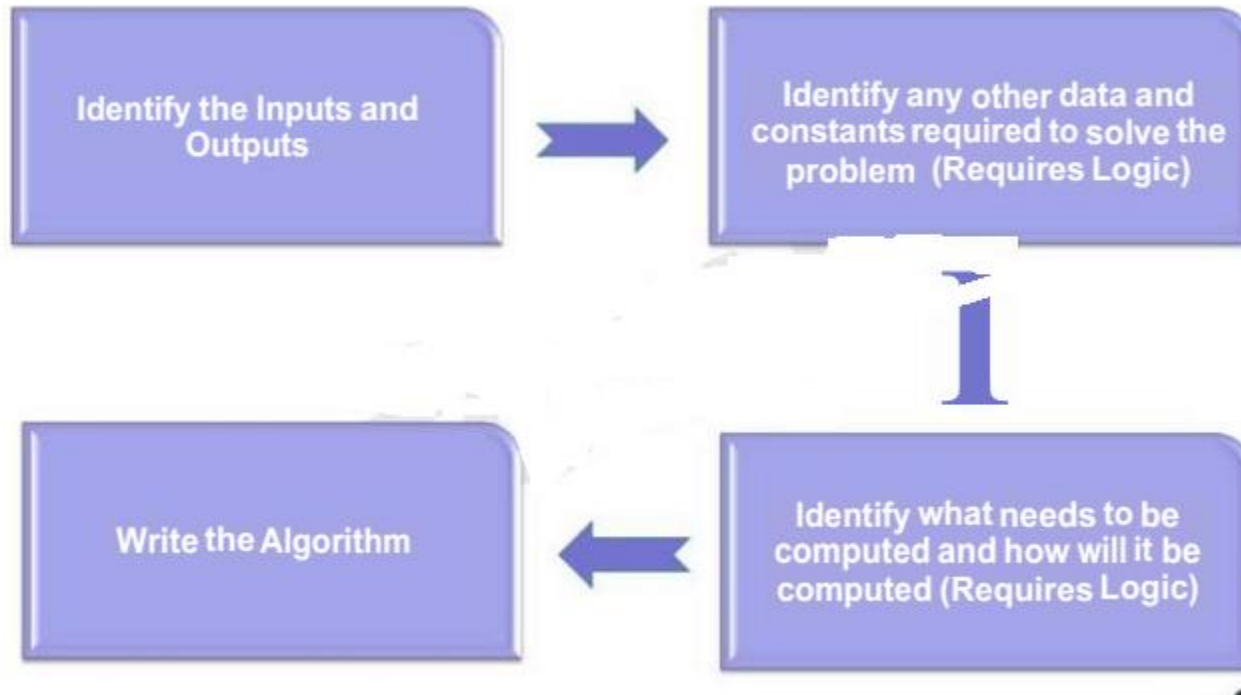
Cool on a rack before cutting



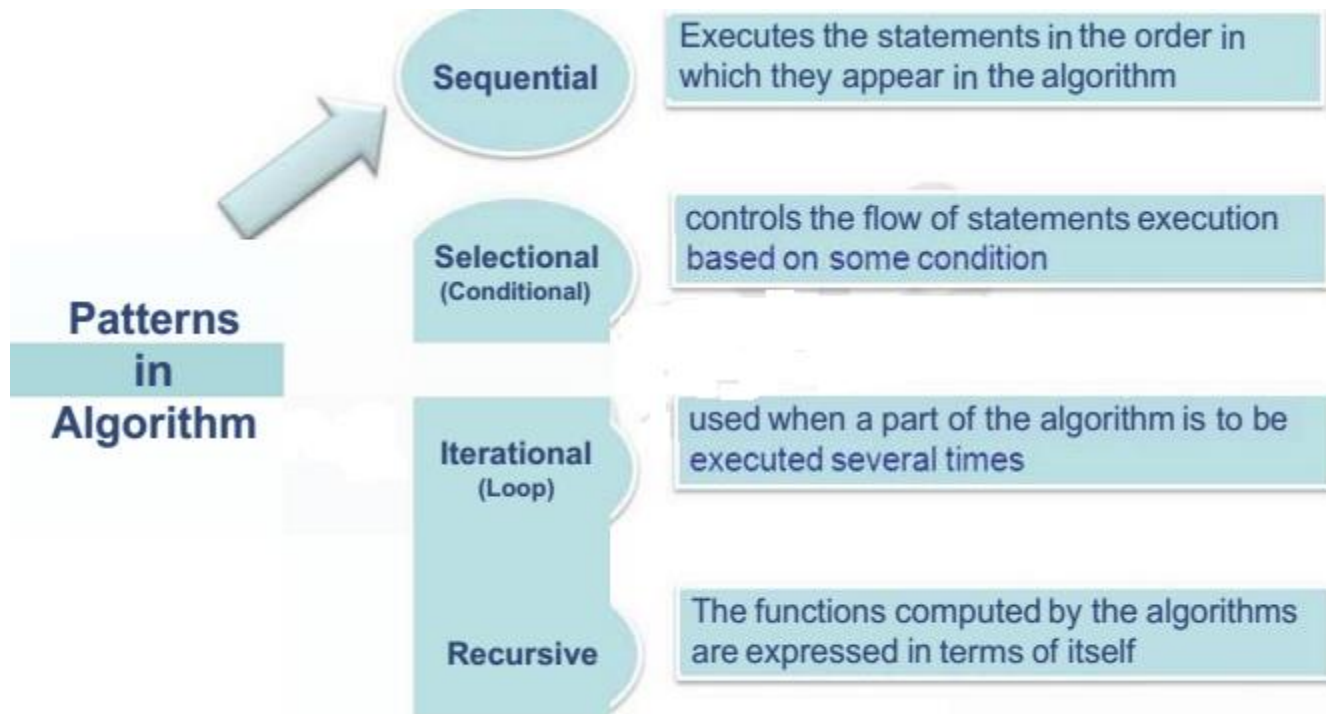
Algorithm

- Algorithms are not specific to any programming language
- An algorithm can be implemented in any programming language
- Use of Algorithms
 - Facilitates easy development of programs
 - Iterative refinement
 - Easy to convert it to a program
 - Review is easier

Steps to Develop an Algorithm



Different patterns in Algorithm



Sequential Algorithms

Algorithm for adding two numbers

Step 1: Read two numbers A and B

Step 2: Let $C = A + B$

Step 3: Display C

Area of a Circle

Step 1 : Read the RADIUS of a circle

Step 2 : Find the square of RADIUS and store it in SQUARE

Step 3 : Multiply SQUARE with 3.14 and store the result in AREA

Step 4: Print AREA

Average Marks

- Find the average marks scored by a student in 3 subjects:

Step 1 : Read Marks1, Marks2, Marks3

Step 2 : $\text{Sum} = \text{Marks1} + \text{Marks2} + \text{Marks3}$

Step 3 : $\text{Average} = \text{Sum} / 3$

Step 4 : Display Average

Selectional Algorithms

Pass/ Fail and Average

- Write an algorithm to find the average marks of a student. Also check whether the student has passed or failed. For a student to be declared pass, average marks should not be less than 65.

Step 1 : Read Marks1, Marks2, Marks3

Step 2 : $\text{Total} = \text{Marks1} + \text{Marks2} + \text{Marks3}$

Step 3 : $\text{Average} = \text{Total} / 3$

Step 4 : Set Output = "Student Passed"

Step 5 : if $\text{Average} < 65$ then Set Output = "Student Failed"

Step 6 : Display Output

Leap Year or Not

Step 1 : Read YEAR

**Step 2 : IF ({YEAR%4=0 AND
YEAR%100!=0)OR (YEAR%400=0))**

Display "Year is a leap year"

ELSE

Display "Year is not a leap year"

ENDIF

Iterational Algorithms – Repetitive Structures

- Find the average marks scored by 'N'
number of students

Step 1 : Read Number Of Students

Step 2 : Let Counter = 1

Step 3 : Read Marks1, Marks2, Marks3

Step 4 : $\text{Total} = \text{Marks1} + \text{Marks2} + \text{Marks3}$

Step 5 : $\text{Average} = \text{Total} / 3$

Step 6 : Set Output = "Student Passed"

Step 7 : If (Average < 65) then Set Output = "Student Failed"

Step 8 : Display Output

Step 9 : Set Counter = Counter + 1

Step 10 : If (Counter <= NumberOfStudents) then goto step 3