BCSE101E

Computer Programming: Python

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Module-1 Introduction to Problem Solving

Skills Required for a Software Engineer

Technical Skills

– Software Design

– Coding

– Testing

Problem Solving Skills

– logical and analytical thinking

Soft Skills

– Communication

– Team Work

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.**

  Example Scenario: VIT Chennai campus has a library. The librarian issues books only to VIT employees. Careful observation suggests...

  Description of reality : There is a library in VIT Chennai 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 - Discussion

Consider a bigger scenario...

A Retail Shop

Demand Planning
Inventory Control

Back Room

Shelf

Store layout

Item Management

POS

Billing

Pricing

Promotions

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**

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

	Decision Problem	
where the answer for every instance is either yes or no.		Deciding whether a given number is prime

	Searching & Sorting Problem	
Searching an element from a given set of elements. Or arranging them in an order		Finding product name for given product ID and arranging products in alphabetical order of names

	Counting Problem	
Counting no. of occurrences of a type of elements in a set of elements		Counting how many different type of items are available in the store

	Optimization Problem	
Finding the best solution out of several feasible solutions		Finding best combination of products for promotional campaign

Problem Solving Life Cycle

What do you understand with point of sale problem?

1- Under¬ problem

What plan can you prepare for solving the problem?

4. Look back i.e. verifying
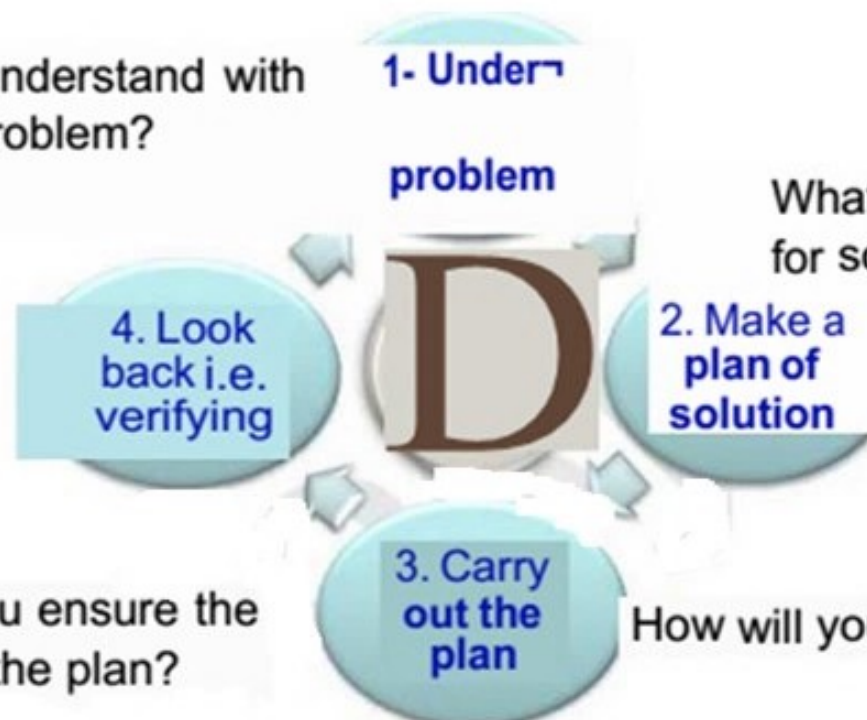
2. Make a plan of solution

How can you ensure the success of the plan?

3. Carry out the plan

How will you carry out the plan?

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┌─────────────────────────────────────┐
│   Defining/Understanding a Problem   │
└─────────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────────┐
│   Identifying Input / Output  of the │
│                Problem               │
└─────────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────────┐
│   Analyzing alternative ways to Solve│
│              the Problem             │
└─────────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────────┐
│        Flowchart / Pseudocode        │
└─────────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────────┐
│   Converting Pseudocode to executable│
│        code (Implementation)         │
└─────────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────────┐
│        Debugging to fix bugs if any  │
└─────────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────────┐
│               Testing                │
└─────────────────────────────────────┘
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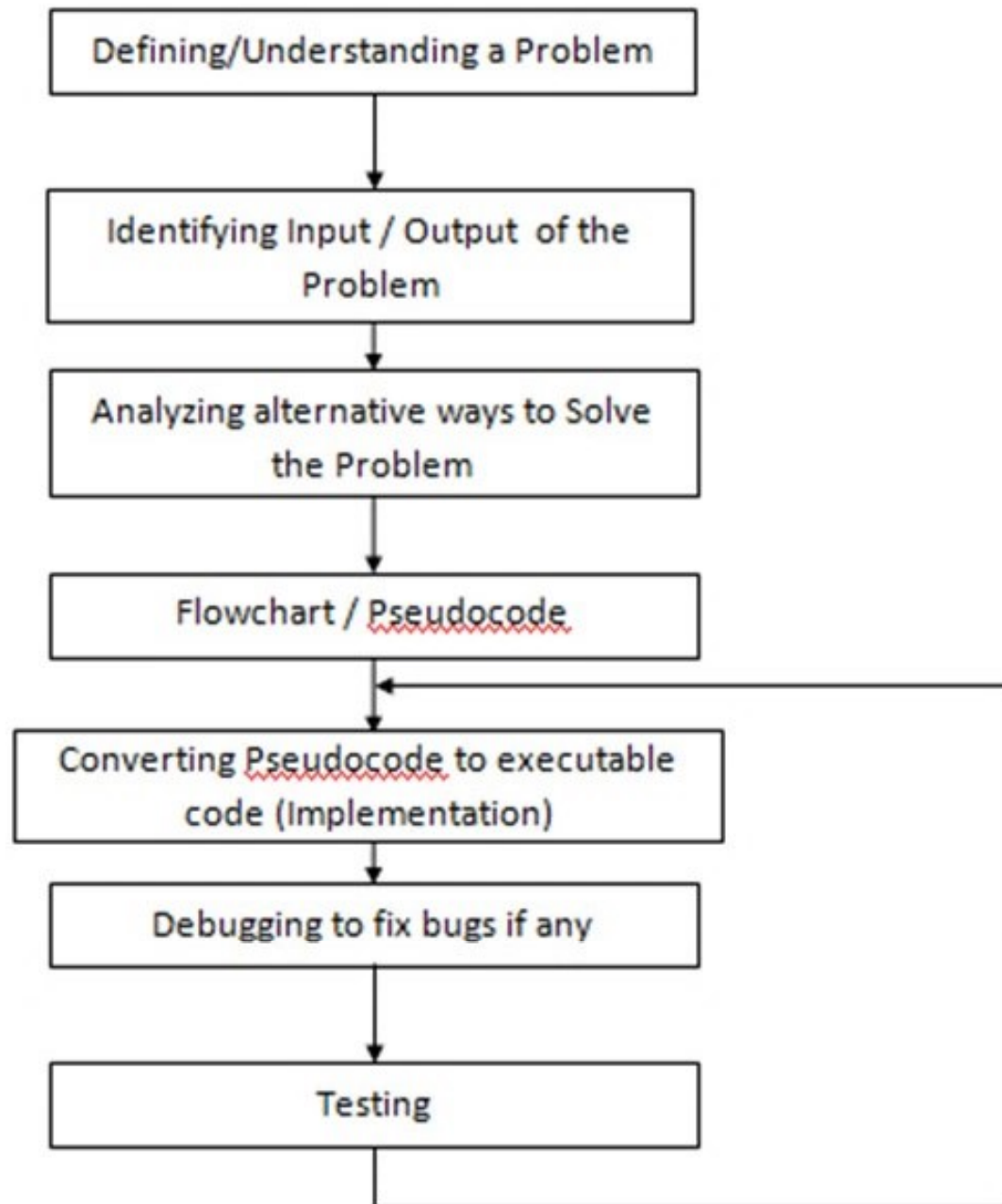
Logic – Basis for solving any problem

- **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

Salary = Hour works * 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.

Miles to Km

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?

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	1. Divide N by numbers from 2 to N and if for all the division operations, the reminder is non zero, the number is prime otherwise it is not prime 2. Same as 1 but divide the N from 2 to N/2 3. Same as Logic 1 but divide N from 2 to square root of N

Importance of Logic in problem solving

In a fun game, MXM 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 MXM grid in the NXN grid and he gains points equal to the number of free cells in the N X N grid.

Importance of Logic in problem solving

Data	Processing	Output	Solution Alternatives
Numbers M and N	If N is less than M Points = 0 Otherwise Compute Points as $N^2 - M^2$	Number of points gained	1. Compute $N^2 - M^2$ as NXN – MXM 2. Compute $(N + M)$ X $(N – M)$ (Number of multiplication is reduced)

Problem 2

Write a **Problem Analysis Chart (PAC)** to find an area of a circle where area = pi * radius * radius

Problem 2

Data	Processing	Output
radius	area = 3.14 x radius x 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

Celsius = 10 x (depth) + 20

Fahrenheit = 1.8 x (Celsius) + 32

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

Celsius = 10 x (depth) + 20

Fahrenheit = 1.8 x (Celsius) + 32

Data	Processing	Output
depth	celsius = 10 x (depth) + 20 fahrenheit = 1.8 x (celsius) + 32	Display celsius, Display fahrenheit

Problem 4

Given the distance of a trip in miles, miles per gallon by the car that is used in the trip and the current price of one gallon of fuel (gas), write a program to determine the fuel required for the trip and the cost spent on the fuel.

Input	Processing	Output
Distance in miles, miles per gallon, cost per gallon	gas needed = distance / miles per gallon. estimated cost = cost per gallon x gas needed	Display gas 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*

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                    ┌─────────────┐
                    │ Main Module │
                    └─────────────┘
   ┌────────────┐   ┌────────────┐   ┌────────────┐
   │  Module 1  │   │  Module 2  │   │  Module 3  │
   └────────────┘   └────────────┘   └────────────┘
   ┌────────────┐              ┌────────────┐  ┌────────────┐
   │  Module 4  │              │  Module 5  │  │  Module 6  │
   └────────────┘              └────────────┘  └────────────┘
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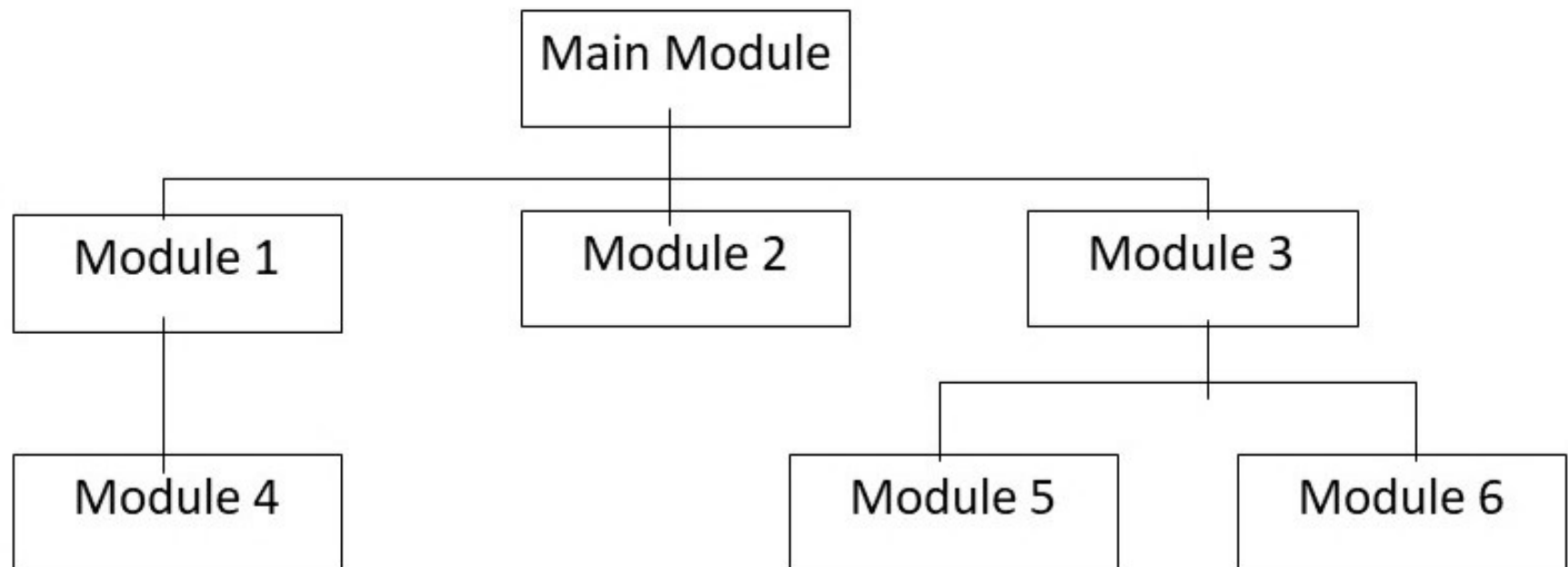
HIPO Chart for Payroll Problem

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                    ┌──────────────┐
                    │   PAYROLL    │
                    │              │
                    └──────┬───────┘
          ┌────────────────┼────────────────┐
┌─────────┴────────┐ ┌─────┴──────────┐ ┌───┴──────────────┐
│      READ        │ │   CALCULATE    │ │     PRINT        │
│                  │ │                │ │                  │
│                  │ │                │ │                  │
└──────────────────┘ └────────────────┘ └──────────────────┘
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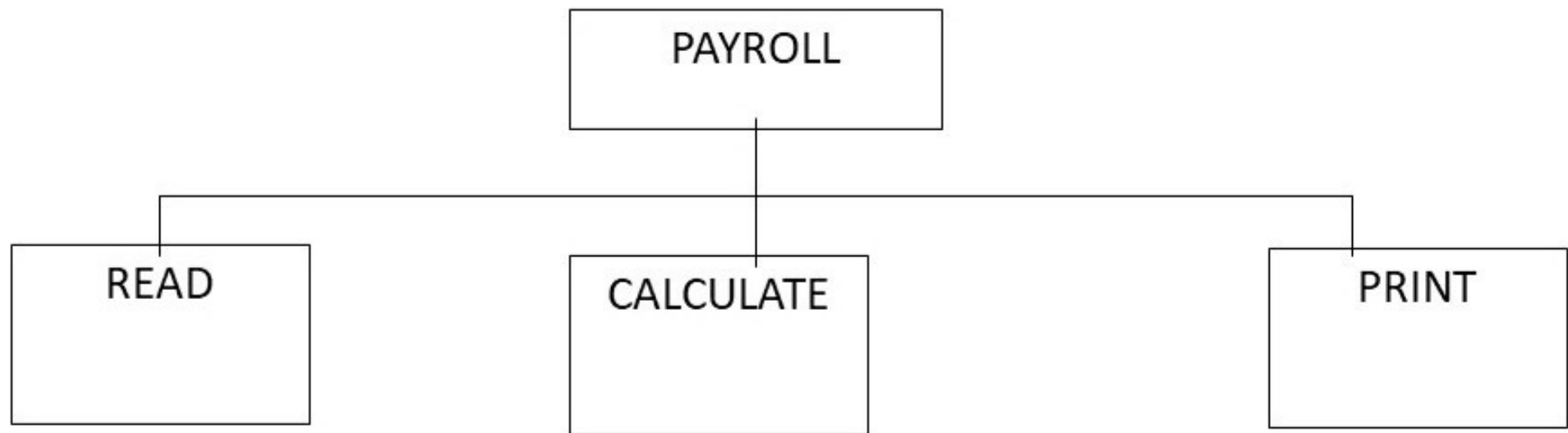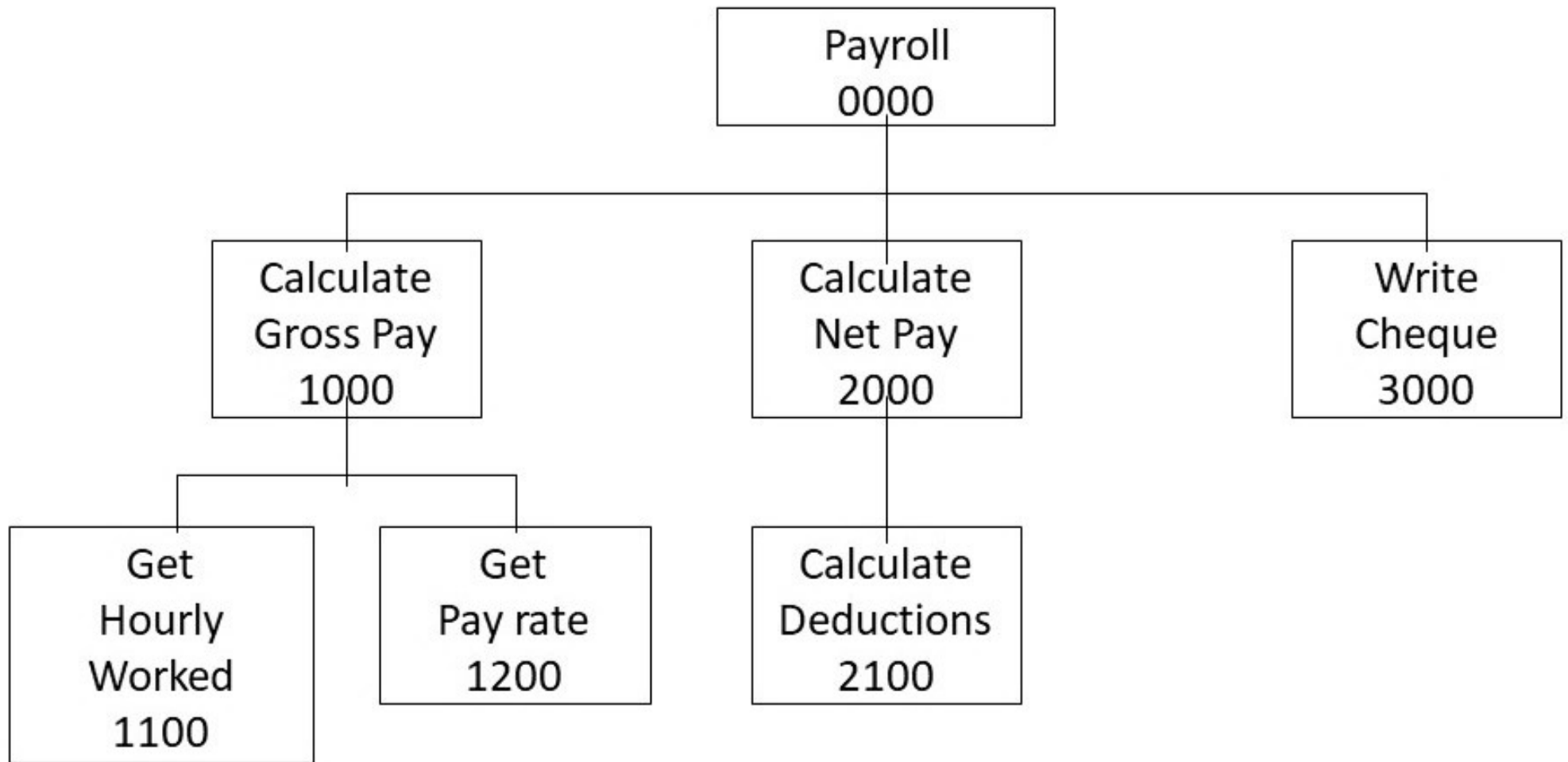
Extended Payroll Problem

- 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

```
                        ┌─────────────┐
                        │  Payroll    │
                        │   0000      │
                        └──────┬──────┘
          ┌────────────────────┼────────────────────┐
┌─────────────────┐   ┌─────────────────┐   ┌─────────────────┐
│   Calculate     │   │   Calculate     │   │    Write        │
│   Gross Pay     │   │   Net Pay       │   │    Cheque       │
│     1000        │   │     2000        │   │     3000        │
└────────┬────────┘   └────────┬────────┘   └─────────────────┘
    ┌────┴────┐                │
┌─────────┐ ┌─────────┐   ┌─────────────────┐
│   Get   │ │   Get   │   │   Calculate     │
│ Hourly  │ │ Pay rate│   │   Deductions    │
│ Worked  │ │  1200   │   │     2100        │
│  1100   │ │         │   │                 │
└─────────┘ └─────────┘   └─────────────────┘
```

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

  Celsius = 10 x (depth) + 20

  Fahrenheit = 1.8 x (Celsius) + 32