CHAPTER 1: INTRODUCTION TO COMPUTERS AND COMPUTER SCIENCE

Computer Definition

The word computer comes from the word “compute”, which means, “to calculate”
A computer is an electronic device capable of executing instructions, developed based on algorithms stored in its memory, to process data fed to it and produce the required results faster than human beings.

The definition from the Merriam-Webster Dictionary :
"one that computes; *specifically* : a programmable electronic device that can store, retrieve, and process data"

Applications of Computers

1. **Computer is used in business organisations for:**
   - Payroll calculations
   - Budgeting
   - Sales analysis
   - Financial forecasting
   - Managing employees database
   - Maintenance of stocks etc.
2. **Banking**
   Today banking is almost totally dependent on computer.
   Banks provide following facilities:
   - Banks provide online accounting facility, which includes current balances, deposits, overdrafts, interest
     charges, shares, and trustee records.
   - ATM machines are making it even easier for customers to deal with banks.
3. **Insurance**
   Insurance companies are keeping all records up-to-date with the help of computers. The insurance companies,
   finance houses and stock broking firms are widely using computers for their concerns.

Insurance companies are maintaining a database of all clients with information showing

- procedure to continue with policies
- starting date of the policies
- next due installment of a policy
- maturity date
- interests due
- survival benefits
- bonus

4. **Education**

   The computer has provided a lot of facilities in the education system.

   - The computer provides a tool in the education system known as CBE (Computer Based Education).
   - CBE involves control, delivery, and evaluation of learning.
   - The computer education is rapidly increasing the graph of number of computer students.

   There are number of methods in which educational institutions can use computer to educate the students.

   - It is used to prepare a database about performance of a student and analysis is carried out on this basis.

5. **Marketing**

   In marketing, uses of computer are following:

   - **Advertising -** With computers, advertising professionals create art and graphics, write and revise copy, and

   print and disseminate ads with the goal of selling more products.

   - **At Home Shopping -** Home shopping has been made possible through use of computerised catalogues that

   provide access to product information and permit direct entry of orders to be filled by the customers.

6. **Health Care**

   Computers have become important part in hospitals, labs, and dispensaries. The computers are being used in

hospitals to keep the record of patients and medicines. It is also used in scanning and diagnosing different
diseases. ECG, EEG, Ultrasounds and CT Scans etc. are also done by computerised machines.

Some major fields of health care in which computers are used are:

- **Diagnostic System -** Computers are used to collect data and identify cause of illness.
- **Lab-diagnostic System -** All tests can be done and reports are prepared by computer.
- **Patient Monitoring System -** These are used to check patient's signs for abnormality such as in Cardiac
Arrest, ECG etc.
- **Pharma Information System -** Computer checks Drug-Labels, Expiry dates, harmful drug's side effects etc.
- **Surgery:** Nowadays, computers are also used in performing surgery

7. **Engineering Design**

Computers are widely used in Engineering purpose.

One of major areas is CAD (Computer aided design).that provides creation and modification of images. Some
fields are:

- **Structural Engineering -** Requires stress and strain analysis for design of Ships, Buildings, Budgets,
Airplanes etc.
- **Industrial Engineering -** Computers deal with design, implementation and improvement of integrated
systems of people, materials and equipments.
- **Architectural Engineering -** Computers help in planning towns, designing buildings, determining a range of
buildings on a site using both 2D and 3D drawings.

8. **Military**

Computers are largely used in defence. modern tanks, missiles, weapons etc. Military also employs computerized control systems. Some military areas where a computer has been used are:

- Missile Control
- Military Communication
- Military Operation and Planning
- Smart Weapons

9. **Communication**

   Communication means to convey a message, an idea, a picture or speech that is received and understood clearly

   and correctly by the person for whom it is meant for. Some main areas in this category are:

   - E-mail
   - Chatting
   - Usenet
   - FTP
   - Telnet
   - Video-conferencing

10. **Government**

    Computers play an important role in government. Some major fields in this category are:

    - Budgets
    - Sales tax department
    - Income tax department
    - Male/Female ratio
    - Computerization of voters lists
    - Computerization of driving licensing system
    - Computerization of PAN card
    - Weather forecasting

COMPUTER SCIENCE

The science that deals with the theory and methods of processing information in digital computers, the design of computer hardware and software, and the applications of computers.

AREAS OF COMPUTER SCIENCE

APPLIED COMPUTER SCIENCE

Applied computer science aims at identifying certain computer science concepts that can be used directly in solving real world problems.

i) Artificial intelligence (AI)

A branch of computer science dealing with the simulation of **intelligent** behavior in computers. The capability of a machine to imitate **intelligent** human behavior.eg Robotics

ii) Computer architecture and engineering

Computer architecture, or digital computer organization, is the conceptual design and fundamental operational structure of a computer system. It focuses largely on the way by which the central processing unit performs internally and accesses addresses in memory. The field often involves disciplines of computer engineering and electrical engineering, selecting and interconnecting hardware components to create computers that meet functional, performance, and cost goals.

ii) Computer graphics and visualization

Computer graphics is the study of digital visual contents, and involves synthesis and manipulation of image data. The study is connected to many other fields in computer science, including computer vision, image processing, and computational geometry, and is heavily applied in the fields of special effects and video games.

iii) Computer security and cryptography

Computer security is a branch of computer technology, whose objective includes protection of information from unauthorized access, disruption, or modification while maintaining the accessibility and usability of the system for its intended users. Cryptography is the practice and study of hiding (encryption) and therefore deciphering (decryption) information. Modern cryptography is largely related to computer science, for many encryption and decryption algorithms are based on their computational complexity.

iv) Computational science

Computational science (or scientific computing) is the field of study concerned with constructing mathematical models and quantitative analysis techniques and using computers to analyze and solve scientific problems. In practical use, it is typically the application of computer simulation and other forms of computation to problems in various scientific disciplines.

v) Computer networks

This branch of computer science aims to manage networks between computers worldwide.

vi) Databases

A database is intended to organize, store, and retrieve large amounts of data easily. Digital databases are managed using database management systems to store, create, maintain, and search data, through database models and query languages.

vii) Human-computer interaction

Research that develops theories, principles, and guidelines for user interface designers, so they can create satisfactory user experiences with desktop, laptop, and mobile devices.

Theoretical computer science

Theoretical Computer Science is mathematical and abstract in spirit, but it derives its motivation from practical and everyday computation. Its aim is to understand the nature of **computation** and, as a consequence of this understanding, provide more efficient methodologies.

i) Theory of computation

According to Peter Denning, the fundamental question underlying computer science is, "What can be (efficiently) automated?"[12] Theory of computation is focused on answering fundamental questions about what can be computed and what amount of resources are required to perform those computations. In an effort to answer the first question, computability theory examines which computational problems are solvable on various theoretical models of computation. The second question is addressed by computational complexity theory, which studies the time and space costs associated with different approaches to solving a multitude of computational problems.

ii) Information and coding theory

Information theory is related to the quantification of information. Coding theory is the study of the properties of codes (systems for converting information from one form to another) and their fitness for a specific application. Codes are used for data compression, cryptography, error detection and correction, and more recently also for network coding. Codes are studied for the purpose of designing efficient and reliable data transmission methods.

iii) Algorithms and data structures

Algorithms and data structure is the study of commonly used computational methods and their computational efficiency.eg algorithm analysis.

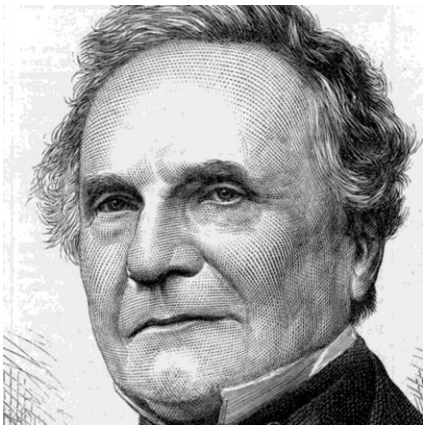
iv) Programming language theory

Programming language theory is a branch of computer science that deals with the design, implementation, analysis, characterization, and classification of programming languages and their individual features. It falls within the discipline of computer science, both depending on and affecting mathematics, software engineering, and linguistics.

EMERGENCE OF COMPUTER SCIENCE

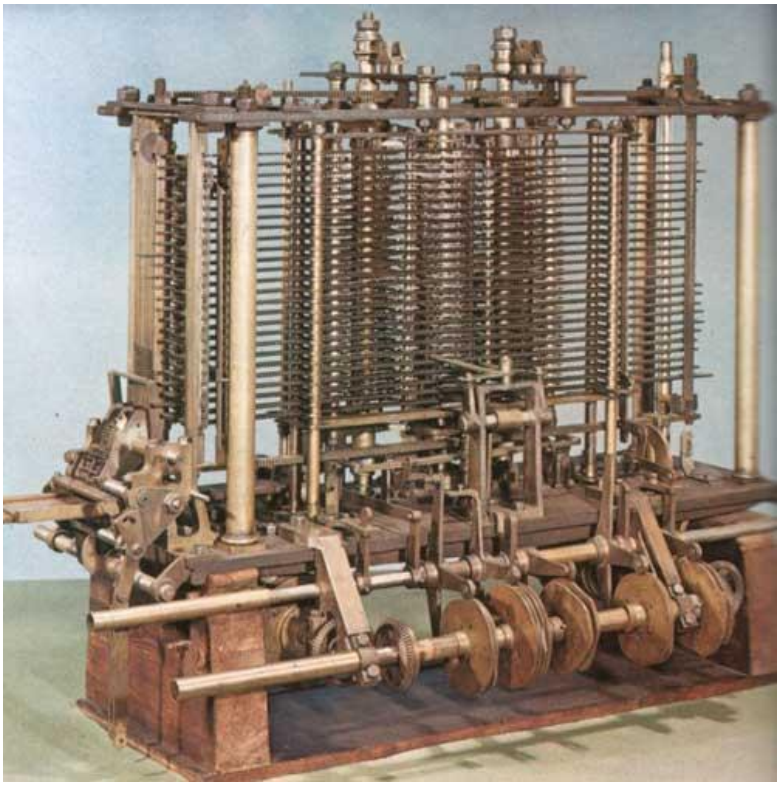
Charles Babbage

Babbage designed a calculator to compute numbers up to 8 decimal points long. Continuing with the success of this idea, Babbage worked to develop a machine that could compute numbers with



up to 20 decimal places. By the 1830s, Babbage had devised a plan to develop a machine that could use punched cards to perform arithmetical operations. The machine would store numbers in memory units, and there would be a form of sequential control. This means that one operation would be carried out before another in such a way that the machine would produce an answer and not fail. This machine was to be known as the “Analytical Engine”, which was the first true representation of what is the modern computer.

Image of Babbage's analytical engine



Ada Lovelace

Ada Lovelace (Augusta Ada Byron) is credited as the pioneer of computer programming and is regarded as a mathematical genius.

Lovelace began working with Charles Babbage as an assistant while Babbage was working on his "Analytical Engine", the first mechanical computer. During her work with Babbage, Ada Lovelace became the designer of the first computer algorithm. Moreover, Lovelace's work with Babbage resulted in her prediction of future computers to not only perform mathematical calculations, but also manipulate symbols, mathematical or not.

Von Neumann and the von Neumann architecture

The von Neumann architecture, which is also known as the von Neumann model and Princeton architecture, is a computer architecture based on that described in 1945 by the mathematician John von Neumann. This describes a design architecture for an electronic digital computer with parts consisting of a processing unit containing an arithmetic logic unit and processor registers; a control unit containing an instruction register and program counter; a memory to store both data and instructions; external mass storage; and input and output mechanisms.

COMPUTER SCIENCE AND SOLVING COMPUTATIONAL PROBLEMS

Regardless of the area of study, computer science is all about solving problems with computers. The problems that we want to solve can come from any real-world problem or perhaps even from the abstract world. We need to have a standard systematic approach to solving problems.

Problem Solving is the sequential process of analyzing information related to a given situation and generating appropriate response options.

There are 6 steps that you should follow in order to solve a problem:

1. Understand the Problem
2. Formulate a Model
3. Develop an Algorithm
4. Write the Program
5. Test the Program
6. Evaluate the Solution

Problem Example: Calculate the average grade for all students in a class.

1. Understand the Problem:

First step to solving any problem is to make sure that you understand the problem that you are trying to solve. You need to know:

- What input data/information is available?
- What does it represent?
- What format is it in?
- Is anything missing?
- Do I have everything that I need?
- What output information am I trying to produce?
- What do I want the result to look like … text, a picture, a graph?
- What am i going to have to compute?

STEP 2: Formulate a Model:

Many problems break down into smaller problems that require some kind of simple mathematical computations in order to process the data. In our example, we are going to compute the average of the incoming grades. So, we need to know the model (or formula) for computing the average of a bunch of numbers. If there is no such "formula", we need to develop one. Often, however, the problem breaks down into simple computations that we well understand.

STEP 3: Develop an Algorithm:

To develop an algorithm, we need to represent the instructions in some way that is understandable to a person who is trying to figure out the steps involved. Two commonly used representations for an algorithm is by using

(1) Pseudo code, or

(2) Flow charts.

Consider the following example) of solving the problem of a broken lamp.

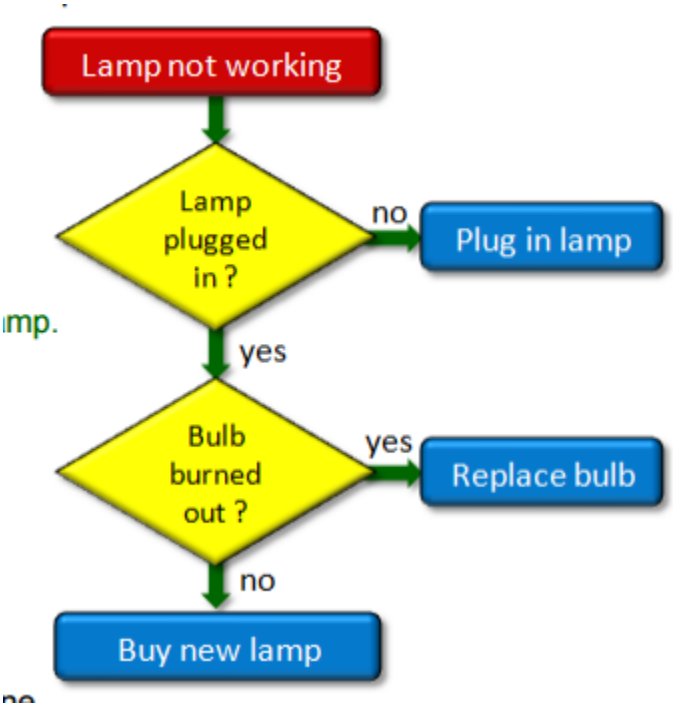
Pseudo Code

1. IF lamp works, go to step 7.
2. Check if lamp is plugged in.
3. IF not plugged in, plug in lamp.
4. Check if bulb is burnt out.
5. IF blub is burnt, replace bulb.
6. IF lamp doesn't work buy new lan
7. Quit ... problem is solved.

Notice that:

pseudocode is a simple and concise sequence of English-like instructions to solve a problem.

Flow chart representation of the above problem



STEP 4: Write the Program:

Involves transforming the algorithm from step 3 into a set of instructions that can be understood by the computer. Writing a program is often called "writing code" or "implementing an algorithm". So the code (or source code) is actually the program itself.

STEP 5: Test the Program:

Once you have a program written that compiles, you need to make sure that it solves the problem that it was intended to solve and that the solutions are correct.

STEP 6: Evaluate the Solution:

Once your program produces a result that seems correct, you need to re-consider the original problem and make sure that the answer is formatted into a proper solution to the problem.