INFORMATION AND COMMUNICATION TECHNOLOGY

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1. Basics of Computers and Information Technology

Artificial Intelligence (AI) and Machine Learning (ML) Basics: Core Concepts and Applications

- **C-DAC (Centre for Development of Advanced Computing)**
  - Established in 1987 with the primary objective to build Supercomputers, addressing technology denial by countries like the USA.
  - Pioneered Indian Language Computing Solutions through its GIST (Graphics and Intelligence based Script Technology) group.
- **Turing Machine**
  - A theoretical computing machine, conceptualized by Alan Turing.
  - Serves as an ideal model for mathematical computation and forms the basis of computability theory.

- **Turing Test / Imitation Game**
  - Originally known as the 'Imitation Game', proposed by Alan Turing.
  - A test of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human.
  - A foundational concept in Artificial Intelligence for evaluating machine intelligence.

Computer Hardware: Components (CPU, Memory, Input/Output Devices, Storage)

- **PARAM 8000** was India's first supercomputer (1991).
- **PARAM** series are examples of **Supercomputers**.
- **Param-Ishan** is a **Supercomputer**.
- India's first computer was installed at the **Indian Statistical Institute, Calcutta** (HEC-2M, 1956).
- **Charles Babbage** is known as the "Father of the Computer".
- The **first electronic digital computer (ENIAC)** was developed in **1946**.
- **UNIVAC (Universal Automatic Computer)** was the first general-purpose electronic digital computer designed for commercial use.
- **General-purpose computers** exist in a wide range of sizes and power.
- **Hybrid computers** combine features of both analog and digital computers.
- **Silicon Valley, USA**, is famous for **electronics** (semiconductor industry).
- **MOEMS** stands for **Micro-Opto-Electro-Mechanical-Systems**.
- **LED** stands for **Light Emitting Diode**.
- **Liquid crystals** are most importantly applied in **digital displays (LCDs)**.
- A **modem** is a device that connects a computer to a phone line (or other network) for data transmission.
- **Magnetic Resonance Imaging (MRI)** generates thin section images of human body parts.
- **QWERTY** keyboard layout: letters start with Q, W, E, R, T.
- **Dvorak** keyboard layout: ergonomic, places common keys (e.g., vowels on left, common consonants on right) for ease of typing.
- **Dextr** keyboard layout: keys in alphabetical order.
- **KALQ** keyboard layout: optimized for thumb typing.
- A **badge reader** is a device designed to read information encoded into small plastic cards.
- **OMR (Optical Mark Recognition)** is an optical input device that interprets pencil/pen marks on paper.

Computer Networks: Types (LAN, WAN, MAN), Network Topologies, Internet Fundamentals (WWW, Email, Protocols)

- **Information Technology (IT)**

  Defined as Computers + Connectivity.

- **NASSCOM**

  National Association of Software and Service Companies.

- **Computer Network Types**
  - **LAN (Local Area Network)**

    Covers a small geographical area (e.g., home, office). High data transfer rates.
  - **MAN (Metropolitan Area Network)**

    Spans a city or large campus. Connects multiple LANs.
  - **WAN (Wide Area Network)**

    Covers a large geographical area (e.g., countries, continents). Connects multiple LANs/MANs; the Internet is the largest WAN.
- **Network Topologies**

  (Physical or logical arrangement of network devices)
  - **Bus**

    All devices share a single communication line (backbone). Simple but single point of failure.
  - **Star**

    All devices connect to a central hub/switch. Easy management; central device failure affects all.

- **Ring**

  Devices connect in a circular fashion; data flows in one direction. Break in ring disrupts entire network.

- **Mesh**

  Every device is connected to every other device. High fault tolerance and redundancy, but complex and costly.

- **Tree**

  A hierarchy of star networks. Scalable.

- **Internet Fundamentals**
  - **WWW (World Wide Web)**

    A global system of interconnected hypertext documents accessed via the Internet.

    - **Favicon**

      A small icon associated with a particular website.

    - **Downloading**

      Transferring a file from a server to a client computer.

  - **Email (Electronic Mail)**

    Method of exchanging digital messages.

    - **Protocols**

      SMTP (Simple Mail Transfer Protocol) for sending; POP3 (Post Office Protocol version 3) and IMAP (Internet Message Access Protocol) for receiving.

  - **Key Internet Protocols**

    - **TCP/IP (Transmission Control Protocol/Internet Protocol)**

      Fundamental suite for Internet communication.

    - **HTTP (Hypertext Transfer Protocol)**

      Basis for data communication on the WWW.

    - **HTTPS (HTTP Secure)**

      Encrypted version of HTTP using SSL/TLS.

    - **FTP (File Transfer Protocol)**

      For transferring files between computers. Originally designed by Abhay Bhushan.

    - **DNS (Domain Name System)**

      Translates human-readable domain names (e.g., google.com) into numerical IP addresses.

      - **Reverse Lookup**

        Maps an IP address back to its corresponding domain name using PTR (Pointer) records.

    - **DHCP (Dynamic Host Configuration Protocol)**

      Assigns IP addresses and other network configuration parameters to devices. Supports zero-conf and plug-and-play.

    - **Gnutella**

      A peer-to-peer (P2P) network protocol primarily used for file sharing.

Computer Software: Types (System, Application), Programming Languages (Basic Concepts)

- Computer Software: Set of instructions, data, or programs used to operate computers and execute specific tasks.
- Software is broadly categorized into System Software and Application Software.
- System Software: Manages and controls computer hardware and software resources; e.g., Operating Systems (Windows, Linux), Device Drivers.
- Application Software: Designed to perform specific tasks for the end-user; e.g., Word Processors, Spreadsheet programs.
- MS Excel: A prominent example of application software, known as a spreadsheet program within the Microsoft Office suite.
- Programming Languages: Formal languages consisting of a set of instructions used to create computer programs.

- LOGO: A programming language devised by D.G. Bobrow, W. Feurzeig, Seymour Papert, and C. Solomon.
- Multimedia: Can contain various data types including graphics, animation, video, music, and voice, processed by specific application software.
- File Formats: `.MP3` is an audio file format; `.MP4`, `.MOV`, `.AVI` are common video file formats.
- Bangalore: Widely recognized as the "Software Capital of India".
- India's IT Industry: Characterized by strong software development and exports, but a comparatively weaker hardware manufacturing base.

Cybersecurity Basics: Common Threats (Malware, Phishing), Basic Protective Measures (Antivirus, Firewall)

- **Cybersecurity:** Protection of internet-connected systems (hardware, software, data) from cyber threats.
- **Common Threats:**
  - **Malware (Malicious Software):** Programs designed to gain unauthorized access, disrupt operations, or cause damage to computer systems.
    - **Virus:** Attaches to legitimate programs; self-replicates; requires user interaction (e.g., opening infected file) to spread.
    - **Worm:** Self-replicating; standalone malware; spreads autonomously across networks without user interaction.
    - **Trojan Horse:** Disguises as legitimate software; performs malicious actions (e.g., creating backdoors) once executed; does not self-replicate.
    - **Ransomware:** Encrypts user data and demands a ransom payment (often cryptocurrency) for its decryption key.
    - **Spyware:** Secretly monitors and collects information about a user's activities (e.g., browsing history, keystrokes).
    - **Adware:** Displays unwanted or intrusive advertisements, often bundled with free software.
    - **Rootkit:** A set of software tools designed to hide its presence and allow continued privileged access to a computer system.
  - **Phishing:** Fraudulent attempt to obtain sensitive information (e.g., usernames, passwords, credit card details) by disguising as a trustworthy entity in electronic communication.
    - **Spear Phishing:** Highly targeted phishing attack against specific individuals or organizations.
    - **Whaling:** Phishing attack specifically aimed at high-profile targets like senior executives.
    - **Smishing:** Phishing conducted via SMS (text messages).
    - **Vishing:** Phishing conducted via voice calls.
    - **Pharming:** Redirects users to fake websites, even if the correct URL is typed, by corrupting DNS records or host files.
- **Basic Protective Measures:**
  - **Antivirus Software:** Detects, prevents, and removes malicious software (viruses, worms, Trojans, ransomware, etc.) from a computer system by scanning files, emails, and web activity.
  - **Firewall:** A network security system that monitors and controls incoming and outgoing network traffic based on predetermined security rules; acts as a barrier between a trusted internal network and untrusted external networks (e.g., the internet).

Data Representation and Units of Measurement (Bits, Bytes, KiloBytes, etc.)

- **Fundamental Units**
  - **Bit (Binary Digit)**

    Smallest unit of data, representing a 0 or 1.

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- **Nibble**

  Group of 4 bits.

- **Byte**

  Group of 8 bits. It is the smallest addressable unit of memory.

- **Data Storage Hierarchy (Binary Prefixes, Base 2)**
  - 1 Kilobyte (KB) = 1024 Bytes = 2^{10} Bytes.
  - 1 Megabyte (MB) = 1024 KB = 2^{20} Bytes.
  - 1 Gigabyte (GB) = 1024 MB = 2^{30} Bytes.
  - 1 Terabyte (TB) = 1024 GB = 2^{40} Bytes.
  - 1 Petabyte (PB) = 1024 TB = 2^{50} Bytes.
  - 1 Exabyte (EB) = 1024 PB = 2^{60} Bytes.
  - 1 Zettabyte (ZB) = 1024 EB = 2^{70} Bytes.
  - 1 Yottabyte (YB) = 1024 ZB = 2^{80} Bytes.

- **Number Systems & Conversions**
  - **Binary System**

    Base-2, uses digits 0 and 1. Requires more places to represent a number than decimal due to its smaller base.

  - **Decimal System**

    Base-10.

  - **Hexadecimal System**

    Base-16, uses digits 0-9 and letters A-F.

  - **Binary Conversions**
    - $(111)_2 = 7_{10}$.
    - $(12)_{10} = 1100_2$.
    - $(53)_{10}$ requires 6 bits for representation (e.g., 110101_2).
    - $(187)_{10} = 10111011_2$ (in 8-bit binary).
    - $(010111100)_2 = 274_8$ (grouping 3 bits: 010 | 111 | 100).

  - **Hexadecimal to Decimal**

    $(4A9.2)_{16} = 1193.125_{10}$ $(4*16^2 + 10*16^1 + 9*16^0 + 2*16^{-1})$.

- **Data Representation in Computers**
  - Computers internally represent data using the

    Binary system.

  - BCD (Binary Coded Decimal) Each decimal digit is represented by its 4-bit binary equivalent.
    - Example: 87.34_{10} = 1000 0111 . 0011 0100 (BCD).

  - **Signed-Magnitude Representation**

    The Most Significant Bit (MSB) is reserved for the sign bit (0 for positive, 1 for negative).

  - **Two's Complement**

    Used for representing signed numbers and performing arithmetic operations.
    - Binary subtraction of $(100)_2$ - $(011)_2 = (001)_2$.
    - Binary addition of -8 and -2 in two's complement (e.g., 5-bit representation): -8 = 11000, -2 = 11110, result -10 = 10110.

- **Character Encoding Standards**
  - **ASCII**
    - Full Form:

      American Standard Code for Information Interchange.

    - **Originally a 7-bit code, representing 128 characters.**
    - **Contains 94 standard printing characters.**

  - Unicode A universal character encoding standard.
    - **UTF (Unicode Transformation Format)**

      Stands for Unicode Transformation Format.

    - Unicode encoding schemes (like UTF-16) often represent a character as a group of 16 bits.