Lesson 13: New Trends and Future Directions of ICT

1. "The Thinking Machine" - AI

Intelligent and Emotional Computing

- The concept of machines that can think and perceive emotions.

Artificial Intelligence (AI)

- **Definition:** The simulation of human intelligence processes by machines.
- **Strong AI (AGI):** An AI system that can think and have a mind, capable of working in multiple fields. (Theoretical).
- **Weak AI (Narrow AI):** An AI system that only pretends to think, excelling in a single, narrow task. *Ex: IBM Deep Blue (Chess)*.

Key AI Techniques

- **Search Techniques:** Finding a goal state in a state space.
- **Expert Systems:** Rule-based (If-Then) systems that store knowledge to advise humans.
- **NLP:** Algorithms to recognize/understand human languages.
- **Machine Learning:** Techniques to learn hidden patterns from data.
- **Neural Networks:** A key ML technique based on artificial neurons.
- **Genetic Algorithms:** Optimization based on evolution.
- **Fuzzy Logic:** Control systems based on "fuzzy" linguistic statements (e.g., 'hot') instead of binary true/false.

Coexistence

- **Man-Machine:** Humans and intelligent machines working together.
- **Machine-to-Machine:** Intelligent machines communicating and acting without human intervention.

2. "The Autonomous Agent" - Agent Technology

Software Agents

- **Definition:** Software that acts on behalf of a user/program, working autonomously and continuously.
- **Characteristics:** Autonomous, Proactive, Reactive, Cooperative, Able to learn, Social ability.

Multi-Agent Systems (MAS)

- **Definition:** A system of multiple interacting agents solving a complex problem.
- **Characteristics:** Agents are autonomous, have a **local view** (only know their part), and are **decentralized**.
- **Common Architecture:**
  - **Interface Agent:** Connects user to the system.
  - **Broker Agent:** Filters information.
  - **Information Agents:** Gather data from sources.

Applications of Agent Systems

- Virtual assistants (Siri, Cortana), e-commerce search, online booking systems.

3. "Future Computing" - Beyond von Neumann

Beyond von-Neumann Computer

- **Reason:** Traditional architecture is reaching physical limits (e.g., heat), as described by Moore's Law.

Nature-Inspired Computing

- Algorithms modeled on natural phenomena.
- **Examples:** Genetic Algorithms, Neural Networks, **Swarm Intelligence** (ant colonies), **Membrane Computing** (living cells).

Bio-Inspired Computing

- Computing models based on biological systems (e.g., DNA, the brain). Closely related to Nature-Inspired Computing.

Quantum Computing

- **Fundamentals:** Based on quantum mechanics, using Qubits which can be in a state of **Superposition**.
- **Applications:** Solving complex problems, drug discovery, materials science.