INTRODUCTION TO AI AND APPLICATIONS

BETC105/205

Module 4

BOS (CS/IS)
VTU Belagavi

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Visvesvaraya Technological University, Belagavi (State Technological University, Govt. of Karnataka)

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2. How Does AI Work?
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7. Introduction to Machine Learning and Deep Learning

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- I roduction to Writing with Prompts
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Module 3: Machine Learning

Reema Thareja, Artificial Intelligence: Beyond Classical AI,Pearson Education, 2023.

1. Machine Learning in AI

- Overview of Machine Learning Techniques
- Introduction to Machine Learning Models

2. Regression Analysis in Machine Learning

- Basics of Regression
- Linear and Non-Linear Regression Techniques

3. Classification Techniques

- Overview of Classification Algorithms
- Naïve Bayes Classification
- Support Vector Machine (SVM)

4. Clustering Techniques

- Introduction to Clustering
- Types of Clustering Algorithm

5. Neural Networks

- Basics of Neural Networks
- Types and Applications of Neural Networks

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Module 4: Machine Learning

Reema Thareja, Artificial Intelligence: Beyond Classical AI,Pearson Education, 2023.

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- Introduction to AI Ethics
- Ethical Implications in AI Development
- Addressing Bias and Fairness in AI

2. AI as a Service (AIaaS)
- Overview of AI as a Service
- Benefits and Challenges of AIaaS
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- IoT Applications in Various Industries

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- Applications of AIoT in Smart Cities, Healthcare, and Industry 4.0

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Module 4: Current Trends in Artificial Intelligence

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8.1.2 Is AI Dangerous? Will Robots Take Over the World?
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Chapter 9 Where AI Is Heading Today?

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8.1 AI and Ethical Concerns

Understanding AI Ethics and Its Importance

AI ethics addresses the moral obligations and responsibilities of AI systems, their creators, and their users. It involves ensuring that AI technologies align with human values and societal norms.

1. Roboethics:
2. Machine Ethics:

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8.1 AI and Ethical Concerns

1. Roboethics:

- Roboethics focuses on **human responsibility when it comes to designing, building, using, and interacting with artificial beings (like robots).**
- It covers a wide range of ethical questions regarding how humans should treat AI entities.
- Some of the critical areas include:
  - **Designing ethical robots:** Ensuring that robots are built with features that align with human morals, including their capabilities and limitations.
  - **Treatment of robots:** Addressing how humans should interact with AI entities, especially those designed to resemble humans.

8.1 AI and Ethical Concerns

2. Machine Ethics:

- Machine ethics, on the other hand, **concerns the moral behavior of AI systems or Artificial Moral Agents (AMAs)**, especially those designed to interact with humans or make important decisions.
- These systems need to make moral decisions independently, without direct human intervention. Examples of AMAs include self-driving cars or AI systems used in healthcare.
- This includes:
  - **Decision-making systems:** AI algorithms that affect people's lives directly, like automated loan approvals, criminal sentencing, or hiring decisions.
  - **Moral programming:** Developing frameworks that allow AI systems to make ethical decisions based on societal norms, laws, and ethics.

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8.1 AI and Ethical Concerns

Key Ethical Concerns in AI

1. **Can AI Make Human-like Decisions?**
   - AI generates human-like outputs (e.g., loan approvals, healthcare decisions).
   - Do AI systems understand the consequences of their actions like humans do?
2. **Are AI Decisions Truly Human-like?**
   - AI decisions are based on data and probabilities.
   - But do they fully comprehend human context behind those decisions?
3. **Justification of AI's Decisions**
   - Is the reasoning behind AI decisions justifiable?
   - Transparency is crucial for aligning AI decisions with ethical and legal frameworks.
4. **Fairness in AI Decisions**
   - Are AI decisions fair and free from bias?
   - AI systems should respect individual rights and avoid discrimination.
5. **Trustworthiness of AI**
   - Can we trust AI systems (e.g., self-driving cars) to make safe decisions?
   - AI must be reliable, transparent, and accountable to earn trust.

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8.1.1 Ethical Use of Artificial Intelligence

- **Bias-Free AI**
  - AI systems should be free from bias, especially with complex algorithms like deep learning and GAN.
- **Explainability**
  - AI decisions, especially in regulated industries, must be explainable (e.g., credit decisions in finance).
  - "Black box" AI systems that can't explain decisions are problematic.
- **Key Features of Responsible AI**
  a. **Explainable:** AI decisions should be understandable.
  b. **Monitorable:** AI should be trackable and auditable.
  c. **Reproducible:** AI systems must yield consistent results.
  d. **Secure:** AI systems must be safe from attacks.
  e. **Human-Centered:** AI should prioritize human well-being.
  f. **Unbiased:** AI must avoid discrimination.
  g. **Justifiable:** Decisions should be defendable and ethical.
- **Challenges in Regulation**
  - Formulating laws for AI is difficult due to rapid advancements in technology.
  - Existing laws (e.g., privacy) may not cover new AI technologies like voice assistants (e.g., Alexa, Siri), which can be exploited by malicious actors.

8.1.2 Is AI Dangerous? Will Robots Take Over the World?

- **AI's Potential for Harm**
  - AI could be risky if specifically programmed for harm (e.g., autonomous weapons).
  - Autonomous drones and self-driving cars can become dangerous if misused or hacked.

- **Lack of Clear Accountability**
  - Current laws don't cover AI's role in society, especially in terms of liability.
  - **Questions arise like:** Who is responsible for AI's actions? Can AI systems be held accountable?

- **Job Automation Risk**
  - AI might replace many jobs, especially low-skilled, repetitive tasks.
  - This could lead to unemployment for millions, particularly in industries like retail, hospitality, and warehouse work.

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8.1.2 Is AI Dangerous? Will Robots Take Over the World?

- **Biased Algorithms**
  - AI systems are vulnerable to bias if trained with biased data.
  - Biased AI can produce unfair results, impacting crucial decisions like hiring or loan approvals.

- **Privacy Concerns**
  - AI systems collect large amounts of personal data, leading to privacy invasion.
  - Facial recognition technology can track individuals without consent, creating privacy risks.

- **Unreliable Information**
  - AI can be used to create fake content (e.g., deepfakes, fake news).
  - Manipulated videos or images can spread misinformation or be used maliciously

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8.1.3 Ethics in AI

- **Ethical AI Definition**
  - Ethical AI refers to AI systems designed to be **fair, just, and unbiased.**
  - It focuses on ensuring AI's actions align with moral principles.
- **Importance of Ethical AI**
  - Ethical AI ensures the **technology benefits society while avoiding harm or unfair treatment.**
  - It guarantees AI decisions are transparent and responsible.
- **Bias in AI**
  - AI systems can produce **biased results if trained on biased data.**
  - Unchecked bias in AI can lead to unethical decisions, such as unfair hiring or loan approval.
- **Example of Unethical AI**
  - Tay Chatbot: Microsoft's Tay learned negative and harmful behaviors after interacting with trolls on Twitter.
  - The bot started spreading hate and offensive messages, forcing Microsoft to shut it down within 24 hours.
- **Features of Ethical AI**
  a. Uses unbiased data for training.
  b. Follows the right learning model for the problem at hand.
  c. Continuously monitored to ensure its outputs are right and fair.

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8.1.4 AI and Bias

- **What is AI Bias?**
  - AI bias occurs when an algorithm produces results that are **unfair** or prejudiced towards a particular group.
  - Example: If AI frequently misidentifies people of color in computer vision systems, it's biased.

- **Examples of AI Bias**
  - Doctors in Images: Search results for "doctor" mostly show white men.
  - Gender Bias in Professions: "Doctor" is often male, while "nurse" is female in many images and videos.
  - Voice Assistants: Virtual assistants like Siri and Alexa use female voices, reinforcing gender bias.
  - Recognition Failures: Computer vision struggles with recognizing people of different skin colors accurately.

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8.1.5 Towards Ethical and Trustworthy AI

- **Challenges with AI in Recruitment:**
  - **Issue:** Some AI hiring platforms show biased results, like women being disproportionately rejected based on years of biased data in male-dominated sectors.
  - **Solution:** Addressing these biases by regulating AI practices and continuously monitoring recruitment algorithms.

- **Regulating Ethical AI:**
  - **European Commission (April 2021):**
    - Launched a legal framework to ensure AI safety, protecting fundamental rights.
    - Introduced a risk-based approach to set requirements and ban AI systems that could harm people's rights, such as systems that manipulate human behavior.
  - **Australia (June 2021):**
    - Launched a similar AI ethics framework to guide businesses and governments on ethical AI usage.

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8.1.5 Towards Ethical and Trustworthy AI

- **Company and Organizational Engagement:**
  - **Building Trust:** Organizations are implementing:
    - Cultural programs to raise awareness.
    - Risk assessments to identify potential AI issues.
    - Third-party audits to ensure compliance with ethical standards.
  - **Framework:** AI systems should be monitored using a prevention, detection, and response framework (like anti-corruption measures).

- **Role of Rights and Activist Groups:**
  - **Human-Centric AI:** AI systems must **prioritize human rights and be developed with social responsibility.**
  - **Challenge:** Civil rights groups should challenge AI practices and amplify the voices of those most affected by technology.
  - **Questions to Ask:**
    - **Is the technology necessary?**
    - **Is there an alternative?**
    - **Does the benefit outweigh the harm?**

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8.1.5 Towards Ethical and Trustworthy AI

- **Ensuring Data Privacy:**
  - **Data Protection:** Essential for ethical AI.
  - **Encryption:** Ensures data is secure.
  - **Secure Computation:** Prevents AI developers from accessing private data.
  - **Dataset Boundaries:** AI should not learn beyond its provided dataset.
  - **Prevent Reverse Engineering:** Ensures data used in AI models is inaccessible to users.

- **Diversify Your Team to Prevent Bias:**
  - **Diverse Teams:** Forming teams with varied backgrounds (e.g., data scientists, business leaders, lawyers, sociologists, and ethicists) can help in identifying and preventing bias in AI systems.
  - **Fairness Checks:** Regular analysis of data and algorithms ensures that biases are spotted early.
  - **Bias Mitigation Tools:** Tools like Bias Analyzer help automate the detection of bias and analyze the effectiveness of mitigation actions.
-

8.1.6 Why is Ethical AI Important?

- **Critical Areas of Application:**
  - AI is used in medicine, law enforcement, recruitment, data privacy, military defense, and self-driving vehicles.
  - These systems must produce accurate, transparent, and understandable results, aligned with societal ethical standards.

- **Risks of Unethical AI:**
  - Biased or incorrect outputs can:
    - Erode privacy (e.g., misusing personal data).
    - Lead to decisions that are impossible to understand.
    - Cause harm without clear accountability for damages.

8.1.6 Why is Ethical AI Important?

- **Importance of Fairness & Accuracy:**
  - AI must be unbiased and accurate
  - Without ethical design, AI systems can be misused, leading to disastrous consequences for humanity.

- **Examples of Unethical AI Outputs:**
  - **Medical Bias:** An algorithm used in US hospitals to predict patients needing extra care favored white patients over black patients due to biased data regarding medical billing and facilities.
  - **Hiring Bias:** Amazon's AI hiring algorithm discriminated against women due to a data bias from previous male-dominated applications.

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8.1.6 Why is Ethical AI Important?

- **Efforts to Ensure Ethical AI:**
  - IEEE Global Initiative and other committees focus on making AI systems more ethical.
  - **Ethically Aligned Design (2016):** A publication providing guidelines for ethical AI solutions.

- **Guiding Principles for Trustworthy AI (European Commission High-Level Expert Group):**
  - **Support Human Autonomy:** AI should enhance human decision-making.
  - **Robust & Safe:** AI must be technically sound with a fallback plan for failure.
  - **Data Privacy:** Protect user data and maintain data quality.
  - **Transparency:** AI should avoid biased data and be transparent about its models.
  - **Fairness:** Train AI systems with non-discriminatory, diverse data to avoid bias.
  - **Benefiting Everyone:** AI should promote societal and environmental wellbeing.
  - **Accountability:** AI must be responsible for accurate, unbiased outcomes.
  - **Data Security:** Ensure confidentiality, transparency, and safety in data management.
  - **Accountability for Decisions:** Ensure organizational responsibility for AI decisions.

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8.1.7 Impact of AI on Jobs

- AI and Job Creation:
  - AI can displace 75 million jobs, but will create 133 million new ones in the coming years.
  - AI brings a paradigm shift in industries, similar to the Industrial Revolution.
- Predicted Job Losses by 2030:
  - 30% of jobs could be replaced by AI and automation, impacting 400-800 million jobs globally.
  - 375 million people might need to switch to new job categories.
- AI's Role in Job Automation:
  - Jobs that involve predictable, repetitive tasks are most likely to be automated, such as waiters in restaurants (e.g., robot waiters).
  - AI will not make all human workers obsolete, especially for tasks requiring emotion, ethics, and complex decision-making.

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8.1.7 Impact of AI on Jobs

- Jobs That Will Grow with AI:
  - **Creative Jobs:** AI will enhance professions like artists, doctors, and scientists, making their work more efficient.
  - **Management Jobs:** AI cannot replace human managers as managing people involves understanding emotions, communication, and ethics.
  - **Tech Jobs:** Roles like programmers, data scientists, and big data engineers will be in high demand as they work on creating and maintaining AI systems.

- **AI's Dual Impact on Jobs:**
  - AI will create new opportunities by removing routine, low-value jobs, replacing them with jobs that require higher skills (programming, robotics, engineering).
  - Flexible and premium jobs will emerge, moving away from traditional blue-collar and white-collar work.

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8.1.7 Impact of AI on Jobs

- **Emerging Job Titles by 2030:**
  - New roles like Chief Bias Officer, Data Detective, AI Tutor, AI Business Development Manager will emerge.

- **AI's Impact on Sectors:**
  - Medical: AI will help in predictive healthcare models, diagnosis, and reducing disease.
  - Automotive: Autonomous vehicles and manufacturing automation are powered by AI.
  - Cybersecurity: AI helps identify and predict cyber threats and fraud.
  - E-commerce: AI powers recommendation systems, chatbots, and inventory management.
  - HR: AI tools can filter resumes, saving time for HR professionals.
  - Legal: AI aids in document handling, classification, and knowledge extraction.

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8.2 AI as a Service (AIaaS)

8.2.1 Factors Triggering Growth of AIaaS

- **Cloud Platforms:** Availability of affordable cloud platforms for enterprise data management.
- **Improved Data Storage:** Cost-effective and reliable data storage technologies.
- **Data Generation:** Streaming devices and IoT generate massive data that can be analyzed for competitive advantage.
- **Automation Tools:** Semi or fully automated data management and analytics tools simplify business analysis.

Module 4: Current Trends in Artificial Intelligence

8.2 AI as a Service (AIaaS)

8.2.2 The Growth of AIaaS

- **Accessibility:** Cloud services make AI available to more companies, reducing the need for massive investment in talent and resources.
- **Key Benefits:**
  - **Focus on Core Business:** Companies can focus on their core business instead of learning AI.
  - **Cost Reduction:** AIaaS lowers operational costs and avoids expensive infrastructure.
  - **Minimized Investment Risk:** No huge upfront costs or resource commitments.
  - **Quick Deployment:** AIaaS offers fast solutions with pre-built algorithms.
  - **Data Insights:** Gain competitive edge by analyzing trends and improving data usage.
  - Scalability: Companies can start small and scale AI projects as needed.

Module 4: Current Trends in Artificial Intelligence

8.2 AI as a Service (AIaaS)

8.2.3 Challenges of AIaaS

1. **Security:** Sharing data with third-party vendors can raise security concerns.
2. **Reliance on Third Parties:** Dependence on vendors for services can lead to delays.
3. **Reduced Transparency:** Lack of insight into the internal workings of AI systems.
4. **Data Governance:** Industry-specific data policies may restrict the use of third-party AIaaS.

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8.2 AI as a Service (AIaaS)

8.2.4 Vendors of AIaaS

- **Major AIaaS Providers:**
  - **Amazon Web Services (AWS)**: Offers machine learning services like bots, APIs, and frameworks.
  - **Microsoft Azure**: Provides AI and ML solutions, including cognitive services and bot services.
  - **Google Cloud Platform (GCP)**: Helps data scientists and developers create and deploy machine learning projects.
- **Other AIaaS Providers:**
  - **MonkeyLearn**: Simplifies text analysis using no-code tools.
  - **IBM Watson**: Offers a suite of AI tools for building virtual assistants and text analysis.
  - **Microsoft Azure**: Provides cognitive services for computer vision and text extraction.
  - **Google Cloud ML**: Facilitates data scientists in creating and deploying ML models.

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8.2 AI as a Service (AIaaS)

8.2.5 Market Growth

- SaaS Market: Valued at $133 billion.
- **AI Platform-as-a-Service (AIPaaS)**: Expected to grow from $11 billion in 2023 to $88.5 billion by 2025.

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8.4 Recent Trends in AI

8.4.1 Collaborative Systems

- **Machine-Human Collaboration:**
  - AI and humans work together to complement each other's strengths.
- **Examples:**
  - Foldit: AI and humans collaborate to fold proteins.
  - AI in Chess: Amateurs and AI beat grandmasters.
  - AI in Business: AI elected to company boards.
  - Military: Drones and humans working together.
  - Exoskeletons: Power suits assist soldiers in the field.
- **Challenges:**
  - Over-reliance on AI could lead to job loss and skill degradation.

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8.4 Recent Trends in AI

8.4.2 Machines Assisting Humans

- **AI Helps Humans Enhance Abilities:**
  - AI boosts creativity, decision-making, and interactions.
- **Examples:**
  - SEB Bank's AI Assistant: Helps customers with tasks and understands tone.
  - AI improves efficiency in various sectors like healthcare, customer service, and homes.

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8.4 Recent Trends in AI

8.4.3 Algorithmic Game Theory

- **Game Theory with AI:**
  - AI helps machines play games ethically using predefined rules.
- **Types of Games:**
  - **Cooperative vs. Non-cooperative:** Alliances or no alliances.
  - **Symmetric vs. Asymmetric:** Same vs. different goals.
  - **Perfect vs. Imperfect Info:** Full visibility vs. hidden moves.
  - **Zero-sum vs. Non-zero sum:** One loses, one wins vs. all gain.
- **Key Concepts:**
  - **Nash Equilibrium:** No player can improve their situation by changing strategies.
  - **Inverse Game Theory:** Designing games based on players' strategies.

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8.4 Recent Trends in AI

8.4.4 Multi-Agent Reinforcement Learning (MARL)

- **Multiple Agents Learning:**
  - Multiple AI agents interact and learn together.
- **Example:**
  - Self-driving cars: Cars learning to manage traffic flow.
- **Challenges:**
  - Increased complexity with more agents interacting.

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8.4 Recent Trends in AI

8.4.5 Neuromorphic Computing

- **Brain-like AI Systems:**
  - Neuromorphic computing mimics the brain's structure for efficient processing.
- **Features:**
  - Parallel processing, low power consumption, flexibility, fault-tolerance.
- **Applications:**
  - Real-time processing, energy-efficient systems, adaptive AI.
- **Difference:**
  - Uses spiking neural networks (SNNs) for processing.
- **Examples:**
  - Intel's Loihi and IBM's TrueNorth chips.

8.4 Recent Trends in AI

8.4.6 Challenges in Neuromorphic Computing

- **Difficult Transition:**
  - Moving from Von Neumann architecture to neuromorphic computing is challenging.
- **Needs:**
  - New programming languages, sensors, and storage technologies.
- **Programming:**
  - Requires new development for neuromorphic systems.

Impact of AI Trends

- **Mainstream AI:**
  - AI is becoming standard across industries.
  - New opportunities with challenges in ethical implementation.

Module 4: Current Trends in Artificial Intelligence

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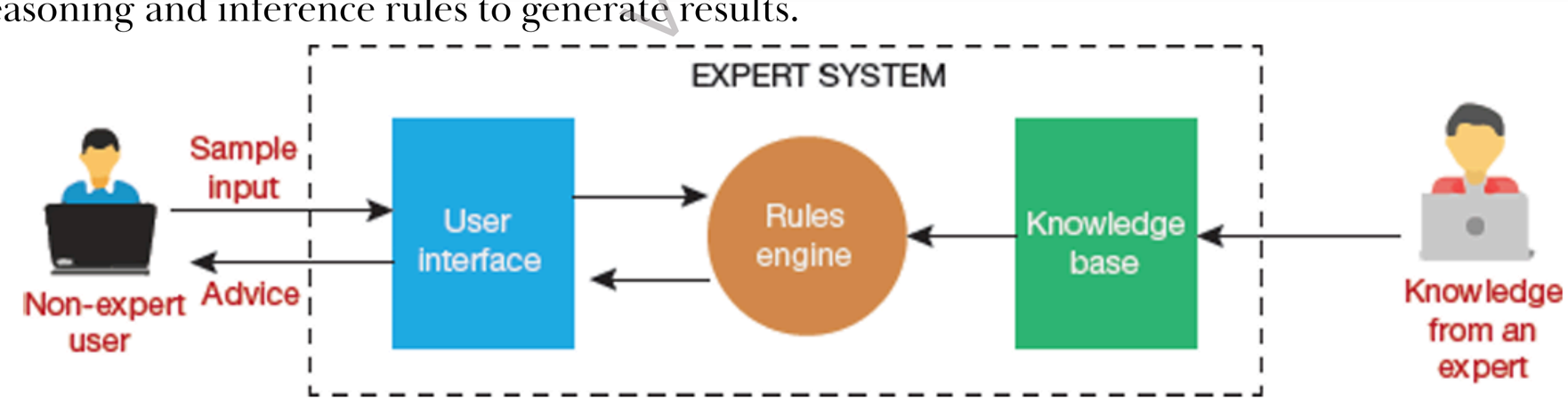
Module 4: Current Trends in Artificial Intelligence

9.1 Expert System

- A computer program designed to solve complex problems with human-like expertise.
- Used to assist, not replace, human decision-making in specific domains (e.g., medicine, science).
- **Key Components:**
  a. User Interface: Allows interaction with the system.
  b. Knowledge Base (KB): Stores expert knowledge for decision-making.
  c. Inference Engine: Applies reasoning rules to extract knowledge and provide decisions.
- **How it Works:**
  - Expert systems analyze user queries.
  - Extract knowledge from the knowledge base.
  - Use reasoning and inference rules to generate results.



9.1.1 Popular Examples of Expert Systems

- DENDRAL:
  - A chemical analysis system.
  - Used in organic chemistry to identify unknown molecules by analyzing mass spectra.
- MYCIN:
  - Designed to diagnose blood clotting diseases and bacterial infections.
  - Recommends antibiotics and drugs based on the patient's condition.
- PXDES:
  - Determines the type and level of lung cancer using images of the upper body.
- CaDeT:
  - Diagnostic support system to detect cancer at early stages.
- R1/XCON:
  - Customizes computer systems based on user requirements.
- DXplain:
  - Clinical support system that suggests diseases based on doctor's findings.

9.1.2 Characteristics of an Expert System

- **High Performance:**
  - Solves complex domain problems with high efficiency and accuracy.
  - Dependent on a well-updated knowledge base.
- **Understandable:**
  - Results are provided in a human-understandable format.
  - Takes input and gives output in natural language.
- **Reliable:**
  - Generates efficient and accurate output consistently.
- **Highly Responsive:**
  - Provides fast results, faster than human experts.
- **No Memory Limitations:**
  - Can store and process huge amounts of data.

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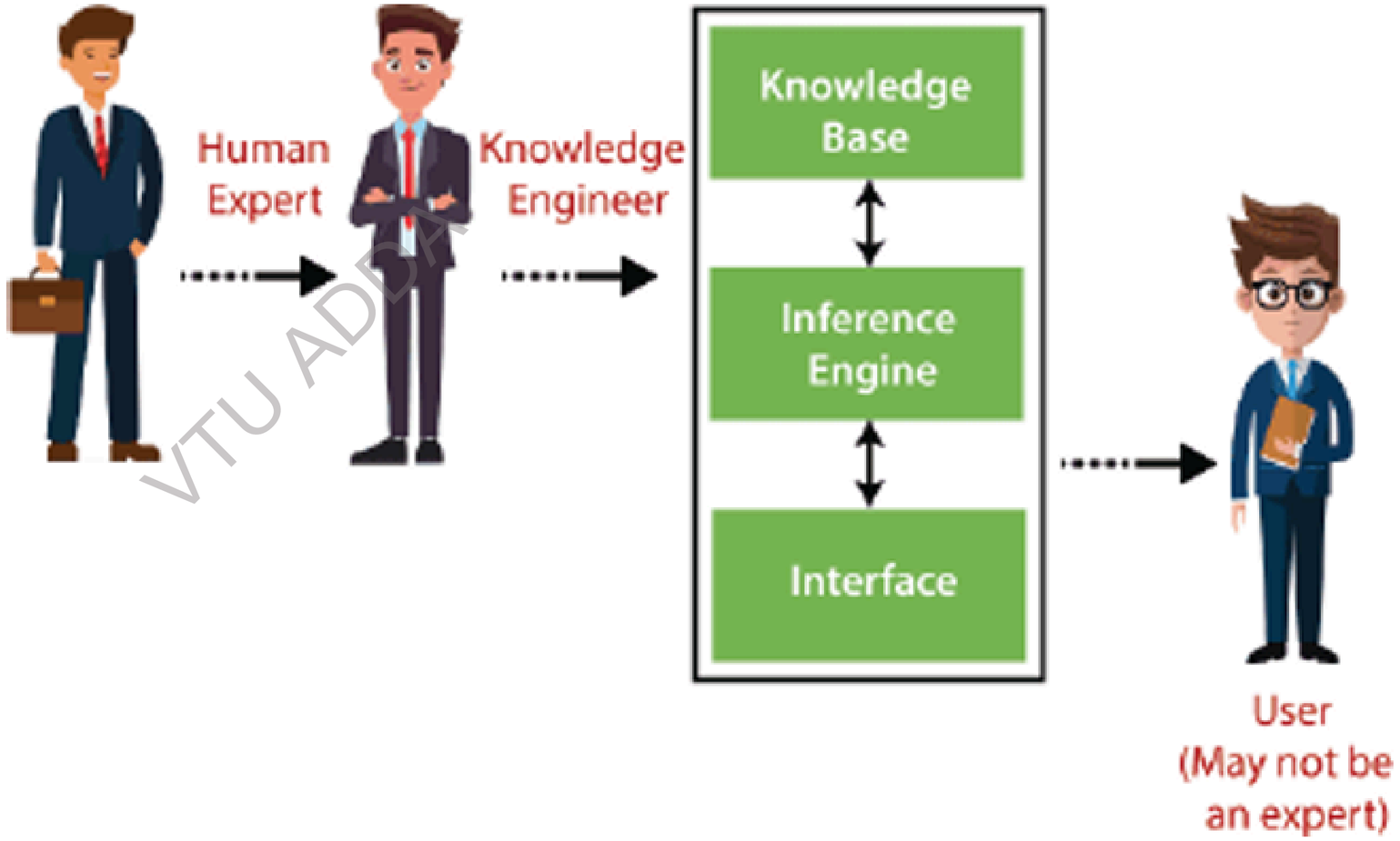
9.1.2 Characteristics of an Expert System

- **Expertise in a Domain:**
  - Integrates knowledge from multiple human experts in specific areas.
- **Not Affected by Emotions:**
  - Consistent performance without the influence of fatigue, stress, or emotions.
- **Not Biased:**
  - Checks all facts before making decisions, ensuring impartial results.
- **Reduce Cost:**
  - Much cheaper than hiring human experts for repeated consultations.
- **Non-perishable:**
  - Can be used indefinitely once developed, unlike human experts.
- **Intelligent:**
  - Uses knowledge and inference rules to deduce new facts and solve problems.

9.1.3 Components of an Expert System

An expert system mainly consists of three components—

1. User interface,
2. Inference engine and
3. Knowledge base



9.1.3 Components of an Expert System

1. User Interface

- **Role:** Allows users to interact with the system.
- **Function:** Accepts user queries in natural language and provides understandable results.
- **Key Features:**
  - Helps users accomplish tasks quickly.
  - Customizable for user requirements.
  - Efficiently handles user input.

9.1.3 Components of an Expert System

2. Inference Engine (Rules Engine)

- **Role**: The "brain" of the expert system.
- **Function**: Processes information from the knowledge base to draw conclusions.
- **Types**:
  - **Deterministic**: Draws conclusions with certainty.
  - **Probabilistic**: Deals with uncertainty and probability.
- **Strategies**:
  - **Forward Chaining**: Starts with known facts to predict what can happen next (e.g., predicting stock prices).
  - **Backward Chaining**: Starts with the goal to work backward and understand the cause (e.g., diagnosing diseases).

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9.1.3 Components of an Expert System

3. Knowledge Base

- **Role**: Stores domain-specific knowledge.
- **Types of Knowledge**:
  - **Factual Knowledge**: Based on facts accepted in the domain.
  - **Heuristic Knowledge**: Based on experience, probability, and practices.
- **Representation**: Knowledge is typically represented using If-Else Rules.

Case Study: MYCIN (Expert System)

- **Step 1**: Knowledge base about bacterial infections is created.
- **Step 2**: The system is updated with new information.
- **Step 3**: The doctor inputs details of a patient (e.g., symptoms, medical history).
- **Step 4**: The system applies If-Then rules using the inference engine.
- **Step 5**: Output is provided through the user interface, guiding diagnosis and treatment.

9.1.3 Components of an Expert System

Inference Engine (Rules Engine)

- The Inference Engine is the core processing unit of an expert system, often referred to as its "brain."
- It processes knowledge from the knowledge base and draws conclusions based on inference rules.

Types of Inference Engines:

1. **Deterministic Inference Engine:**
   - **How it works:** Uses facts and rules to draw conclusions.
   - **Output:** Conclusions are assumed to be true based on the given data.
2. **Probabilistic Inference Engine:**
   - **How it works:** Deals with uncertainty and draws conclusions based on probability.
   - **Output:** Conclusions have some level of uncertainty attached.

9.1.3 Components of an Expert System

Inference Engine (Rules Engine)

- **Functions of Inference Engine:**
  - **Efficient Processing:** Applies rules and procedures to generate correct solutions.
  - **Conflict Resolution:** If multiple rules apply, the engine selects the best rule based on the current context.
  - **Explanation and Debugging:** Can explain how conclusions are reached, ensuring transparency.

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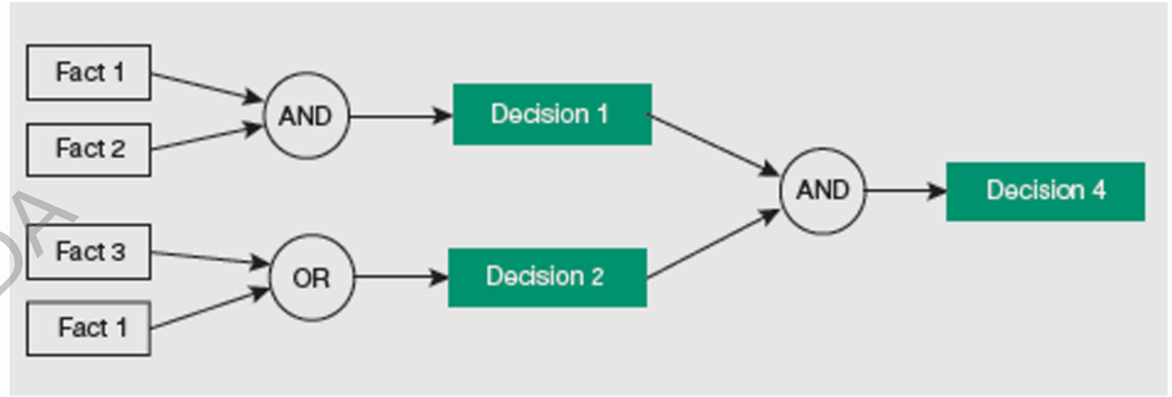
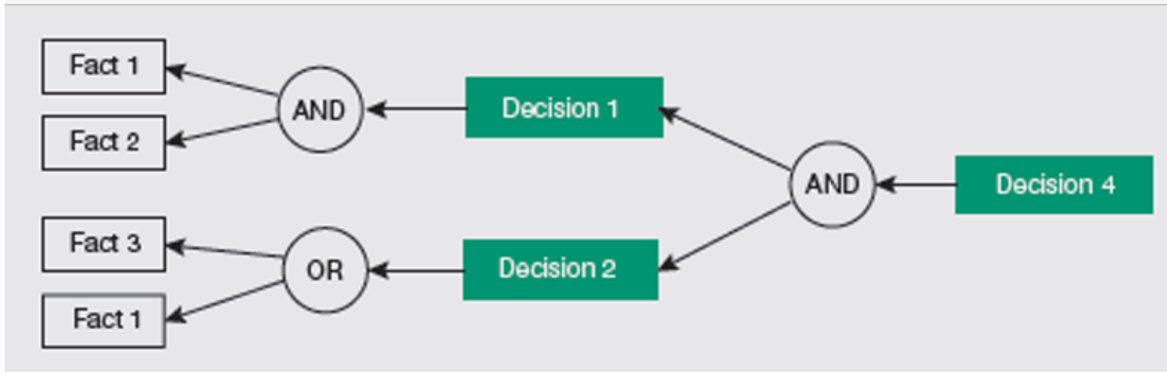
9.1.3 Components of an Expert System

Inference Engine (Rules Engine)

- **Strategies for Knowledge Acquisition:**
  - **Forward Chaining:**
    - **How it works:** Starts with known facts and rules to predict what can happen next.
    - **Example:** Predicting stock prices after interest rate changes.
  - **Backward Chaining:**
    - **How it works:** Starts from the goal and works backward to prove the facts that lead to it.
    - **Example:** Diagnosing blood cancer by tracing the cause from the symptoms.





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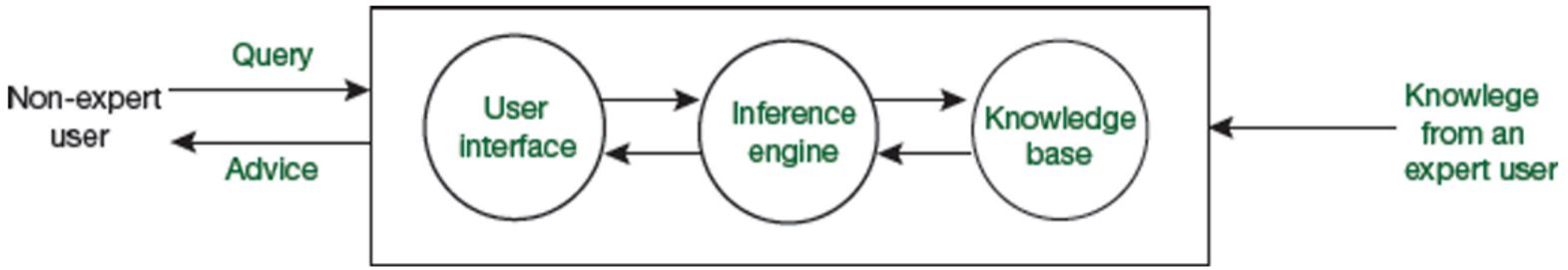
9.1.4 Participants in the Development of Expert System



Expert:

- **Role**: Provide the domain-specific knowledge that feeds into the expert system's knowledge base.
- **Importance**: The accuracy and performance of the expert system rely on the quality and depth of knowledge provided by the experts.

Knowledge Engineer:

- **Role**: Responsible for building the expert system by acquiring, organizing, and structuring knowledge.
- **Importance**: The knowledge engineer ensures the knowledge is represented in a format that the expert system can use effectively to solve problems.

End User:

- **Role**: The person who interacts with the expert system to get solutions or advice for specific queries.
- **Importance**: They may not have deep knowledge in the domain but rely on the expert system to address complex issues or tasks.

9.1.5 Capabilities of the Expert System

- **Advise:** Provides advice for any query within its domain.
- **Decision-Making:** Makes complex decisions in fields like finance, medicine, etc.
- **Demonstrate Devices:** Demonstrates features, specifications, and usage of new products.
- **Problem-Solving:** Solves complex problems within its domain.
- **Explain a Problem:** Offers detailed descriptions of input problems.
- **Interpret Input:** Interprets user input for further processing.
- **Predict Results:** Predicts outcomes based on historical data.
- **Assist in Decision-Making:** Assists humans in making informed decisions.
- **Diagnose:** Used in medical fields to diagnose diseases.
- **Justify Conclusions:** Explains the reasoning behind the conclusions drawn.
- **Suggest Alternatives:** Suggests alternative solutions to problems.

9.1.5 Capabilities of the Expert System

Limitations of the Expert System

- **Cannot Substitute Human Decision-Makers:** It does not replace human judgment.
- **Lacks Human Capabilities:** Cannot replicate human emotions or intuitive thinking.
- **Inaccurate Output with Inadequate Knowledge Base:** Performance depends on the quality of the knowledge base.
- **Cannot Refine Knowledge Base:** It cannot autonomously improve or update its knowledge.
- **Cannot Use Emotions in Decisions:** Decisions are purely logical, without emotional influence.

9.1.6 Advantages of Expert Systems

- **Reproducible Results:** Results are consistent and can be reproduced each time.
- **Safe in Risky Environments:** Can be used in hazardous places where human presence is risky.
- **Accuracy:** Provide accurate results, especially with regularly updated knowledge bases.
- **Consistent and Fast Performance:** They perform consistently without being affected by emotions or fatigue.
- **Easily Available:** Mass-produced software makes expert systems widely available.
- **Affordable:** Production costs are reasonable, making them cost-effective.
- **High Speed:** Operate at high speed, reducing human effort and time.
- **Explainable Results:** Capable of explaining how conclusions or solutions were reached.
- **Improved Decision Quality:** Enhance the quality of decisions made.
- **Efficient Use of Expert Knowledge:** Efficiently gather and use scarce expertise for better solutions.

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9.1.7 Limitations of Expert Systems

- **Wrong Results:** Incorrect or outdated knowledge leads to wrong results.
- **Different Solutions:** Human experts may give different answers from the system.
- **Lack of Creativity:** Can't handle unusual or creative scenarios.
- **High Cost: Expensive to develop and maintain.**
- **Hard to Gather Knowledge:** Collecting the right knowledge is difficult.
- **Depend on Experts:** Success relies on expert knowledge input.
- **No Self-Learning:** Can't learn from experience, needs manual updates.
- **Needs Plenty of Knowledge:** Can't work with limited information.
- **Training Intensive:** Requires extensive training to function well.
- **No Emotions: Cannot understand or use emotions in decisions.**
- **No Common Sense:** Lacks human-like reasoning.
- **Domain-Specific:** Only works for a specific area.
- **Struggles with Unusual Situations:** Can't make decisions in rare cases.
- **Garbage In, Garbage Out (GIGO):** Poor data leads to poor results.
- **High Maintenance Cost:** Regular updates and maintenance are expensive.

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9.1.8 Applications of Expert Systems

- **Design & Manufacturing:** VLSI systems, camera lenses, automobiles.
- **Knowledge Publishing:** Tax advisors and other advisory systems.
- **Finance:** Detect fraud, suspicious activities, stock trading, loan approvals.
- **Medical Diagnosis:** Used extensively for diagnosing diseases and treatment.
- **Planning & Scheduling:** Project goals, airline scheduling, cargo, manufacturing.
- **Software Development:** Tracking project progress.
- **Monitoring Systems:** Detect leaks in pipelines, continuous data comparison.
- **Process Control:** Control physical processes through monitoring.
- **Automobile & Electronics:** Fault detection in vehicles and computers.
- **Complex System Diagnosis:** Electronic, electromechanical, diesel-electric systems.

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9.1.9 Expert System Technology

- **Expert System Development Environment:**
  - **Hardware:** Workstations, minicomputers, mainframes.
  - **Programming Languages:** LISP, PROLOG (high-level symbolic programming).
  - **Databases:** Large databases for storing information.
- **Tools:**
  - **Powerful Editors:** Help developers efficiently create systems.
  - **Debugging:** Multi-window debugging for easy identification of errors.
  - **Rapid Prototyping:** Fast development and testing.
  - **Predefined Models:** In-built knowledge representation and inference design.
- **Shells:**
  - **Definition:** Expert systems without a knowledge base, providing essential modules.
  - **Modules:** Knowledge acquisition, inference engine, user interface, and explanation.
  - **Popular Shells:**
    - **JESS:** Java Expert System Shell, used with Java API.
    - **Vidwan:** Enables encoding knowledge in IF-THEN rules.

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9.1.10 Development of Expert Systems

- **Identify Problem Domain:**
  - Identify the problem to solve.
  - Ensure it is solvable by an expert system.
  - Collaborate with human experts and assess cost-effectiveness.

- **Design the System:**
  - Choose hardware, tools, and shells.
  - Plan system integration with other systems and databases.
  - Design a framework for representing knowledge.

- **Develop the Prototype:**
  - Acquire domain knowledge from experts.
  - Represent knowledge in If-THEN-ELSE rules.
  - Integrate heuristic knowledge for reasoning.

- **Test and Refine the Prototype:**
  - Test the prototype with sample cases.
  - Work with end-users to find errors and discrepancies.
  - Refine the system based on test results.

- **Develop and Complete the System:**
  - Test the system with end-users and databases.
  - Integrate the system with other information systems.
  - Document the system and train users.

- **Maintain the System:**
  - Regularly review and update the knowledge base.
  - Integrate new requirements and interfaces as systems evolve.

Module 4: Current Trends in Artificial Intelligence

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9.2 Internet of Things

IoT is a system of interrelated computing devices, machines, objects, animals, or people with unique identifiers that can transfer data over a network without human-to-human or human-to-computer interaction.

Examples of IoT Devices:

- People: Heart monitor implants.
- Animals: Biochip transponders.
- Automobiles: Sensors for monitoring tyre pressure.
- Objects: Any device assigned an IP address to transfer data.

Applications of IoT:

- Precision Agriculture: Monitoring crops, soil, and environment.
- Building Management: Automating lighting, heating, and security systems.
- Healthcare: Remote patient monitoring with wearable devices.
- Energy: Smart grids and energy management systems.
- Transportation: Traffic management, vehicle monitoring, etc.

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9.2.1 Examples of Applications of IoT

- Smart Car Navigation:
  - Car suggests the best route, updates on traffic, and sends notifications if delayed.
- Smart Home Automation:
  - Alarm rings, and coffee machine starts brewing automatically.
- Wearable Fitness Trackers:
  - Smartwatch tracks activity and productivity, providing insights.
- Self-Driving Cars:
  - Equipped with sensors for detecting objects and ensuring safe navigation.
- Smart Football:
  - Tracks distance and speed, records stats for training.
- Smart Refrigerator:
  - Notifies when groceries run out or when food is expired.
- Smart Air Conditioner:
  - Controlled remotely via smartphone to set the desired temperature before arrival
- Smart Cities:
  - IoT helps in reducing traffic congestion, managing resources efficiently, and reducing pollution and crime.

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9.2.2 IoT Products

- **Amazon Echo (Alexa):**
  - Voice assistant for smart homes.
  - Can perform various tasks like playing music, providing weather reports, or ordering an Uber.
- **Fitbit One (Wearables):**
  - Tracks physical activities (steps, calories, sleep).
  - Syncs with smartphones and computers to monitor progress.
- **Barcelona - Smart City:**
  - Implemented IoT solutions for smart parking and environmental improvements.
  - One of the leading smart cities globally.
- **Popular IoT Platforms:**
  - Amazon Web Services (AWS)
  - Microsoft Azure
  - IBM Watson
  - Cisco IoT Cloud Connect
  - Salesforce IoT Cloud
  - Oracle Integrated Cloud
  - GE Predix
- **AT&T - Connected Car:**
  - Added 1.3 million connected cars to its network in 2016.
  - Brings the total to 9.5 million connected cars.

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9.2.3 Challenges in IoT

- **Security:**
  - Privacy and data sharing concerns.
  - Hackers target connected devices (e.g., cars, homes).
  - Lack of encryption in communication can cause security vulnerabilities.
- **Scalability:**
  - Huge volumes of data generated need big data analytics and cloud storage.
  - Devices must be scalable to process and store ever-increasing data.
- **Interoperability:**
  - Lack of common standards for IoT devices.
  - Difficulty integrating with legacy systems.
- **Lack of Standardization:**
  - Standardization issues hinder IoT device compatibility.
  - Prevents achieving truly connected systems.
- **Lack of Government Support:**
  - Regulatory bodies (e.g., FDA) lack IoT-specific safety and security regulations.
  - Limited governmental oversight.

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9.2.3 Challenges in IoT

- **IoT Malware and Ransomware:**
  - IoT devices vulnerable to malware and ransomware attacks.
  - Hackers can take control of devices and demand ransom.
- **Connectivity:**
  - Poor internet connectivity affects IoT device performance.
  - IoT devices require stable connections for effective monitoring and control.
- **Privacy Policies:**
  - Lack of clear regulations on what data is private or public.
  - Example: IoT toys collecting children's data without parental consent.
- **Bandwidth Strain:**
  - Growing number of IoT devices creates strain on network bandwidth.
  - Increased data flow demands higher bandwidth and powerful servers.
- **IoT Skills Gap:**
  - Shortage of trained professionals in IoT network management.
  - Difficulty in training new staff due to rapid IoT development.

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9.2.4 Sensors

Sensor Type	Description	Example
Oxygen Sensor	Detects the gasoline/oxygen ratio	Car emission control system
Motion Sensor	Detects interruption in energy flow	Home security lights, automatic doors
Vision and Imaging Sensor	Detects objects or colors in view	Cameras for object detection
Temperature Sensor	Measures thermal parameters	Industrial processes for gases, liquids, and solids
Radiation Sensor	Detects alpha, beta, or gamma	Surveys and sample counting
Proximity Sensor	Detects presence of objects without contact	Manufacturing operations
Pressure Sensor	Detects force per unit area in gases/liquids	Control and display devices
Position Sensor	Senses position of objects like valves or doors	Control systems for machinery
Photoelectric Sensor	Detects objects and can sense color	Manufacturing and material handling automation

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9.2.4 Sensors

Sensor Type	Description	Example
Particle Sensor	Detects airborne particulates	Bin and baghouse monitoring
Motion Sensor	Senses movement or stoppage	Conveyor detection, stalling bearings
Metal Detector	Senses the presence of metal	Security checks
Level Sensor	Determines height of substances in tanks	Control and display systems
Leak Sensor	Detects unwanted discharge of liquids/gases	Monitoring gas leaks
Humidity Sensor	Measures water content in the air	Control systems for temperature regulation
Gas and Chemical	Detects gases/chemicals	Environmental monitoring
Force Sensor	Measures forces like weight or torque	Control systems for load measurement
Flow Sensor	Detects movement of gases/liquids/solids	Industrial processing systems
Flaw Sensor	Detects inconsistencies on surfaces	Manufacturing processes like welding

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9.2.4 Sensors

Sensor Type	Description	Example
Flame Detector	Senses fire presence and quality	Combustion control systems
Electrical Sensor	Detects electrical parameters like current and voltage	Monitoring electrical systems
Contact Sensor	Detects physical touch or contact	Alarm systems for doors/windows
Non-contact Sensor	Does not require physical touch	Radar guns for speed detection
Speed Sensor	Measures speed of an object/vehicle	Vehicle monitoring
Ultrasonic Sensor	Measures distance using high-frequency sound waves	Object distance measurement in robotics

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9.3 Artificial Intelligence of Things (AIoT)

- AIoT combines Artificial Intelligence (AI) with the Internet of Things (IoT) to enhance efficiency, improve decision-making, and enable better data management.
- AI simulates human intelligence, while IoT connects devices to transfer data over networks without human intervention.
- AIoT improves IoT by adding machine learning algorithms to enhance decision-making.

9.3.1 How Does AIoT Work?

- AI is embedded in IoT devices and connected through IoT networks.
- Devices collect data, which is analyzed using AI techniques to improve productivity and efficiency.
- Edge AI reduces bandwidth needs and minimizes delays in data processing.

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9.3 Artificial Intelligence of Things (AIoT)

- **9.3.2 Where Does AI Unlock IoT?**
  - AI enhances the Analysis step in IoT, which directly impacts efficiency.
  - AIoT helps:
  - Manage, analyze, and obtain meaningful insights from data.
  - Provide fast, accurate data analysis.
  - Balance localized and centralized intelligence.
  - Ensure data privacy and security.

Module 4: Current Trends in Artificial Intelligence

9.3 Artificial Intelligence of Things (AIoT)

- **9.3.3 Applications and Examples of AIoT**
- AIoT is widely used in various fields:
  - **Smart Cities:** Enhances operational efficiency, improves traffic management, and optimizes resource use.
  - **Smart Retail:** Uses smart cameras to track customers and optimize store operations.
  - **Smart Homes:** Devices analyze user habits to provide customized support.
  - **Manufacturing:** Monitors equipment and detects malfunctions.
  - **Autonomous Vehicles:** Uses real-time data to make driving decisions.
  - **Healthcare:** Devices monitor patient data, enabling remote care and accurate diagnoses.
  - **Smart Thermostats:** AI-powered devices adjust temperature based on user preferences and schedules.
  - **Fleet Management:** Monitors vehicles, tracks fuel usage, and identifies driver behavior.

Module 4: Current Trends in Artificial Intelligence

9.3 Artificial Intelligence of Things (AIoT)

- **9.3.4 Benefits and Challenges of AIoT**
  - **Benefits:**
    - Increases operational efficiency by analyzing and adjusting system operations in real-time.
    - Enables on-the-fly decision-making with real-time data analysis.
    - Reduces workload and saves time by automating data analysis.
    - Scalable systems that connect more devices as needed.
    - Better risk management by predicting potential problems in advance.
    - Improves products and services through real-time data analysis.

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9.3 Artificial Intelligence of Things (AIoT)

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  - **Benefits:**
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    - Enables on-the-fly decision-making with real-time data analysis.
    - Reduces workload and saves time by automating data analysis.
    - Scalable systems that connect more devices as needed.
    - Better risk management by predicting potential problems in advance.
    - Improves products and services through real-time data analysis.
  - **Challenges:**
    - **Security**: Protection of sensitive data is a significant concern.
    - **Scalability**: Managing large volumes of data from multiple devices.
    - **Interoperability**: Lack of standardization among different IoT devices.
    - **Privacy**: Handling user data and ensuring privacy compliance.

9.3 Artificial Intelligence of Things (AIoT)

- **9.3.5 Future of AIoT**
  - **Growth with 5G:** 5G will boost AIoT by providing faster data transfer and lower latency.
  - **Revolutionizing Industries:** AIoT will improve supply chains, operational efficiency, and decision-making.
  - **Exponential Data Growth:** With more devices connected, AI will help manage the massive amount of data generated.
    - By 2025, the number of IoT devices is expected to rise to 42 billion, and AI will help process and analyze the increasing data efficiently.

Module 4: Current Trends in Artificial Intelligence

Chapter 9 Where AI Is Heading Today?

9.1 Expert System
9.1.1 Popular Examples of the Expert System
9.1.2 Characteristics of an Expert System
9.1.3 Components of an Expert System
9.1.4 Participants in the Development of Expert System
9.1.5 Capabilities of the Expert System
9.1.6 Advantages of Expert System
9.1.7 Limitations of Expert System
9.1.8 Applications of Expert Systems
9.1.9 Expert System Technology
9.1.10 Development of Expert Systems

9.2 Internet of Things
9.2.1 Examples of Applications of IoT
9.2.2 IoT Products
9.2.3 Challenges
9.2.4 Sensors

9.3 Artificial Intelligence of Things (AIoT)
9.3.1 How Does AIoT Work?
9.3.2 Where Does AI Unlock IoT?
9.3.3 Applications and Examples of AIoT
9.3.4 Benefits and Challenges of AIoT
9.3.5 Future of AIoT

Thank You

Module 4 - Completed