GROUP 43 WEEK 6 ASSIGNMENT

Part 1: Essay Questions

Q1: Explain how Edge AI reduces latency and enhances privacy compared to cloud-based AI.

Introduction

Edge AI refers to the deployment of artificial intelligence algorithms locally on devices ("the edge") instead of relying on centralized cloud servers. This architectural shift offers significant benefits in terms of latency reduction and privacy preservation.

Latency Reduction

In cloud-based AI systems, data must travel from the device to a remote server for processing and back again. This round-trip can introduce significant delays, especially over unreliable or high-latency networks. Edge AI eliminates this by performing inference locally on the device itself, enabling near-instantaneous responses. For real-time applications such as autonomous vehicles or drones, this speed is critical for safety and functionality.

Enhanced Privacy

Edge AI also improves data privacy. In cloud-based models, sensitive user data must be transmitted and stored remotely, increasing the risk of breaches or misuse. Edge AI keeps data on-device, minimizing exposure and ensuring compliance with data protection regulations. Users maintain greater control over their personal information.

Real-World Example: Smart Home Security Systems

Smart home security systems demonstrate Edge AI's benefits clearly. Modern security cameras and sensors use onboard AI to detect motion, recognize faces, or identify unusual sounds in real-time. Sending raw video streams to the cloud for analysis would introduce delays that could allow intruders to go undetected or prevent immediate alerts. By processing data locally, these systems trigger alarms instantly and store only essential metadata or events in the cloud, preserving user privacy by avoiding continuous video uploads. This design ensures both rapid response and enhanced data protection for homeowners.

Q2: Compare Quantum AI and classical AI in solving optimization problems. What industries could benefit most from Quantum AI?

Introduction

Optimization problems involve finding the best solution from many possible configurations. Classical AI uses methods like gradient descent, simulated annealing, or heuristic search to approximate optimal solutions. Quantum AI leverages quantum computing principles to tackle these problems more efficiently.

Classical AI

Classical AI approaches are well-established and run on traditional hardware. They rely on deterministic or probabilistic algorithms, but can be limited by computational complexity. For large, high-dimensional optimization problems, these methods may require impractically long runtimes to reach near-optimal solutions.

Quantum AI

Quantum AI uses quantum bits (qubits) and phenomena like superposition and entanglement to explore multiple solutions simultaneously. Quantum algorithms (e.g., **Quantum Approximate Optimization Algorithm - QAOA**) can offer speedups for certain classes of optimization problems, potentially finding better solutions faster than classical methods.

Industry Applications

- **Logistics and Transportation**: Optimizing delivery routes, warehouse layouts, and supply chains.

- **Finance**: Portfolio optimization, risk modelling, fraud detection.

- **Energy**: Grid optimization, energy trading strategies.

- **Drug Discovery**: Molecular configuration and binding site optimization.

- **Manufacturing**: Scheduling, production planning.

These industries often involve complex optimization problems with large search spaces, where Quantum AI could deliver transformative efficiency gains once mature quantum computers are available.

Q3: Discuss the societal impact of Human-AI collaboration in healthcare. How might it transform roles like radiologists or nurses?

Introduction

Human-AI collaboration in healthcare combines the strengths of clinicians with AI's analytical capabilities. This synergy promises improved diagnostic accuracy, efficiency, and patient outcomes, but it also necessitates changes in healthcare roles.

Impact on Radiologists

AI systems can detect patterns in medical imaging (X-rays, MRIs, CT scans) with high sensitivity, flagging anomalies that may be missed by humans. Rather than replacing radiologists, AI serves as a diagnostic assistant, enabling them to focus on complex cases, integrate contextual clinical information, and communicate findings effectively. Radiologists' roles shift toward overseeing AI results, ensuring quality, and providing nuanced interpretations.

Impact on Nurses

AI-powered systems can handle routine documentation, patient monitoring, and early warning alerts (e.g., detecting vital sign deterioration). This automation frees nurses to spend more time on direct patient care, emotional support, and complex clinical decision-making. AI can also aid in personalized care planning and medication management.

Broader Societal Impact

Human-AI collaboration can increase healthcare access, particularly in underserved regions by democratizing expert-level diagnostics. However, it also requires investment in training to ensure clinicians understand and trust AI tools, and policies to address ethical concerns like bias and accountability.

Part 2: Case Study Critique

How Integrating AI with IoT Improves Urban Sustainability

Integrating AI with IoT in traffic management systems enables cities to reduce congestion, lower emissions, and improve quality of life. IoT sensors collect real-time data on vehicle flow, pedestrian

crossings, and environmental conditions. AI analyses this data to optimize traffic light timings, predict congestion hotspots, and suggest alternative routes. This leads to reduced fuel consumption, less air pollution, and improved transit efficiency, contributing to sustainable urban development.

Two Challenges

1. **Data Security and Privacy**

IoT devices generate massive amounts of potentially sensitive data, such as vehicle locations and personal movement patterns. Without robust security measures, these systems are vulnerable to hacking, data breaches, or misuse. Ensuring end-to-end encryption, secure data storage, and strict access controls is essential.

2. **Interoperability and Infrastructure Costs**

Smart city deployments often involve multiple vendors and legacy systems. Integrating these diverse technologies requires standardized protocols and significant investment in infrastructure upgrades. Without careful planning, cities risk fragmented, incompatible systems that undermine sustainability goals.