PART 1

Q1

One of the most significant advantages of Edge AI is the capacity to minimize latency. With AI systems in the cloud, data generated by a device must be sent to a remote server for processing, and the outcome needs to be sent back to the device. This round-trip communication delay can be significant, especially for poorly optimized networks, longer distances, or remote geographic servers. In contrast, Edge AI processes data on the device or a nearby edge server. This obviates the need to communicate with the cloud and allows for real-time analytics. Consider autonomous drones, for example. Edge AI enables drones to evaluate proximity and identify hurdles in real time, bypassing a remote data center for analytics. In drones, rapid Edge AI processing is a reliable safety measure, as even brief processing delays can cause fatal crashes or mission failures.

Q2

Incorporating the principles of quantum computing with artificial intelligence enables the solving of problems more effectively and quickly than with classical AI. Classical AI processes data sequentially and linearly using binary computing, which consists of bits with a 0 and 1 value. Although conventional systems are beneficial in many areas, they become inefficient in solving large-scale problems that require optimization as they have multiple variables with numerous potential solutions.

In contrast, Quantum AI approaches problems differently. Using qubits and the concepts of superposition, Quantum AI evaluates numerous solutions concurrently which enables it to significantly optimize reduction computation time. For instance, classical AI algorithms would take time to analyze millions of configurations sequentially. Quantum algorithms are able to analyze and configure millions at once in a much shorter time.

Some of the industries that stand to gain the most from Quantum AI include logistics and transportation, finance, pharmaceuticals, and energy. These industries have to optimize/routes and supply chains, portfolios and risk models, drug discovery and molecular simulations, and power grid management and resource allocation, respectively. Quantum AI will optimize computational solutions in these industries as it will be able to perform tasks that were computationally impossible.

Q3

The integration of AI within the health care human professions is now impacting the way health care providers are diagnosing and treating patients and how they care for them. The cooperation optimizes the whole health care system, combining human input, and AI streamlining analysis and diagnosis. Routine data analysis takes too many resources, so data is analyzed and only the pertinent to patient care information is forwarded to the health care professional. This change allows the health care provider to prioritize the patient.

In the case of radiologists, the AI system takes the role of the apprentice rather than the replacement. AI pre-screens the digital radiographs and flags potential lesions, and assists in reducing the erroneous diagnoses. Radiologists can then take unequivocal decisions as they correlate the AI diagnosis with their clinical judgment and amplify the speed of the preliminary diagnosis. AI also assists the nurses in triage, and in real-time monitoring, and automates charting and scheduling, increasing the time the professional can spend with the patient.

The health care system responding to the human compassion in the professional's work, AI technology increasing the compassion and efficiency in the care provided, and decreasing professional burnout. The integration of AI in human professions in the health system enhances the care provided, responding to the compassion in the professional's work. The response to human compassion in the professional’s work can be AI technology, compassion and efficiency in the care provided decreasing professional burnout.

Integrating AI with IoT for Urban Sustainability

The combination of AI and IoT is changing the way cities resource and resource sustainability. IoT systems gathers and tracks information through sensors integrated with infrastructures (traffic lights, waste bins, and energy grids), and then AI utilizes this information for urban operation optimization. For example, AI driven traffic systems and smart energy grids decreases congestions and emissions by waste avoidance, and real time balance power demand shifting towards pro renewable energy. The combination of AI and IoT is turning cities into sustainable urban areas. The urban systems efficiency is improved, the struck level sustainability of the environment is also improved.

The integration AI and IoT into urban systems also incur unsolved problems. The first one is data security. Versatile network connected devices collect and store data which may get and become the target of cyber threat. Infringing power of personal data and public safety is a serious risk. The second unsolved problem is infrastructure and interoperative. Measuring different systems (old utility and new sensors) integration need set key basics and big money.

PART 2

Task 2

Smart Agriculture System

Objective:
This project aims to create a smart agriculture system that combines Artificial Intelligence (AI) and the Internet of Things (IoT) to help farmers make better decisions, use resources efficiently, and predict crop yields more accurately. By using connected sensors and intelligent algorithms, the system will improve productivity, conserve water, and support sustainable farming practices.

Sensors Needed

To capture the necessary field data, the system will use:

- **Soil sensors:** to measure moisture, temperature, electrical conductivity, and pH levels.
- **Weather sensors:** for air temperature, humidity, rainfall, and light intensity (sunlight or PAR).
- **Imaging devices:** such as drones or fixed cameras to monitor crop growth, plant color, and health through NDVI images.
- **Plant sensors:** to detect leaf wetness and canopy temperature, helping identify crop stress.
- **Location sensors:** GPS on equipment to track where and when data is collected.

AI Model for Crop Yield Prediction

The AI component will combine data from all sensors to predict crop yields and provide recommendations. The proposed model will have two main parts:

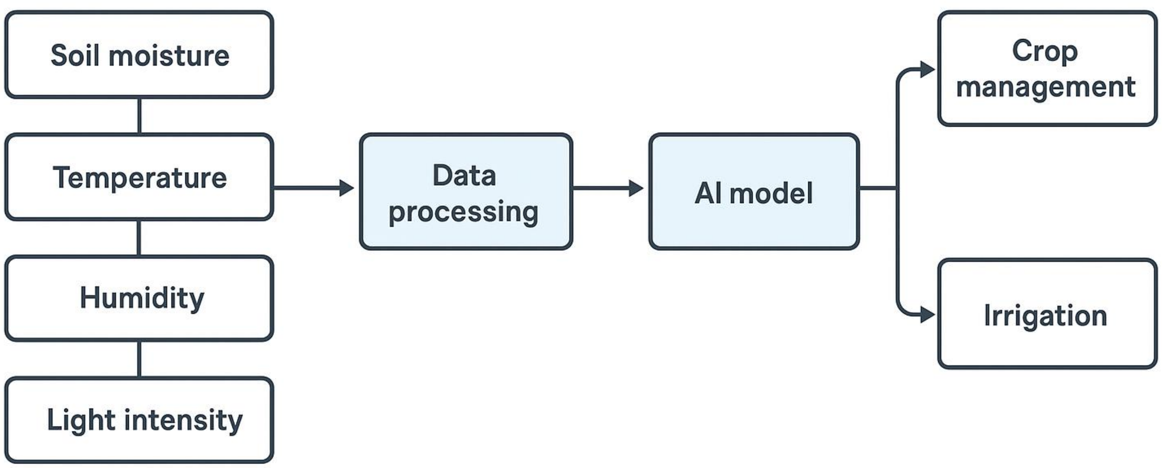
- A **Convolutional Neural Network (CNN)** to process satellite or drone images and extract plant health patterns.
- A **Long Short-Term Memory (LSTM)** network to analyze time-series data like soil moisture and weather changes over the growing season.

These two outputs will be merged to produce an accurate yield forecast. The model will learn from past seasons' data, improving with every cycle.

Data Flow Overview

1. **Sensors** collect soil, plant, and weather data from the field.
2. **Edge gateway devices** process raw data locally, reducing delays and ensuring fast decisions (e.g., adjusting irrigation).
3. **Cloud storage and AI engine** receive aggregated data for deeper analysis and model training.
4. **Farmer dashboard** displays real-time insights and sends alerts or recommendations.

Data Flow Diagram



Benefits and Challenges

Benefits: Real-time monitoring, better resource use, improved yields, and reduced waste.
Challenges: Protecting sensitive data from cyber threats and ensuring reliable connectivity between devices.

Next Steps

1. Start with a small-scale pilot on one farm.

2. Collect and label data for one growing season.
3. Train and test the AI model.
4. Deploy the full system with real-time dashboards and alerts.

Task 3

AI Bias and Fairness in Cancer Treatment Recommendations Using the Cancer Genomic Atlas

The Cancer Genomic Atlas (TCGA) is one of the most valuable resources in cancer research, containing detailed genetic and clinical data across many cancer types. It has made it possible to develop AI systems that can detect mutations, predict disease outcomes, and even suggest personalized treatment options. However, relying heavily on this dataset also raises important concerns about bias and fairness in AI-driven recommendations.

A major issue lies in the lack of diversity within the TCGA dataset. Most of the samples come from people of European ancestry, meaning that the genetic variations common in other populations—such as African, Asian, or Indigenous groups—are not equally represented. As a result, AI models trained on this data may perform well for some groups but poorly for others, leading to inaccurate or less effective treatment suggestions. Other biases may also appear if the dataset underrepresents certain ages, genders, or socioeconomic backgrounds, potentially reinforcing existing health inequalities.

To make AI systems fairer and more inclusive, several steps can be taken. First, training data should come from diverse populations, combining TCGA with other global genomic databases. Second, researchers should regularly test models for bias, checking whether they perform equally well across different demographic groups. Third, using fairness-aware algorithms can help correct imbalances during training. Finally, AI systems should be transparent and explainable, allowing doctors to understand how decisions are made and build trust in their use.

In short, while AI trained on TCGA data holds great promise for cancer treatment, addressing bias through diversity, testing, and transparency is essential. Doing so ensures that the benefits of precision medicine reach everyone—no matter their background.

PART 3

AI-Powered Ocean Climate Stabilization System (AIOCS) — 2030 Concept Paper

Problem Statement

By 2030, climate change will continue to disrupt our oceans, leading to rising temperatures, coral bleaching, and more frequent marine die-offs. Ocean acidification will also threaten fish populations and the livelihoods of coastal communities. Current climate solutions are often reactive and limited in scale. What we need is a smart, adaptive system capable of understanding and stabilizing ocean conditions before irreversible damage occurs.

Proposed Solution

The AI-Powered Ocean Climate Stabilization System (AIOCS) is a network of autonomous ocean drones, satellites, and floating sensors that continuously monitor the health of the oceans. Using AI, the system would predict areas at risk of overheating or acidification and respond automatically—by deploying cooling microbubbles, releasing safe mineral compounds to absorb excess carbon, or adjusting local circulation patterns. AIOCS acts like an "ocean guardian," constantly learning how to keep marine ecosystems in balance.

AI Workflow

- **Data Inputs:** Real-time readings from ocean drones, satellite imagery, and historical climate data.
- **AI Model:** A combination of **deep reinforcement learning** (to optimize interventions), **graph neural networks** (to map ocean interactions), and **LSTM models** (to forecast temperature and acidity trends).
- **Output:** The AI coordinates fleets of drones and sensors to take corrective actions and refine its strategies based on results.

Societal Risks and Benefits

The benefits are enormous: stabilizing ocean temperatures, protecting coral reefs, preserving fish stocks, and mitigating climate change impacts on coastal communities. However, risks include possible ecosystem disruptions or misuse of such powerful technology. To prevent this, international oversight, transparency, and shared governance would be essential.

In essence, AIOCS envisions a future where AI and humanity work together to heal and protect the planet's oceans.

Bonus Task

How Quantum Computing Could Transform Drug Discovery

Quantum computing has the potential to revolutionize how we discover and design new medicines. Unlike traditional computers, which process information in bits (0s and 1s), quantum computers use qubits that can exist in multiple states at once. This allows them to handle complex calculations that are practically impossible for even the fastest classical supercomputers.

In drug discovery, one of the hardest problems is accurately simulating how molecules behave at the quantum level. Traditional AI models can predict molecular interactions, but they rely on approximations because the underlying chemistry is too complex to model perfectly. Quantum computers, however, can directly simulate molecular structures and chemical reactions using the same quantum principles that govern them.

Imagine using an AI system that scans millions of potential drug compounds, then sends the most promising candidates to a quantum algorithm for deeper analysis. The quantum computer could calculate how each molecule binds to a target protein, predict energy states, and identify the most stable and effective compounds. This hybrid AI quantum approach could drastically reduce the time and cost of developing new drugs.

Beyond speed, it could also help design safer and more personalized medicines. By combining AI's pattern recognition with quantum computing's precision, scientists could explore molecular possibilities that were previously out of reach bringing us closer to curing diseases that today still have no treatment.