AI in SOFTWARE ENGINEERING

WEEK 6: AI Future Directions

Q1: Explain how Edge AI reduces latency and enhances privacy compared to cloud-based AI. Provide a real-world example (e.g., autonomous drones).

-Edge AI means running AI directly on local devices like phones or drones, not in the cloud.

-Less Latency: Data doesn't travel far, so decisions are faster. This is important for things like drones avoiding obstacles quickly.

-More Privacy: Data stays on the device instead of being sent to a server, so it's safer.

Example: Autonomous drones use Edge AI to make real-time decisions without waiting for cloud servers. This keeps data private and makes reactions quicker.

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

-Classical AI uses regular computers and works well for small or medium problems.

-Quantum AI uses quantum computing. It can try many solutions at once, making it much faster for big, complex problems.

Industries that benefit:

-Logistics (like finding best delivery routes)

-Finance (for managing risks and portfolios)

-Drug discovery and materials science

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

-Human-AI Collaboration means people and AI work together to improve care.

-AI helps by doing repetitive tasks fast, like reading X-rays or tracking patient records.

-Radiologists can focus more on diagnosis since AI flags issues.

-Nurses get help with monitoring patients and managing schedules.

Impact: Jobs change, but don’t disappear. Humans still make final decisions. Patients may get better, faster care

Case Study Critique: AI in Smart Cities Analyze: How does integrating AI with IoT improve urban sustainability? Identify two challenges (e.g., data security).

AI + IoT improves sustainability by:

-Making traffic flow smoother → less fuel used

-Reducing pollution and travel time

-Lowering energy use in street lights and public transport

Two Challenges:

-Data Security: Lots of personal data collected → risk of hacking

-High Cost: Setting up AI and IoT systems is expensive for cities.

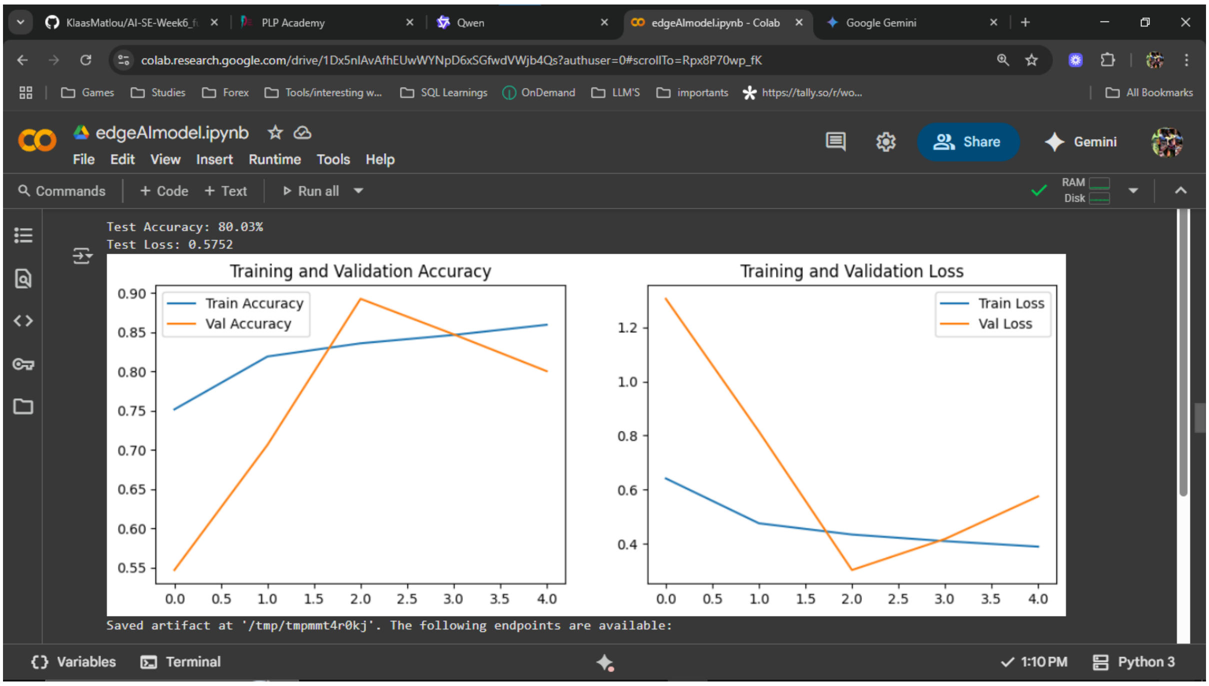
Part 2: Practical Implementation (50%)

Task 1: Edge AI Prototype

```
 Total params: 282,435 (1.08 MB)
 Trainable params: 282,115 (1.08 MB)
 Non-trainable params: 320 (1.25 KB)

Training the model...
Epoch 1/5
/usr/local/lib/python3.11/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning: Your `PyDataset` class should
  self._warn_if_super_not_called()
235/235 ━━━━━━━━━━━━━━━━━━━━ 56s 221ms/step - accuracy: 0.7002 - loss: 0.7891 - val_accuracy: 0.5467 - val_loss: 1.3059
Epoch 2/5
235/235 ━━━━━━━━━━━━━━━━━━━━ 55s 233ms/step - accuracy: 0.8155 - loss: 0.4865 - val_accuracy: 0.7063 - val_loss: 0.8152
Epoch 3/5
235/235 ━━━━━━━━━━━━━━━━━━━━ 51s 219ms/step - accuracy: 0.8388 - loss: 0.4358 - val_accuracy: 0.8927 - val_loss: 0.3028
Epoch 4/5
235/235 ━━━━━━━━━━━━━━━━━━━━ 56s 237ms/step - accuracy: 0.8457 - loss: 0.4126 - val_accuracy: 0.8473 - val_loss: 0.4178
Epoch 5/5
235/235 ━━━━━━━━━━━━━━━━━━━━ 50s 215ms/step - accuracy: 0.8573 - loss: 0.3901 - val_accuracy: 0.8003 - val_loss: 0.5752

Test Accuracy: 80.03%
```



Explanation of how Edge AI benefits real-time applications:

Edge AI benefits real-time applications by processing data directly on the device, which reduces delay and allows instant decision-making. It works without an internet connection, improves privacy by keeping data local, and uses less network bandwidth. This makes it ideal for applications like autonomous vehicles, smart cameras, and industrial sensors where speed, reliability, and security are important

Task 2: AIdriven IoT

1. Sensors needed

-Soil Moisture Sensors: To measure the volumetric water content in the soil

-Soil Temperature Sensors: To monitor soil temperature, impacting seed germination and root growth.

-Air Temperature and Humidity Sensors: To assess ambient environmental conditions affecting plant transpiration and disease susceptibility.

-Light Intensity Sensors (PAR/Lux): To measure Photosynthetically Active Radiation (PAR) or general light levels, vital for photosynthesis.

-pH Sensors: To monitor soil acidity/alkalinity, which significantly impacts nutrient availability.

-Nutrient Sensors (N, P, K): To measure the levels of essential macronutrients in the soil, guiding fertilization strategies.

-Rainfall Sensors: To record precipitation, aiding in water management and irrigation planning.

-Camera Sensors (RGB, Multispectral/Hyperspectral): For visual inspection of crop health, pest detection, and early disease identification through spectral analysis.

2. Proposed AI Model for Crop Yield Prediction:

A Recurrent Neural Network (RNN) with Long Short-Term Memory (LSTM) units is proposed for crop yield prediction. This model is particularly well-suited for time-series data, which is characteristic of agricultural sensor readings.

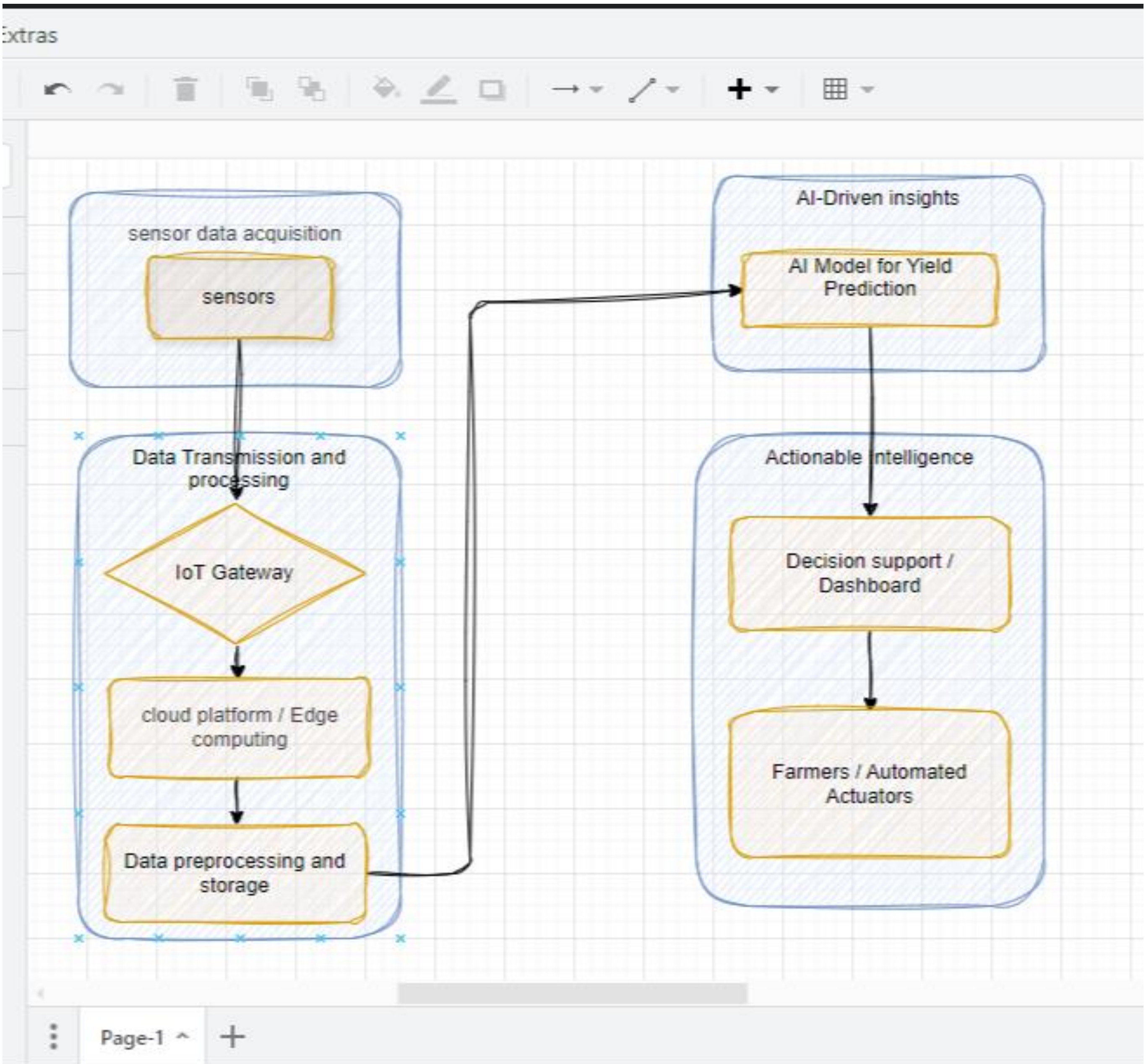
Why RNN-LSTM? Agricultural data is inherently sequential (daily temperature, moisture, nutrient levels change over time), and past conditions significantly influence future outcomes. LSTMs can effectively capture long-term dependencies in time-series data, allowing the model to learn complex relationships between historical environmental conditions, growth stages, and final crop yields.

Inputs: The model will take as input a time series of aggregated sensor data (daily/weekly averages or specific readings), historical weather data, historical yield data for the specific crop and region, and potentially satellite imagery data (NDVI, EVI).

Outputs: The primary output will be a predicted crop yield (e.g., tons per hectare) for a given future period (e.g., end of season, next harvest cycle).

Training: The model will be trained on a large dataset of historical sensor readings, environmental data, and corresponding actual crop yields.

3. Sketch a data flow diagram (AI processing sensor data)



Task 3: Ethics in Personalized Medicine

1. Identify potential biases in using AI to recommend treatments (e.g., underrepresentation of ethnic groups).
2. Suggest fairness strategies (e.g., diverse training data).

AI is increasingly used in personalized medicine to recommend cancer treatments based on genomic data, such as from The Cancer Genome Atlas (TCGA). However, these systems can unintentionally reinforce biases.

One major issue is data bias . Most genomic datasets are built from patients of European descent, leading to underrepresentation of other ethnic groups. This can result in less accurate treatment recommendations for minority populations, worsening health disparities.

Another concern is algorithmic bias . If an AI model is trained mostly on data from one group, it may not perform well for others. For example, genetic markers linked to drug response can vary across populations, and models that ignore this may give incorrect or harmful advice.

To promote fairness, several strategies can be used. First, include diverse populations in training data by expanding data collection globally and ensuring representation across age, gender, and ethnicity. Second, use bias detection tools to test models before deployment and identify performance gaps across groups. Third, apply fairness-aware machine learning techniques , such as reweighting data or using adversarial training, to reduce bias in predictions.

Transparency is also key. Researchers should clearly report the demographic makeup of training data and model performance across groups. Finally, involving ethicists and patient advocates in AI development helps ensure that ethical concerns are addressed early.

In conclusion, while AI has great potential to improve cancer care, it must be developed responsibly. By addressing data and algorithmic biases and promoting fairness, we can build more trustworthy and inclusive AI tools for personalized medicine.

Part 3: Futuristic Proposal

Prompt: Propose an **AI application for 2030** (e.g., AI-powered climate engineering, neural interface devices).

By 2030, we propose an AI-integrated neural interface device — a safe, wearable brain-computer interface that helps restore memory, improve focus, and support independent living for people with cognitive impairments.

This system uses non-invasive neural sensors and onboard AI to understand brain activity and provide real-time cognitive assistance.

AI Workflow

Data Inputs:

Brainwave data (EEG or similar)

Voice commands

Movement tracking

Daily routines and behavior patterns

AI Model:

Transformer-based neural networks

Personalized deep learning models trained on user data

Natural Language Processing (NLP) for voice interaction

Output:

Memory recall prompts (e.g., “Your keys are in the kitchen drawer”)

Real-time reminders and task guidance

Emergency alerts if confusion or falls are detected

Societal Risks and Benefits

Benefits:

Helps elderly and cognitively impaired live more independently

Reduces caregiver burden

Improves quality of life and dignity for millions

Risks:

Privacy concerns with brain data

Possible over-reliance on technology

High cost could limit access for some groups

Conclusion

This AI-powered neural interface has the potential to transform how we age and manage cognitive health. With ethical design, fair access, and strong privacy protections, it can be a powerful tool for improving human well-being in the future.