Human Activity Recognition Using Multiple Learning & XAI Techniques From Wearable Sensor Data

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Abstract

We emphasize the critical need for elder patient monitoring, considering the global shortage of nurses. Implementing HAR systems holds the potential to significantly improve elder patient care, addressing this pressing issue.

Our study focuses on Human Activity Recognition (HAR) using accelerometer and gyroscope data. We explore various techniques including machine learning, deep learning, Federated Learning, and Explainable AI, achieving high accuracies of 85% for Random Forest and 82% for our top-performing deep learning model ANN. By employing SHAP values and LIME, we interpret model decisions effectively.

Furthermore, our exploration of Federated Learning, with a 72% accuracy for the global model, underscores the collaborative approach's efficacy in enhancing elder patient care.

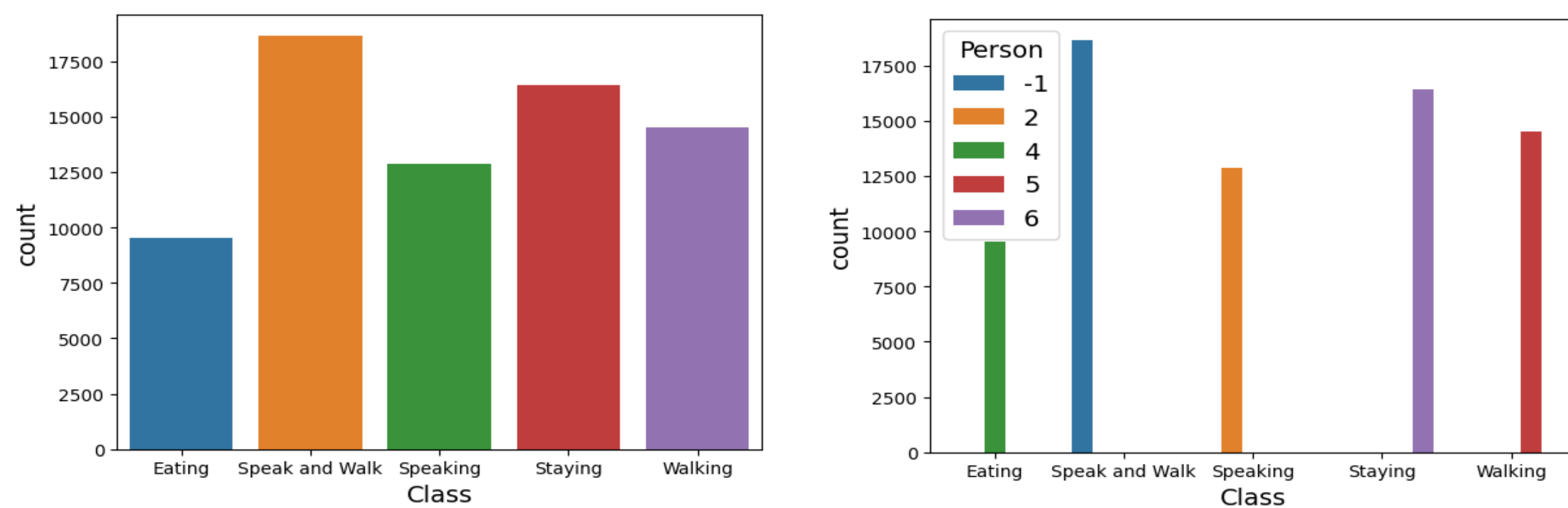Accelerometer   Gyroscope
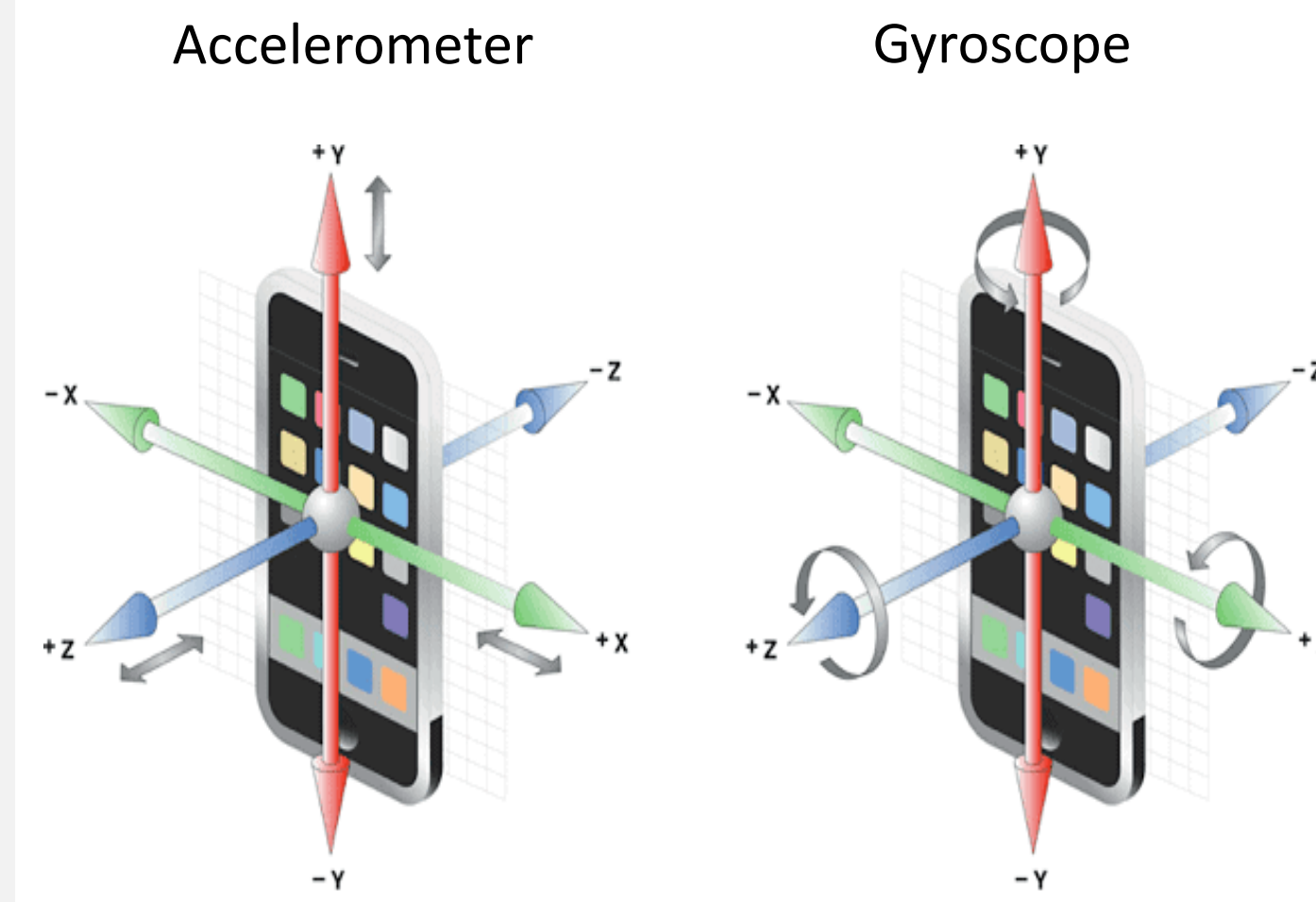
- We have applied **10 Machine Learning** model and **3 Deep Learning** Models where Random Forest gives the highest accuracy of **85%**.

- We have analyzed **14 Statistical Features Extraction**.

- We have implemented Explainable AI techniques (**SHAP** and **LIME**) in this research work.

- Lastly, we implemented **Federated Learning** technique in our project with 3 clients, where we achieved **72%** accuracy on Global Model.

- We have developed a Mobile App called "**SMH Activity Tracking App**" which will collect sensor data and predict the activity.

- **Federated Learning** yielded a combined Global Model with **72%** accuracy with 3 clients, showcasing effective collaborative learning.
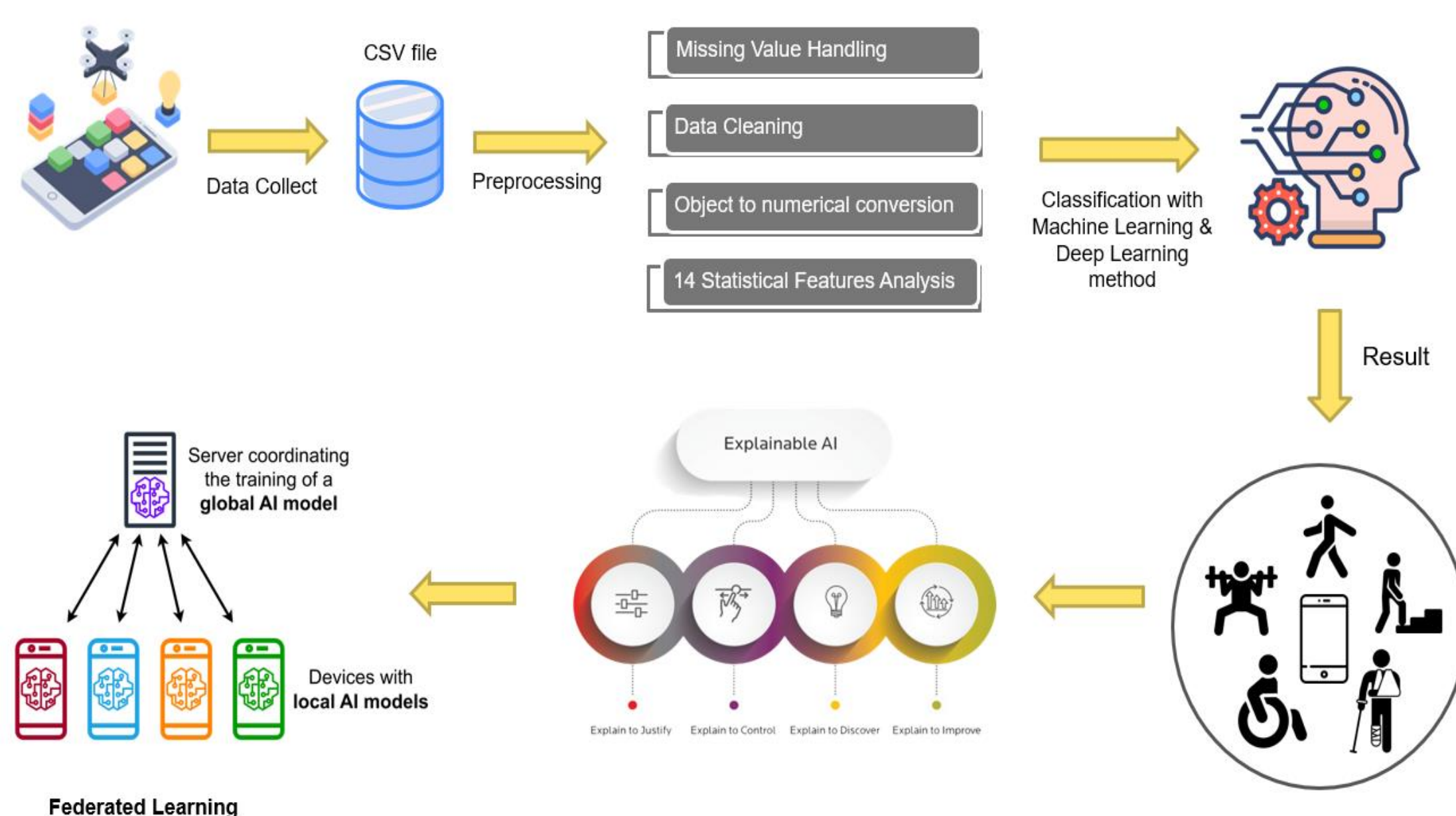

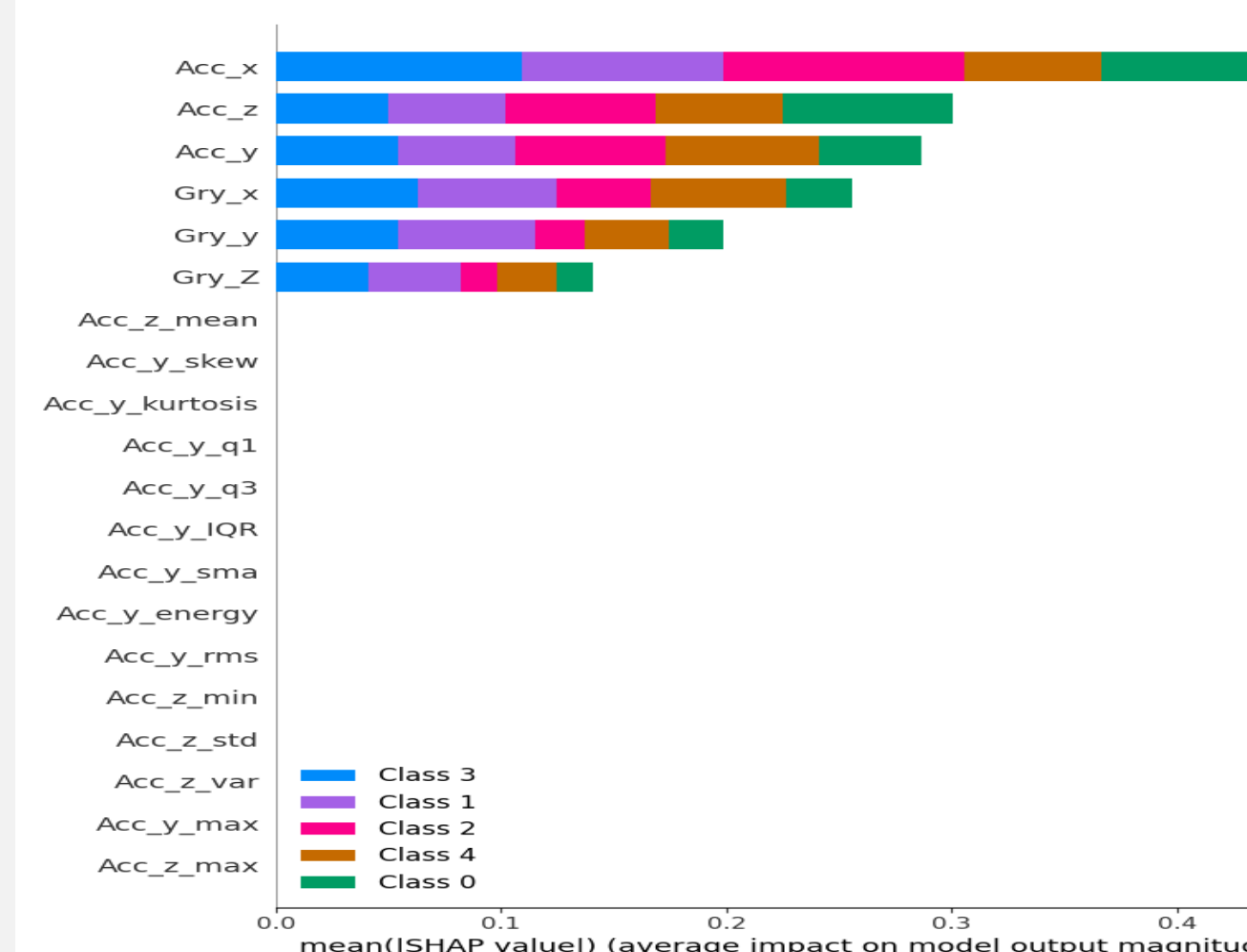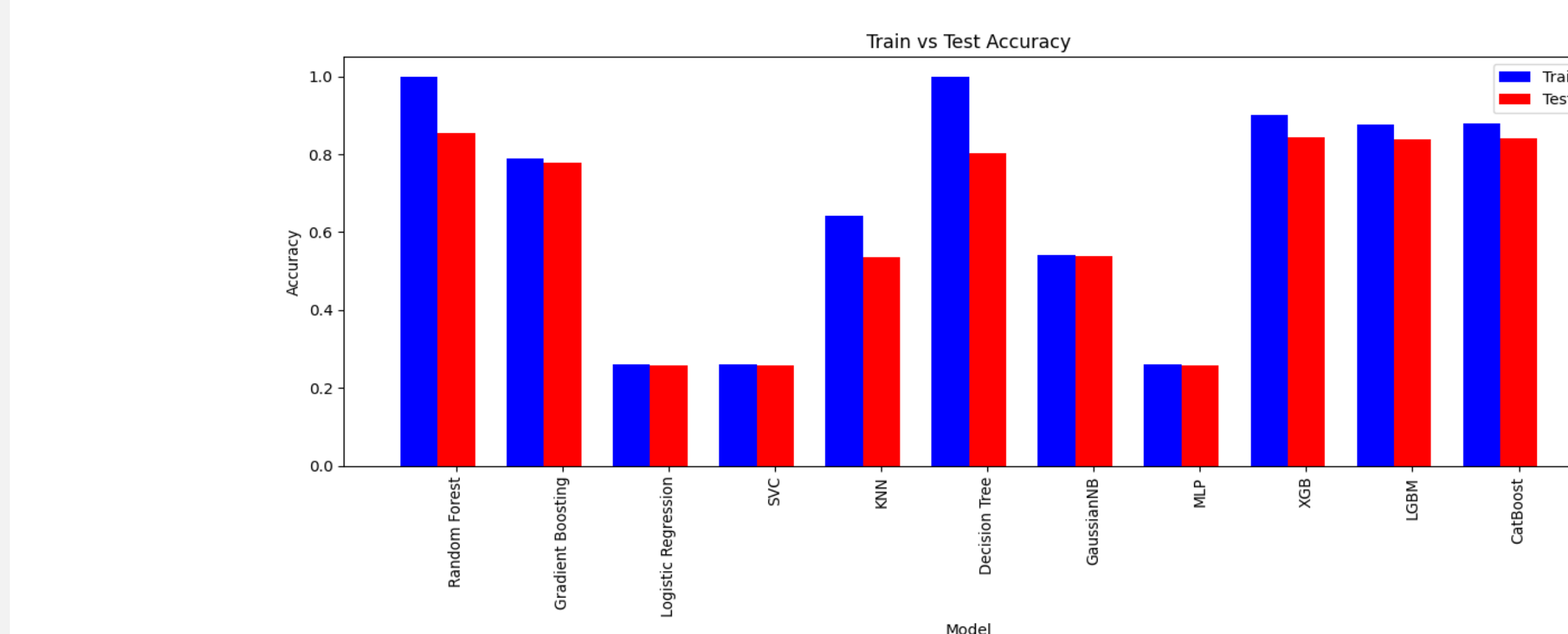## Proposed Mobile App
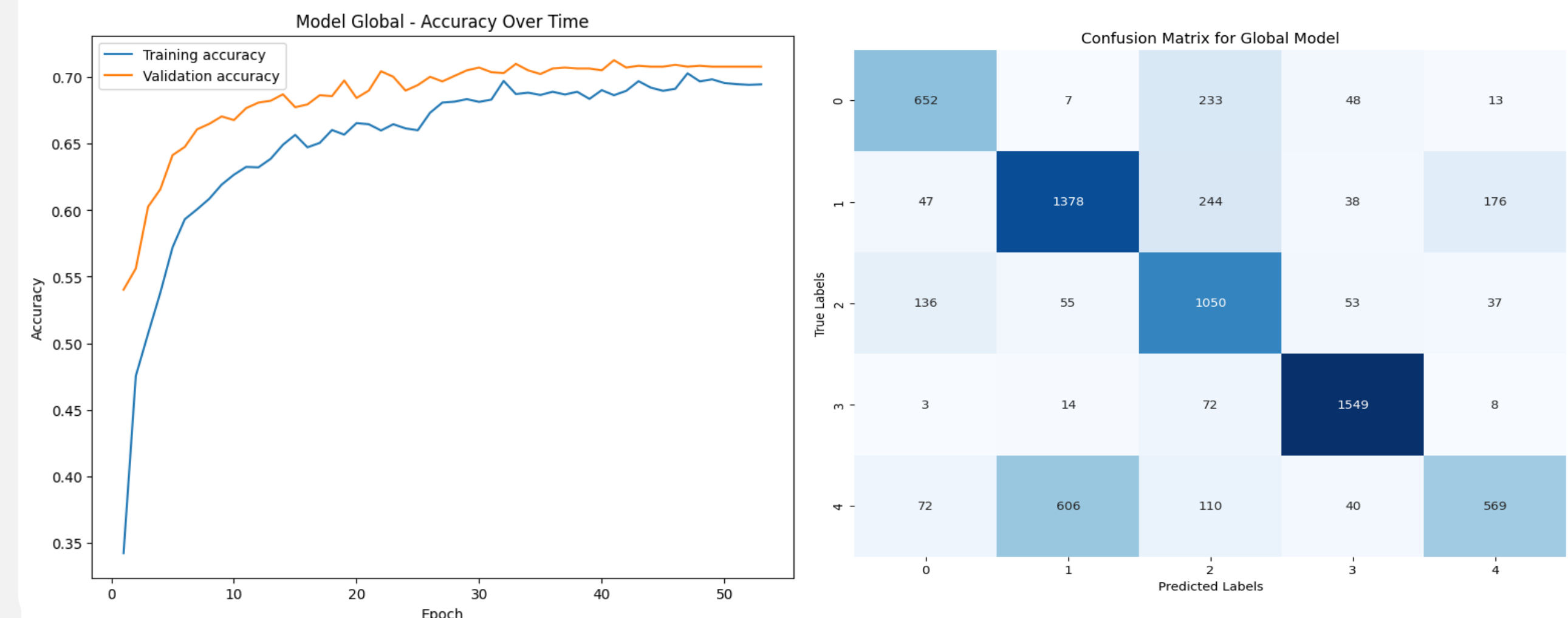
Dataset & Features

- Our dataset comprises **72,000** entries, collected from **Japan**.
- It captures 3D Accelerometer and Gyroscope data from 6 individuals performing activities like walking, speaking, and eating.
- Key features include Time, Acceleration (Acc_x, Acc_y, Acc_z), Gyroscope (Gry_x, Gry_y, Gry_Z), Person, and Activity Class.
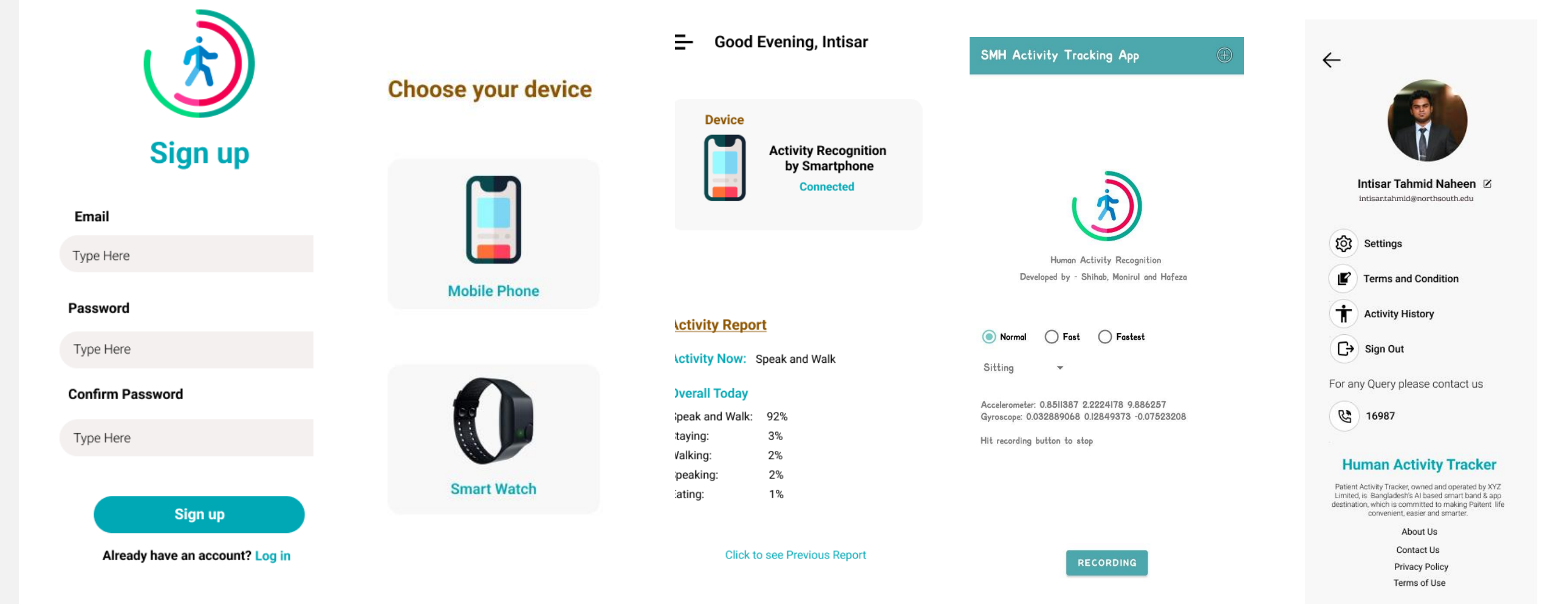
Result Analysis

- **Random Forest** achieved **85%** accuracy, making it the top-performing machine learning model. Artificial Neural Network (ANN) Attained 82% Accuracy, establishing it as the best performing deep learning model.

- XAI **SHAP** Technique identified **ACC_X** as the most important feature in the random forest, reinforcing its significance in model interpretability for machine learning.

Methodology
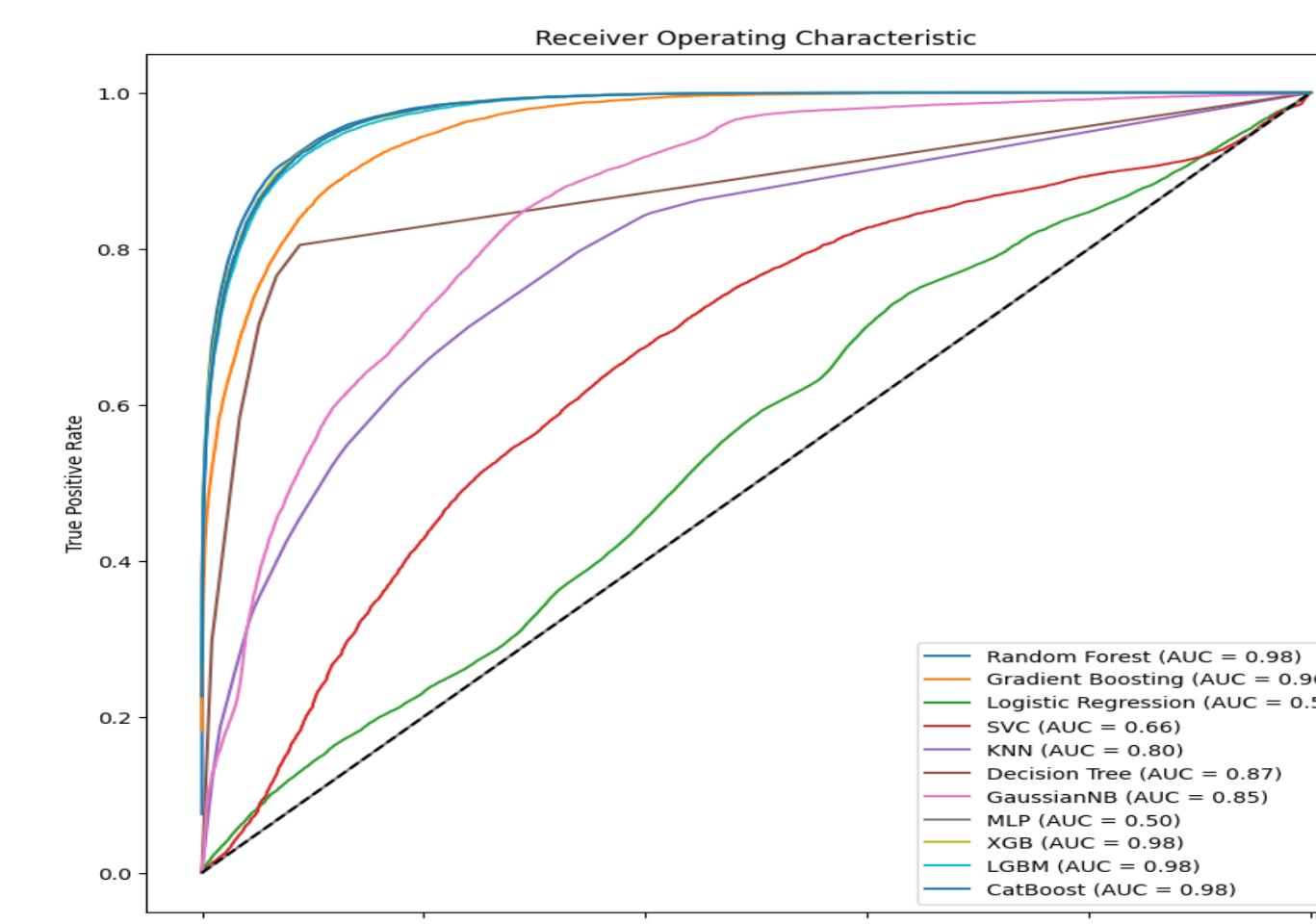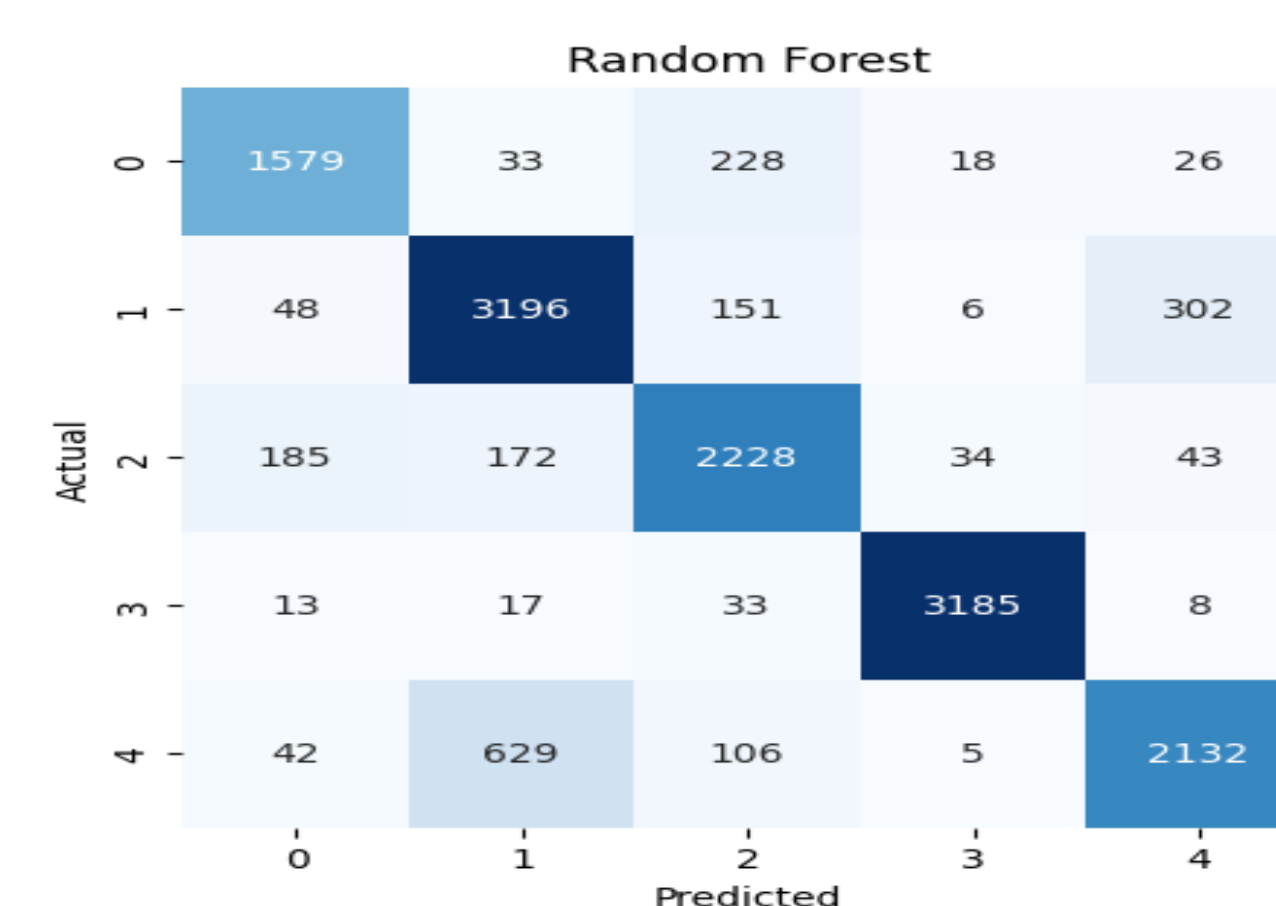
Conclusion & Future Work

Conclusion:

- Explored various machine learning and deep learning models for human activity recognition, with Random Forest and Artificial Neural Network (ANN) models demonstrating superior performance.

- Showcased the transformative potential of Explainable AI and Federated Learning in enhancing elder patient monitoring, providing a pivotal contribution to the study's outcomes.

Future Work:

- Aim to refine underperforming models such as AdaBoost and Long Short-Term Memory (LSTM) for improved accuracy.

- Increase the Federated Learning accuracy.

- Improve user interface of our app.