

REAL-TIME DRIVER DROWSINESS DETECTION USING MACHINE LEARNING AND DEEP LEARNING TECHNIQUES

Presented by: Lee Jia Sheng
12 April 2025



MEET

JIA SHENG

- MEng Civil Engineering
- Geotechnical Engineer
- Certificate in Data Science & AI
- Aspired data scientist



AGENDA

1. INTRODUCTION

- Project context
- Business objectives
- Modelling objective

2. DATA TRANSFORMATION

- Data overview
- Data pre-processing
- Features extraction
- Image sequences preparation

3. EXPLORATORY DATA ANALYSIS (EDA)

- Key insights
- Feature selection

4. MACHINE LEARNING PROCESS

- Model pipeline
- Model selection
- Evaluation metrics selection

5. MODEL EVALUATION

- Classification models
- CNN + LSTM model

6. MODEL DEPLOYMENT & FUTURE WORKS

- Trial model deployment
- Moving forward

INTRODUCTION

- Driver drowsiness is a **major road safety risk**, linked to many accidents and fatalities worldwide.
 - In Malaysia, 54% of drivers reported **accidents**, and 61% reported **near misses** due to drowsiness.
 - **Microsleep episodes**, lasting just seconds, can lead to catastrophic accidents—especially at high speeds.
 - Existing systems **monitor steering or basic facial cues** to detect fatigue.
 - **Miss subtle signs, struggle in real-time**, and may generate **false positives** under varied conditions.
 - Mostly integrated into **private cars**, but not widely adopted in **commercial buses** or **freight vehicles**, where the risk is often higher.



TOPICS: Flood Alert | Connecting Communities | StarExtra | Home | Business | Sports | Travel | Malaysia | Sarawak | Do You Know | Hi

Lorry driver lapsed into micro-sleep, say cops on fatal NSE crash

By MOHD FARHAAN SHAH

NATION

Wednesday, 20 Nov 2024
11:25 PM MYT

Related News



WORLD 03 Apr 2025
Hungary welcomes Netanyahu and announces it's...

NATION 7h ago
Federal Court dismisses former activist appeal for...

NATION 2h ago
Zayn Rayyan neglect trial: Two individuals exchanged messages...

MUAR: A lorry driver lapsed into micro-sleep behind the wheel of the vehicle he was driving, leading to the accident on the North-South Expressway that killed a toddler and injured seven others.

Micro-sleep refers to very short periods of sleep lasting seconds as opposed to minutes or hours.

Muar OCPD Asst Comm Raiz Mukhliz Azman Aziz said police were notified about the incident at around 3.44pm.

BUSINESS OBJECTIVES

STAKEHOLDER:

LOCAL BUS COMPANIES



ENHANCE PASSENGER SAFETY

Improve transport company reputation and operational reliability



REDUCE ACCIDENT-RELATED COSTS

Estimated savings: preventing 5 drowsiness-related accidents per year can save up to RM 500,000 annually.



SUPPORT REGULATORY COMPLIANCE AND PROMOTE PUBLIC TRUST

MODELLING OBJECTIVE

GOAL:



**TO DEVELOP AND IMPLEMENT A ROBUST, REAL-TIME
DRIVER DROWSINESS DETECTION MODEL THAT
LEVERAGES VISUAL DATA TO ACCURATELY CLASSIFY
DRIVER DROWSINESS AND TRIGGER TIMELY ALERTS.**

DATA QUESTION:

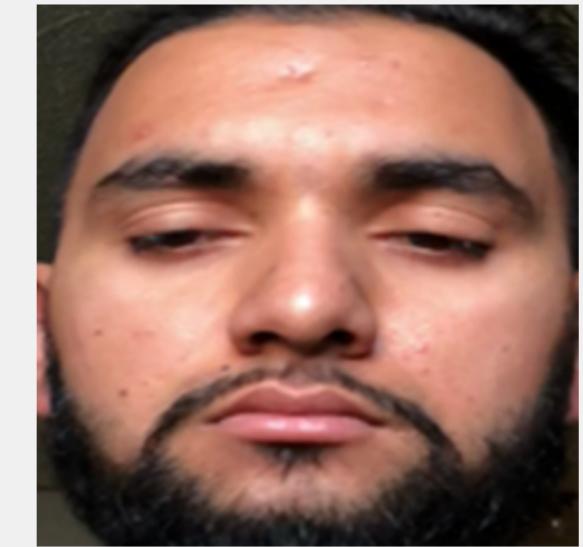


How can visual data (e.g. facial features, eye movements, head position) be used to accurately detect signs of driver drowsiness in real time and distinguish between alert and drowsy states with high accuracy and reliability?

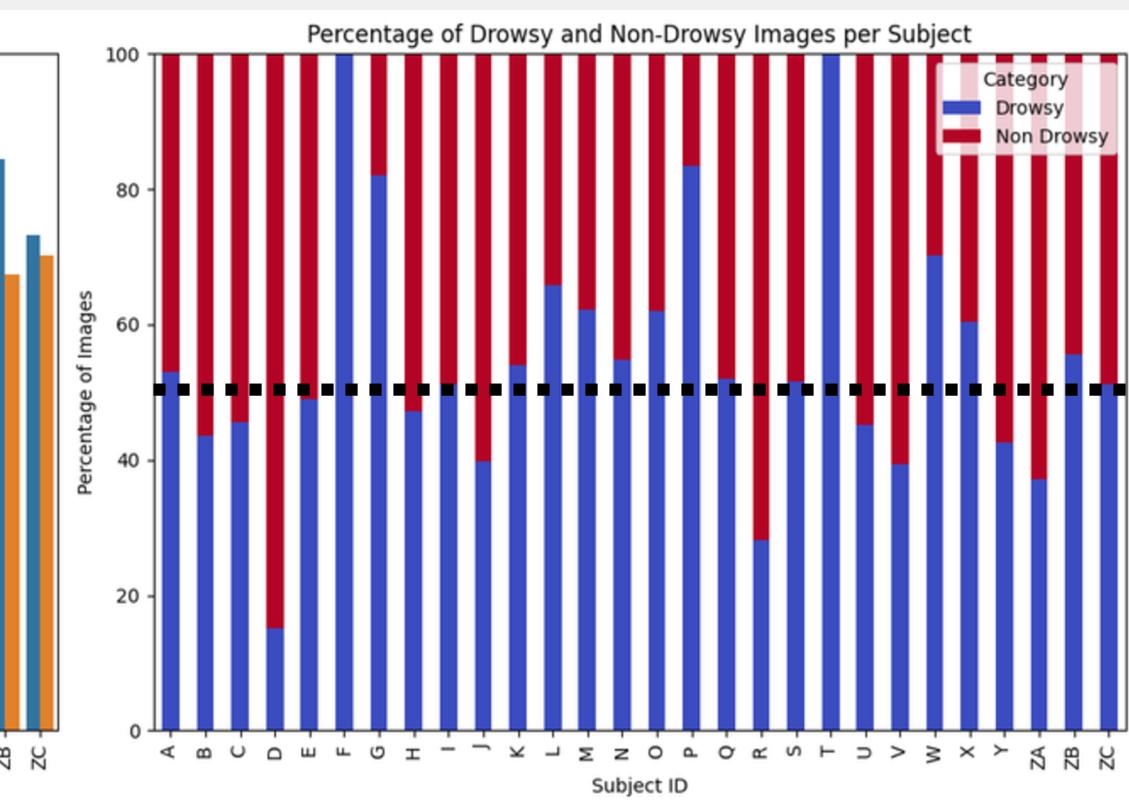
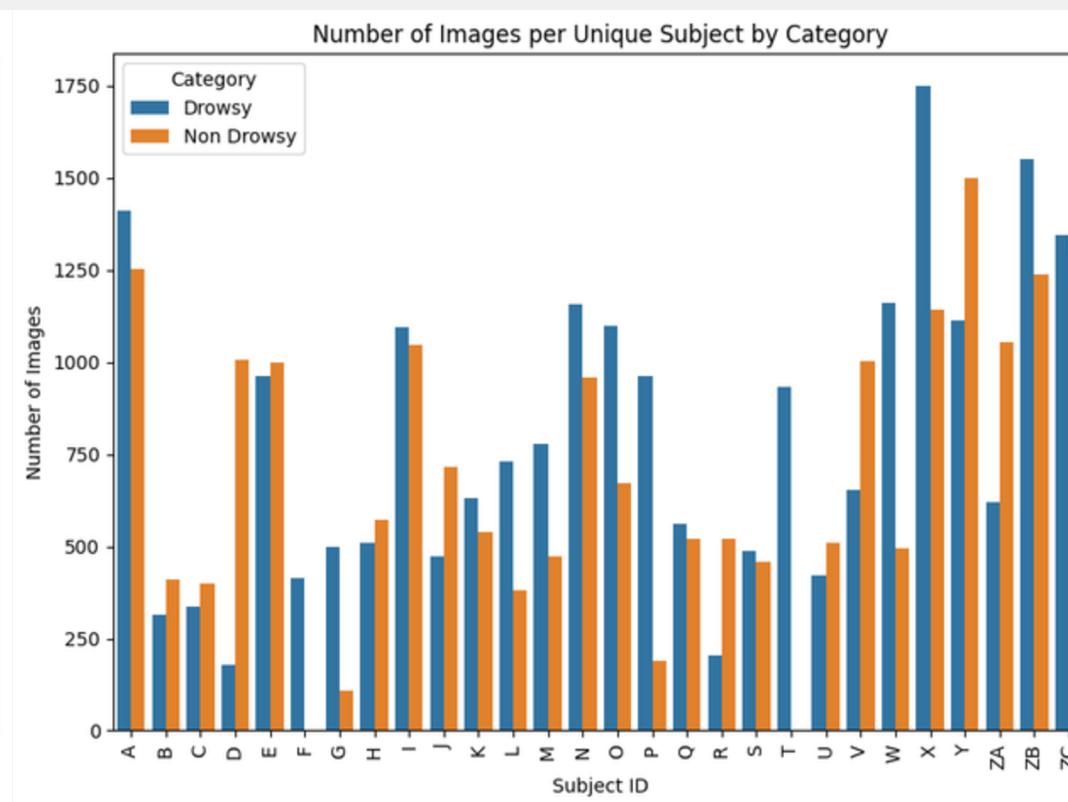
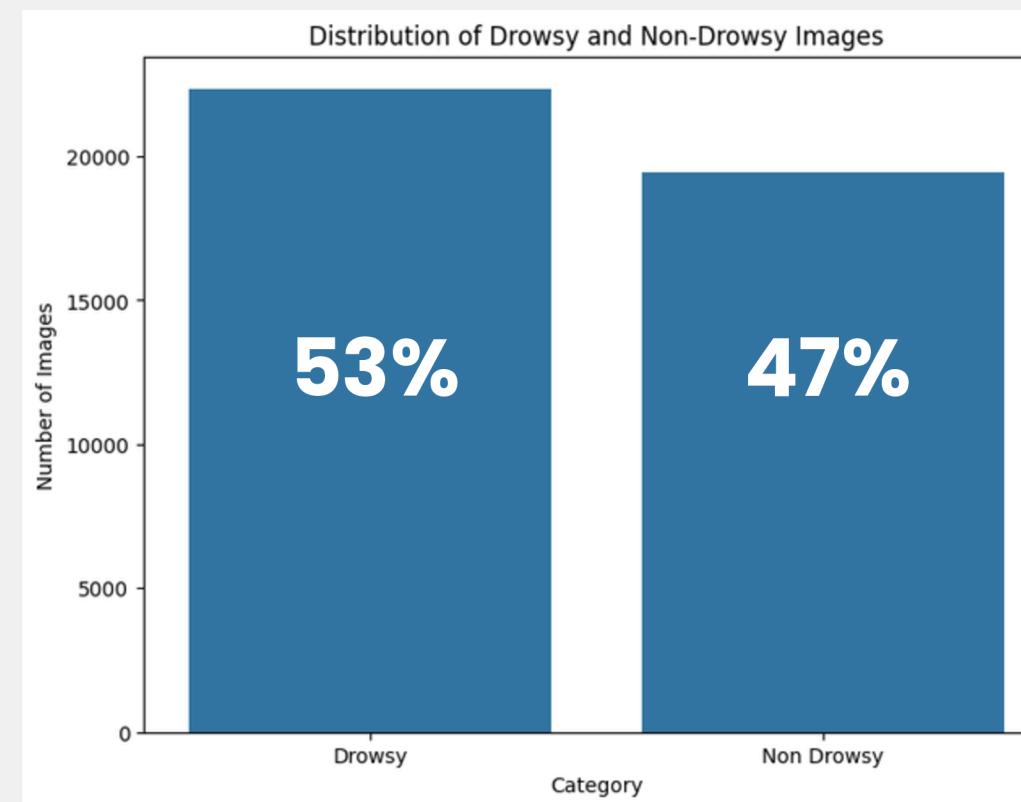
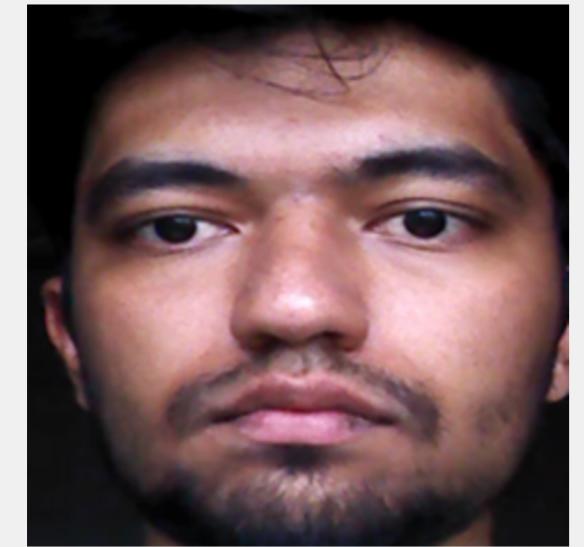
DATA OVERVIEW

- **Source: Driver Drowsiness Dataset (DDD) from Kaggle**
- Derived from the **UTA Real-Life Drowsiness Dataset**
- **41,793** extracted and cropped facial images of drivers
- Images are grouped as '**Drowsy**' or '**Non-Drowsy**'

Drowsy



Non-Drowsy

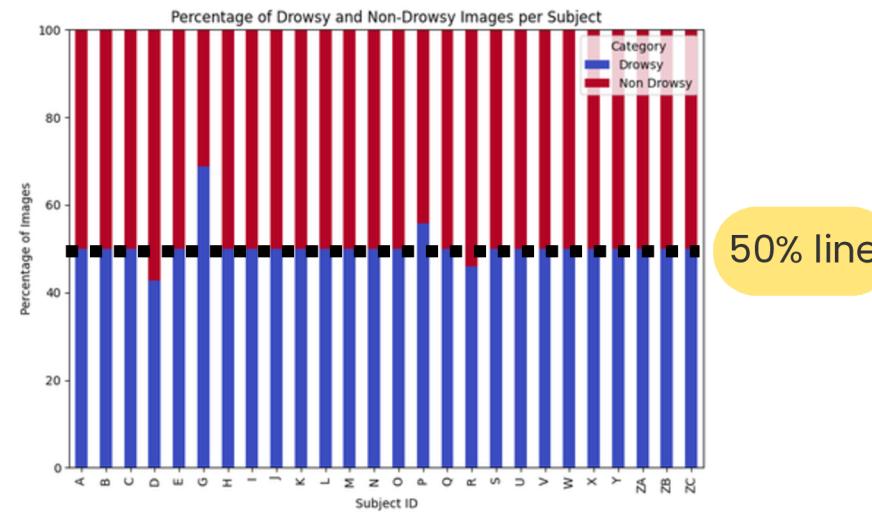
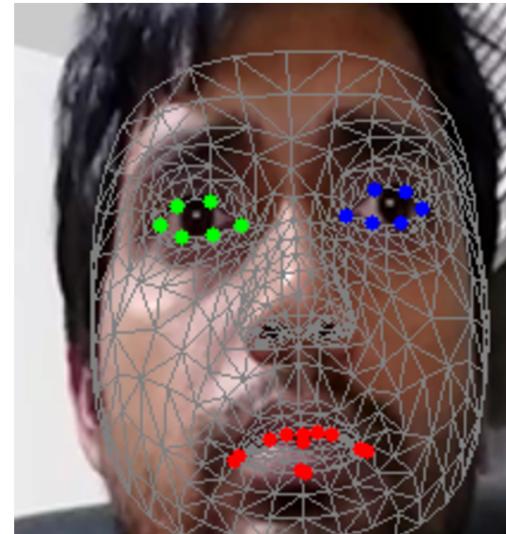
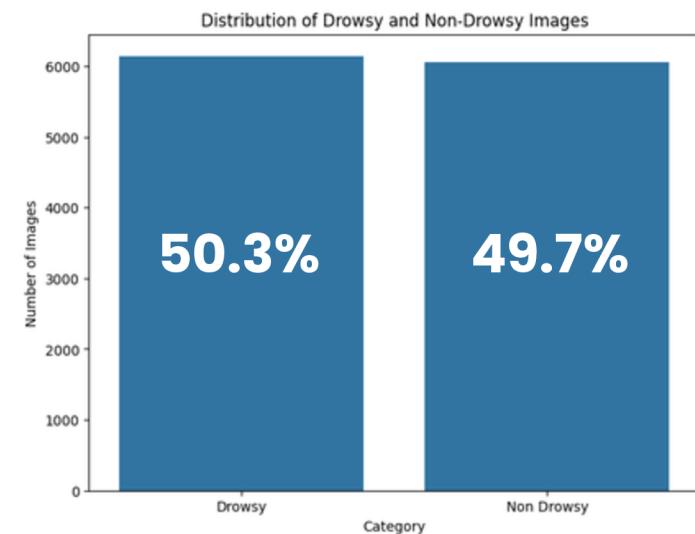
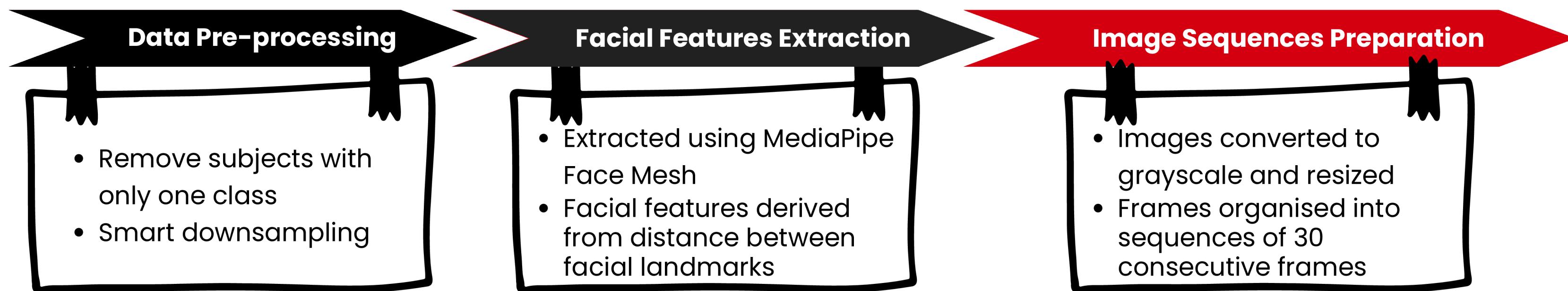


7

Data source:

[1] Nasri, I. et al. (2021) 'Detection and prediction of driver drowsiness for the prevention of road accidents using deep neural networks techniques,' in Lecture notes in electrical engineering, pp. 57–64. https://doi.org/10.1007/978-981-33-6893-4_6.

DATA TRANSFORMATION



Eye Aspect Ratio (EAR)

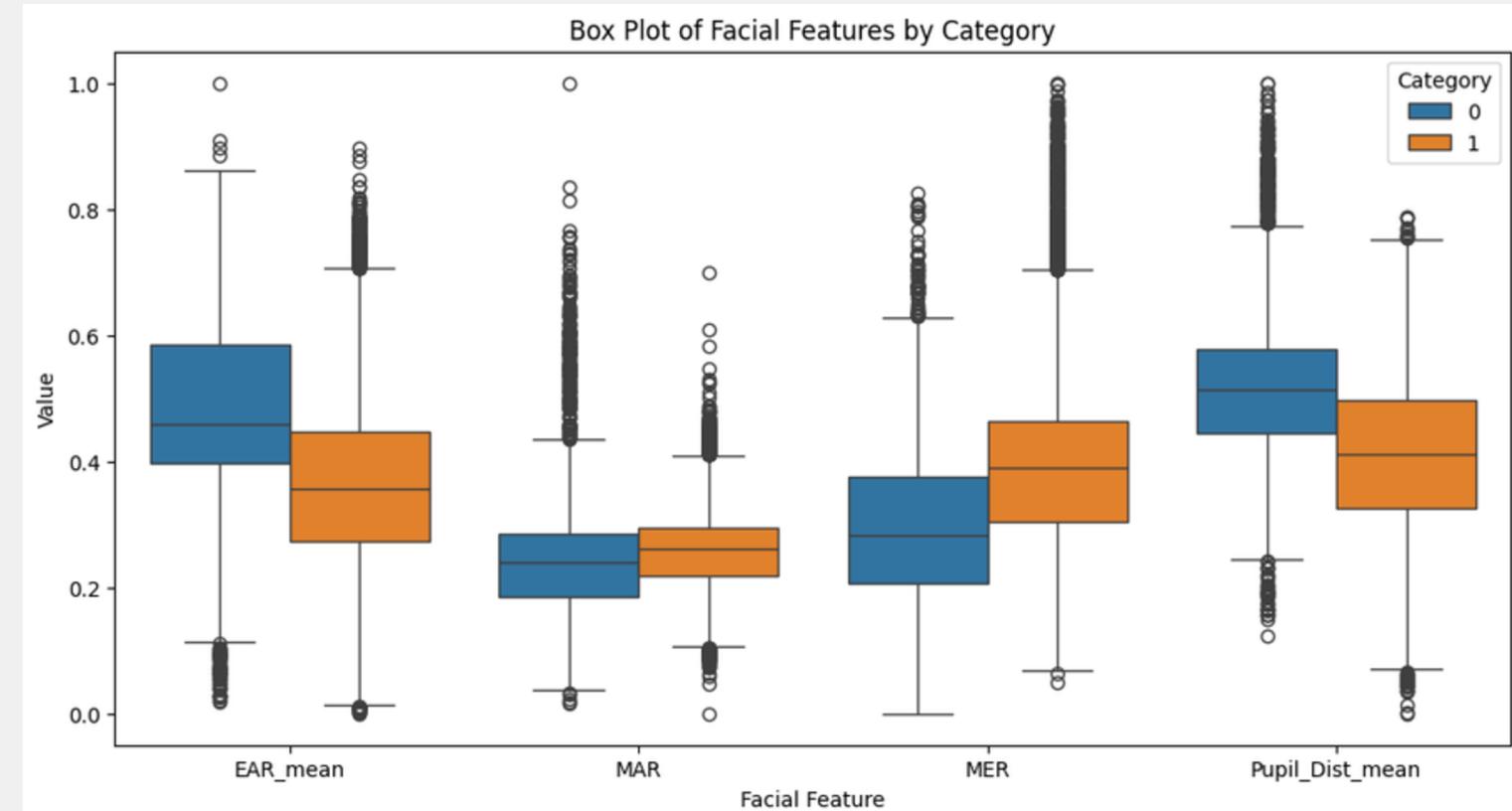
Mouth-Eye Ratio (MER)

Mouth Aspect Ratio (MAR)

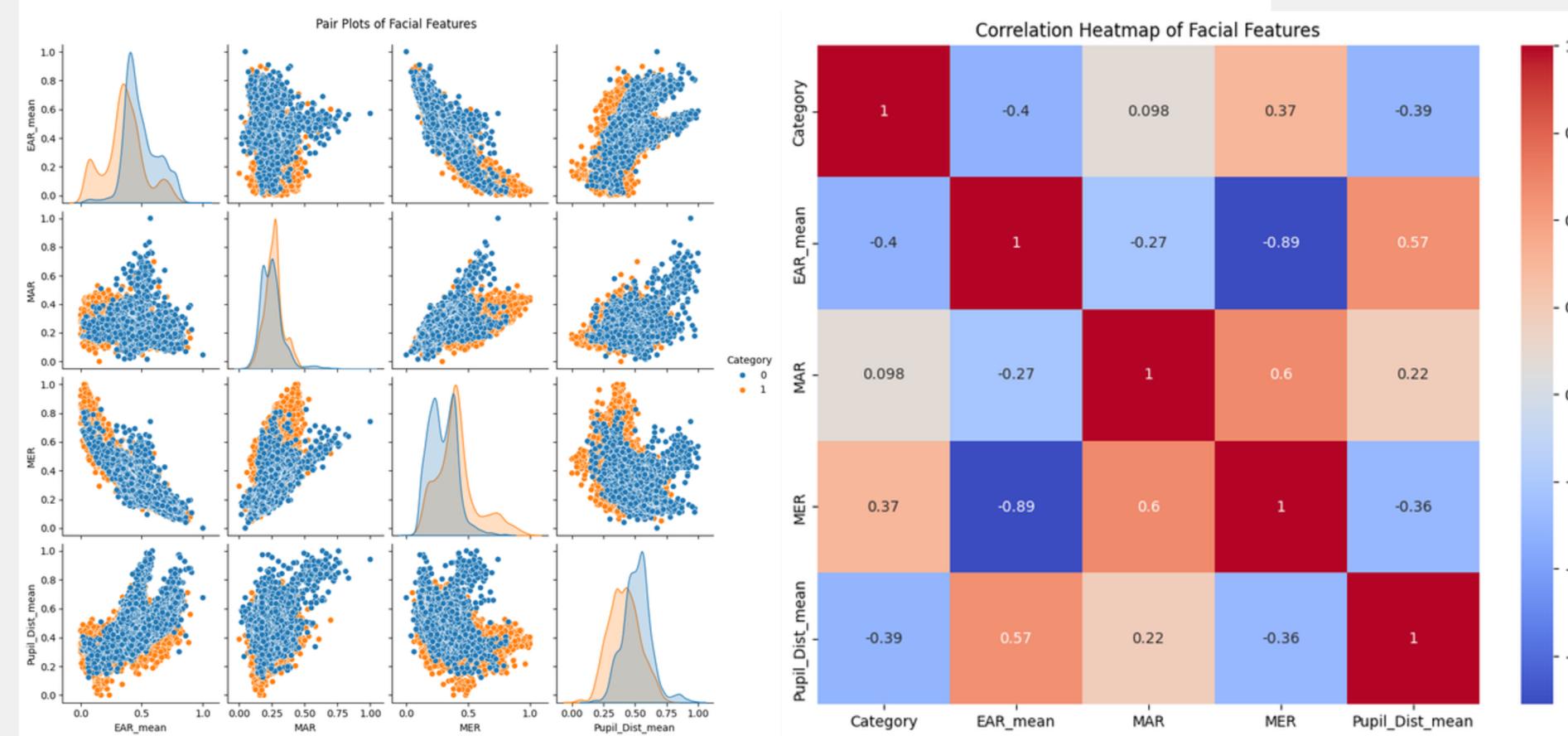
Pupil-to-Eye Center Distance (PECD)



KEY INSIGHTS FROM EDA



- **EAR:** Strong indicator of eye closure in drowsy states.
- **MAR:** Mouth opening is more frequent in drowsy individuals.
- **MER:** Increased mouth opening relative to eye openness during drowsiness.
- **PECD:** Unfocused gaze in drowsy individuals.
- **Strong negative correlation between EAR & MER:** As eyes close, yawning tends to increase.
- **Moderate negative correlation between EAR & PECD with drowsiness:** Strong indicators for drowsiness detection.



FEATURE SELECTION:

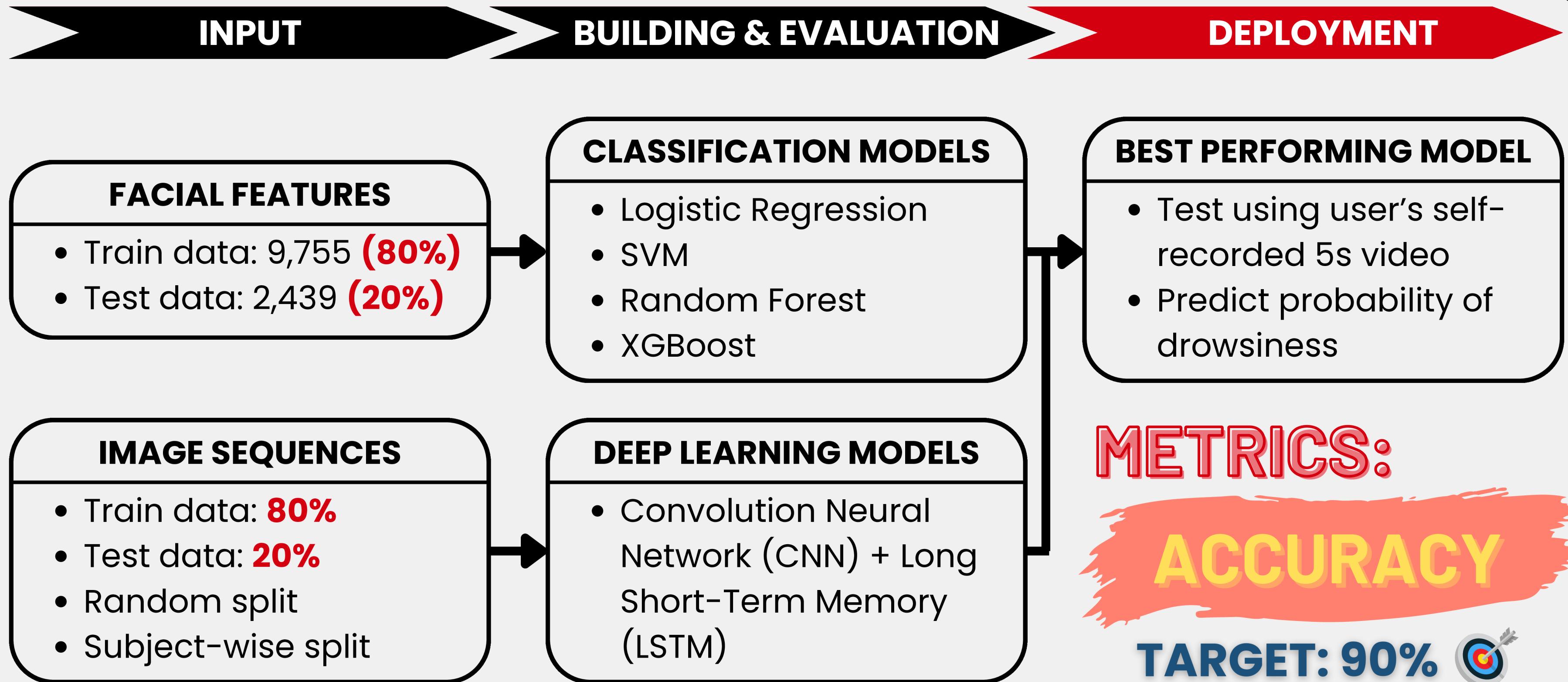
EAR ✓

MAR ✓

MER ✓

PECD ✓

MACHINE LEARNING PROCESS



EVALUATION - CLASSIFICATION MODELS

BASELINE ACCURACY

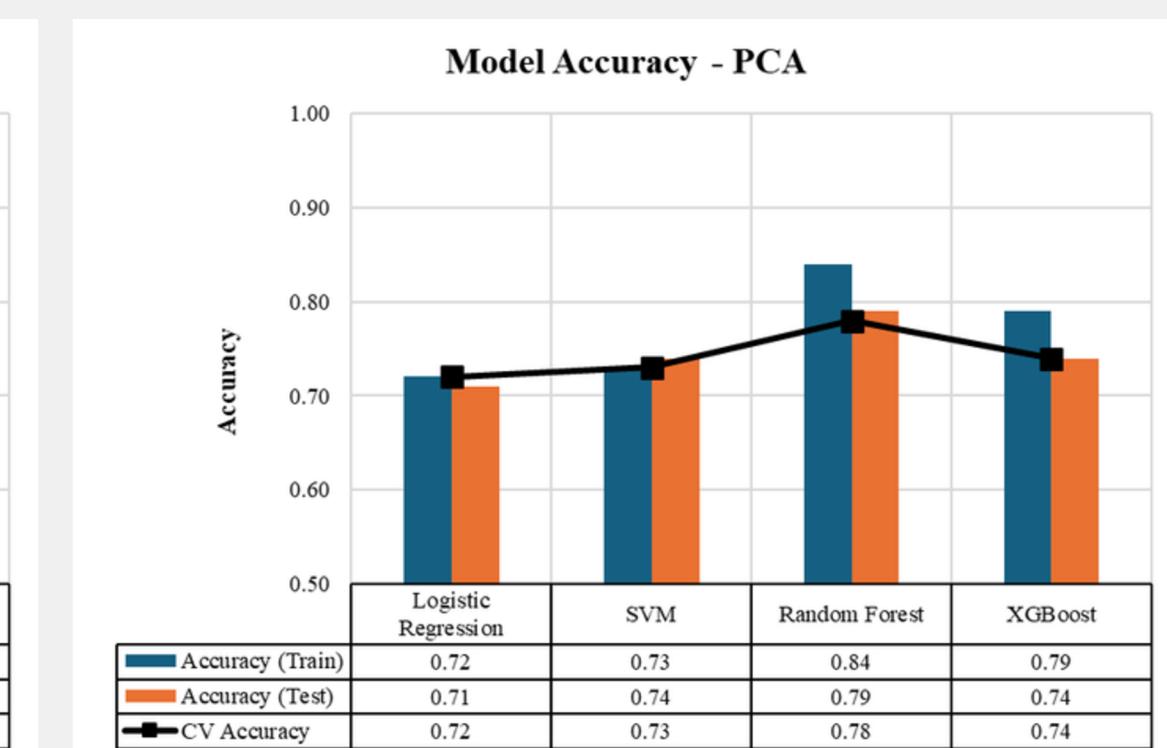
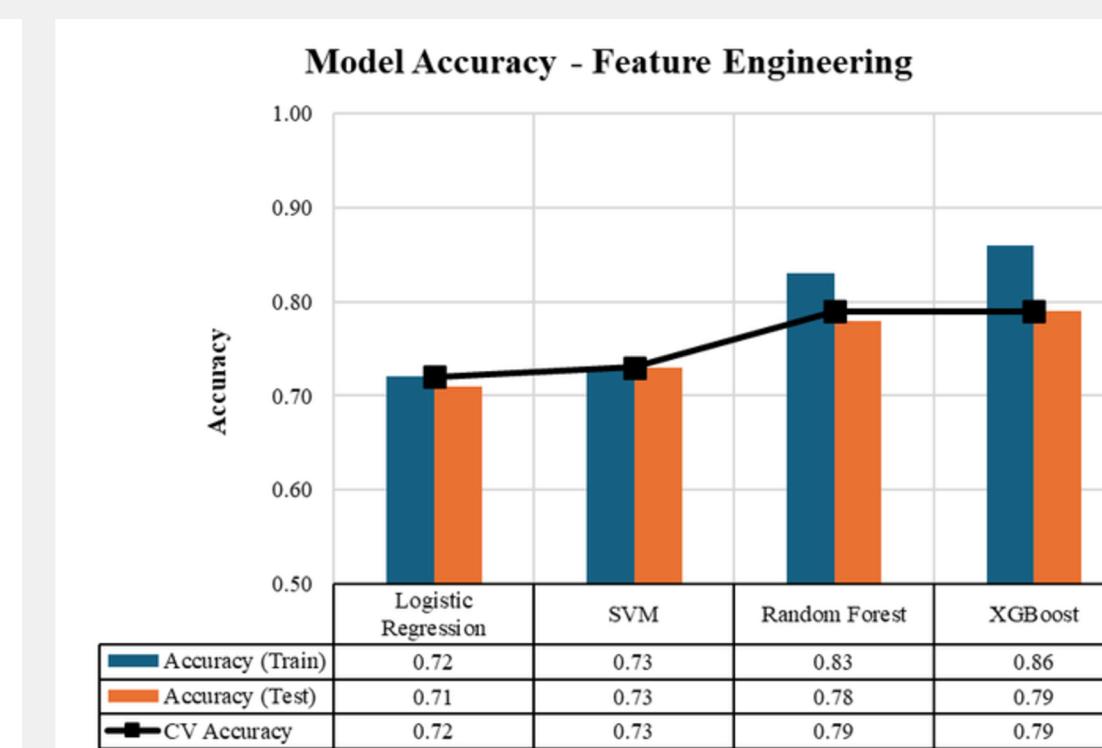
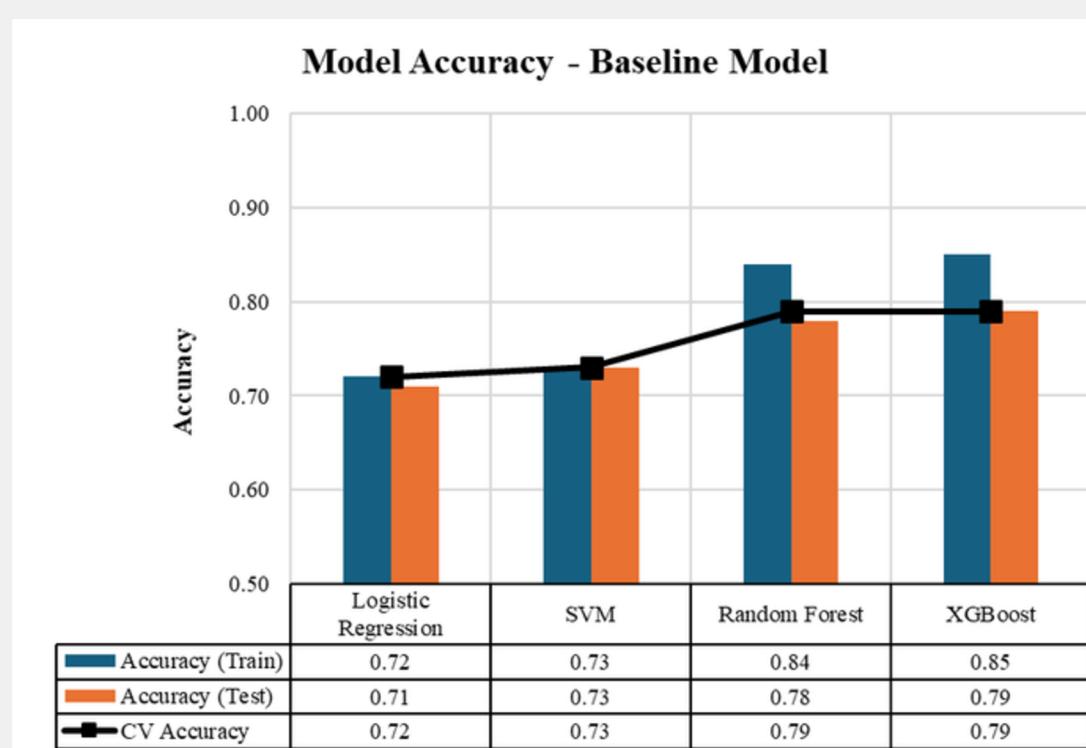
FEATURE ENGINEERING

PCA

- **LR & SVM:** limited model complexity but stable generalisation
- **RF & XGB:** slight overfitting between training and testing sets but still generalises well
- **Accuracy < 90%**

- 3 additional engineered features based on existing research:
Mouth Openness, Mouth-Eye Interaction, Mouth Difference*
- **Marginal improvement** in model accuracy
- **Accuracy < 90%**

- PCA applied to engineered feature set
- 4 components for **LR, SVM & RF**, 2 components for **XGB**
- Slightly improved generalisation but **limited gains in accuracy**
- **Accuracy < 90%**



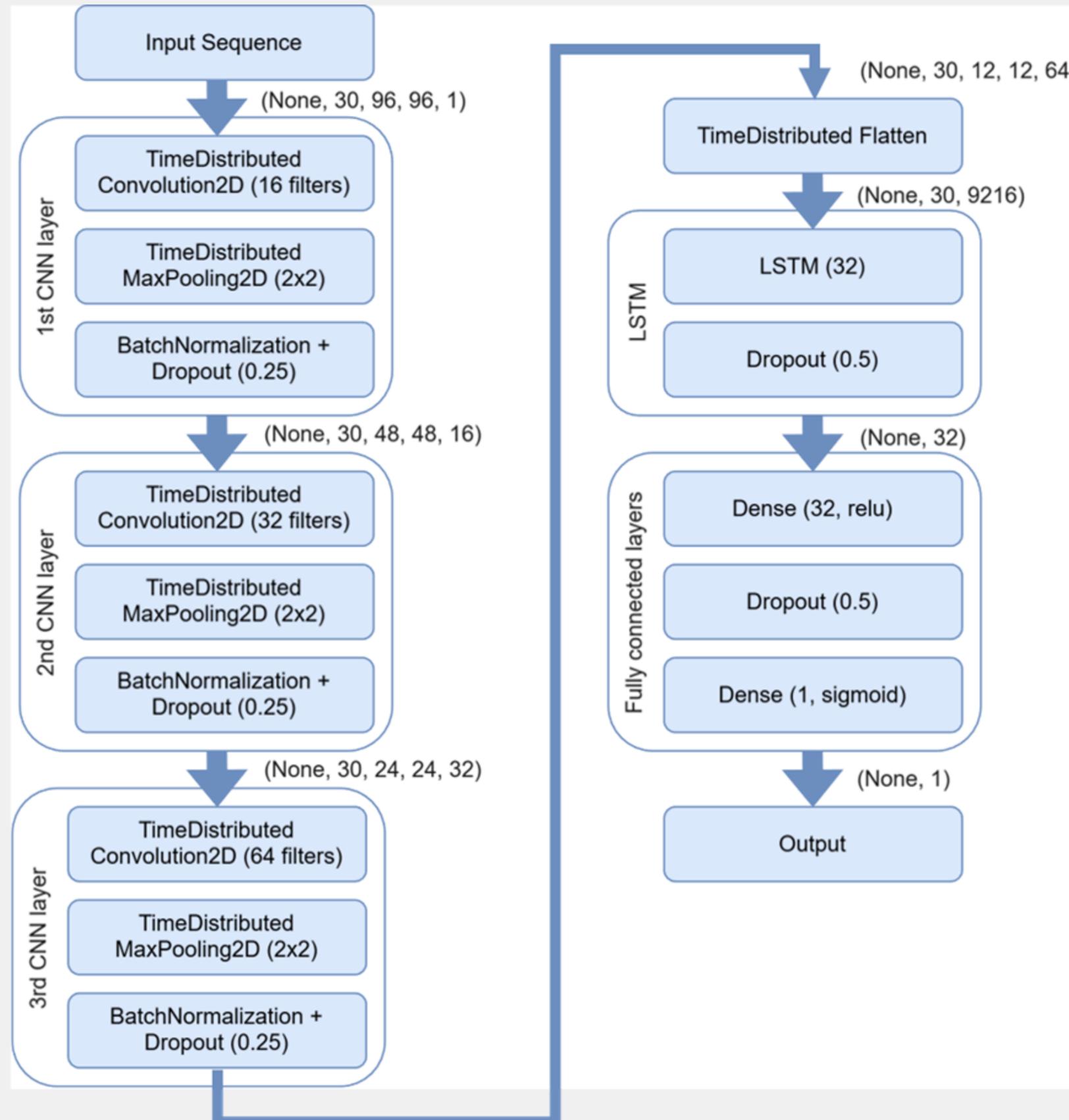
***Note:**

Mouth Openness = MAR + MER

Mouth-Eye Interaction = MAR x EAR

Mouth Difference = | MAR - MER |

CNN + LSTM MODEL



Input: 30 grayscale frames of size 96x96

Feature Extraction (CNN):

- 3x TimeDistributed Conv2D layers
- Each followed by MaxPooling2D, BatchNormalization & Dropout
- L2 regularization applied to reduce overfitting

Temporal Modelling (LSTM):

- 1 LSTM layer to capture sequential dynamics

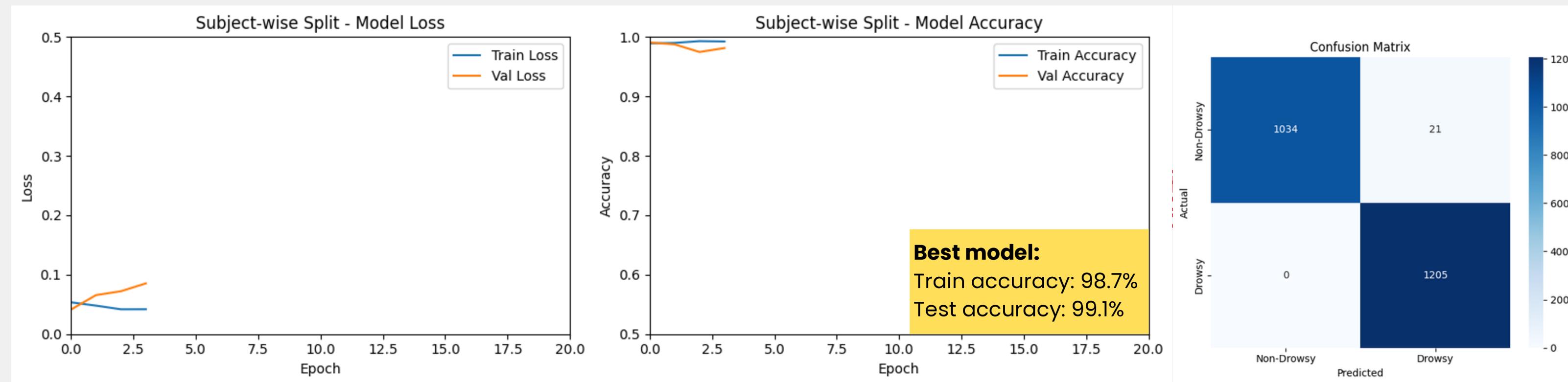
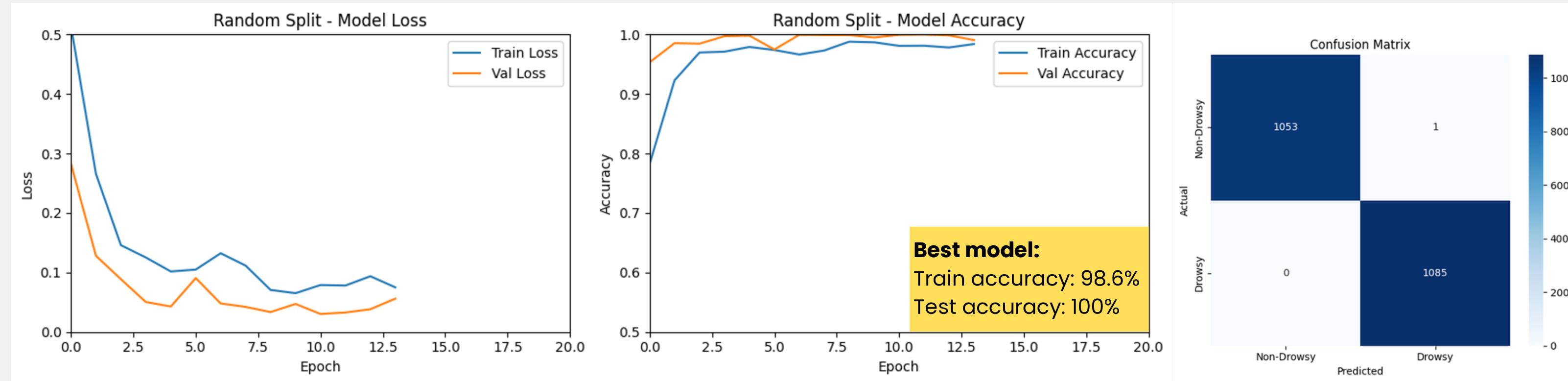
Classification:

- Dense layer followed by sigmoid activation for binary classification (alert vs drowsy)

Training:

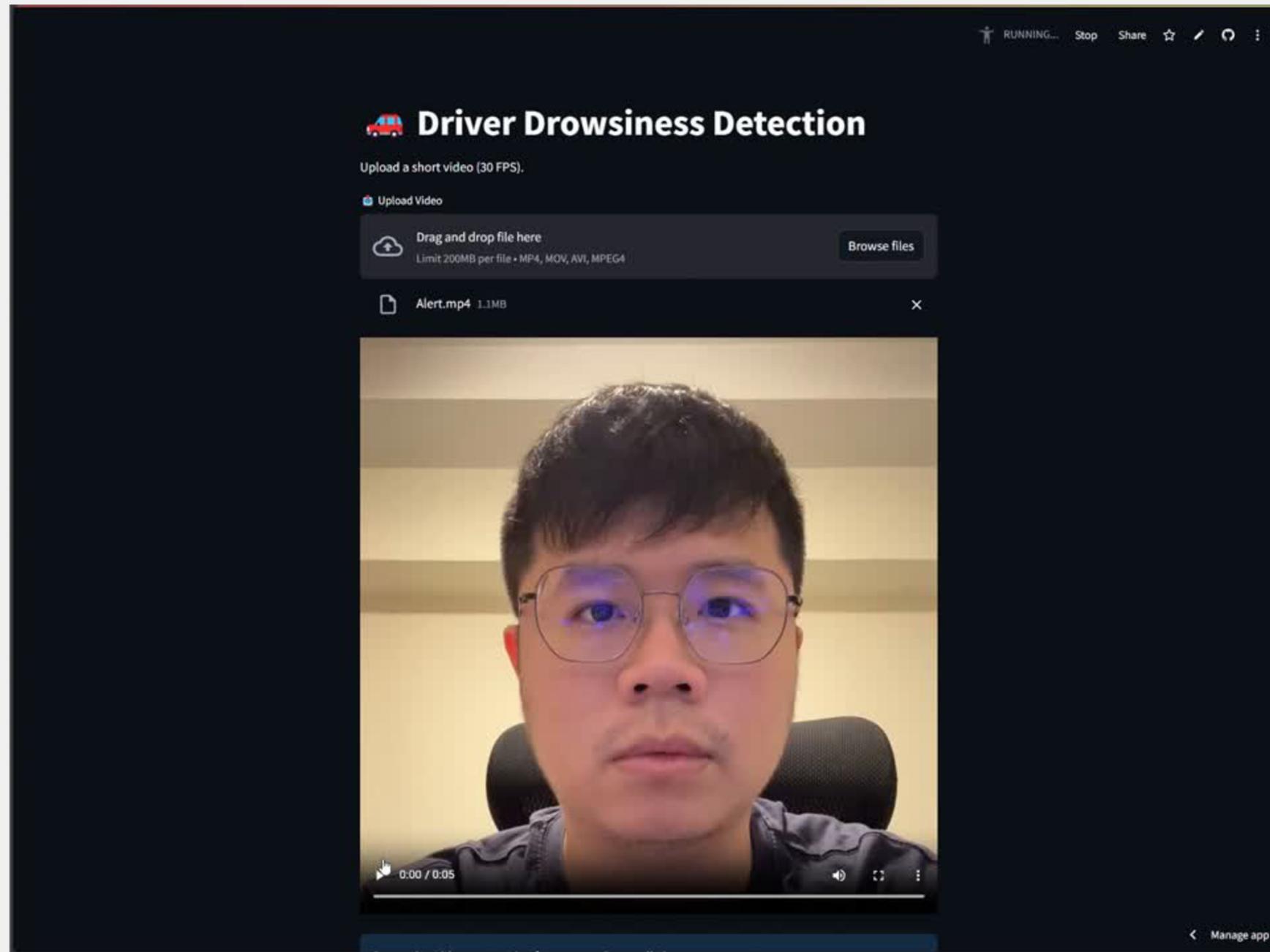
- Adam optimiser
- Binary cross-entropy loss

EVALUATION - CNN + LSTM MODEL

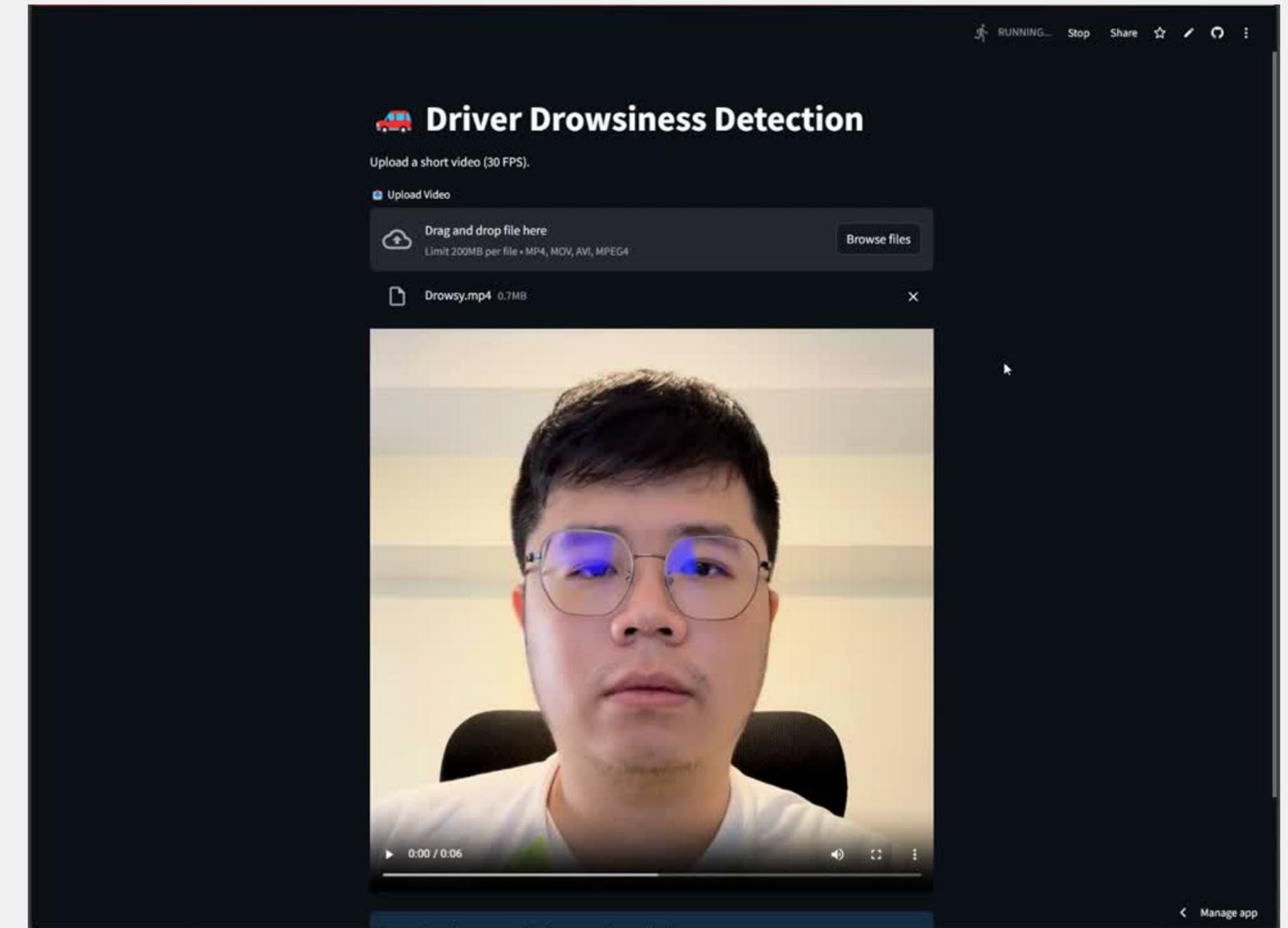


TRIAL MODEL DEPLOYMENT

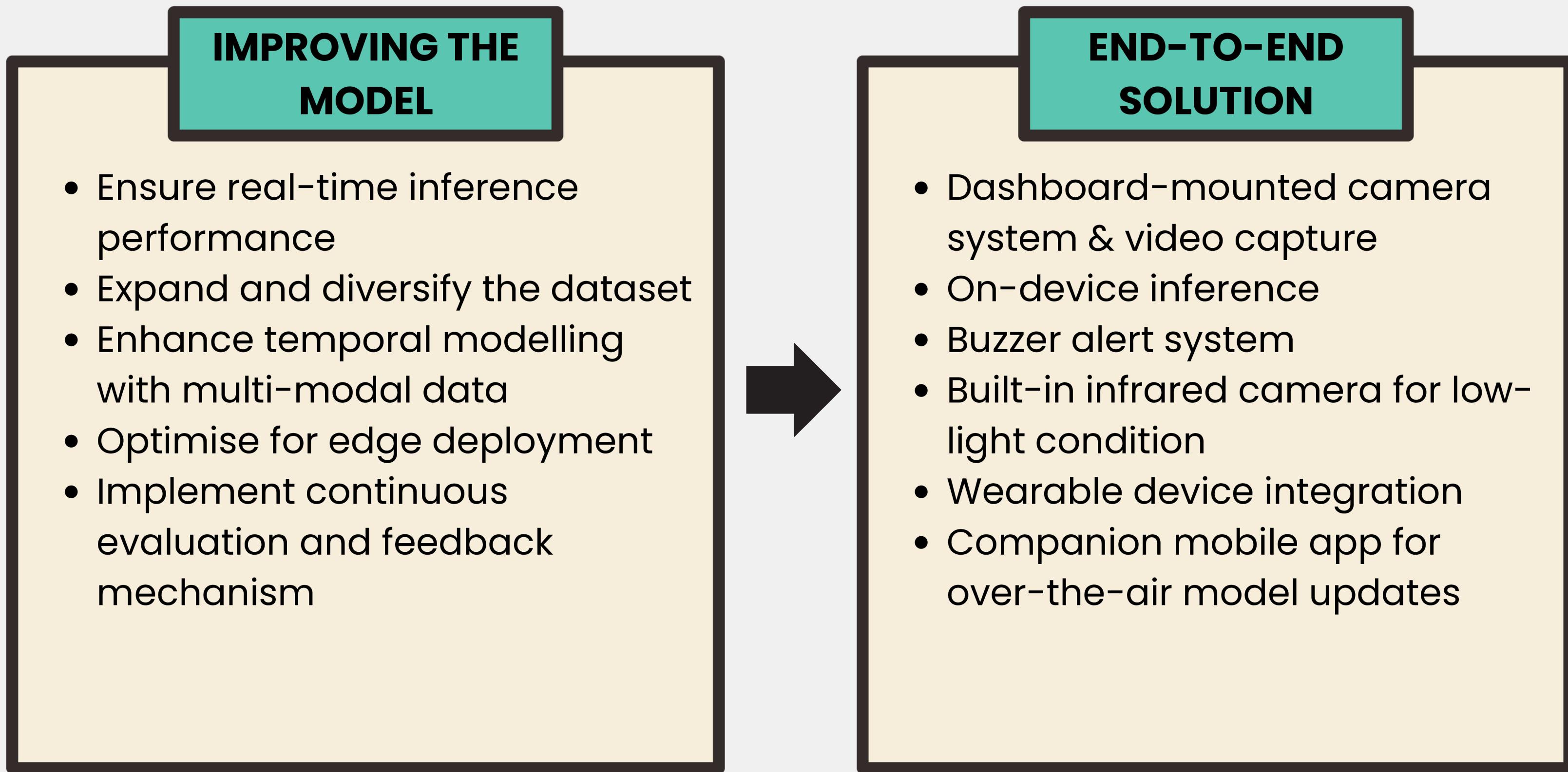
ALERT



DROWSY



MOVING FORWARD



Let's Connect



+65 8887 9820



jslee0119@hotmail.com



[Jia Sheng Lee](#)



[J1A5h3nG0119](#)

THANK YOU

