Problem Statement

- **What specific problem are you solving?**

  We're developing an AI-powered VAR system tailored for boxing that reviews and analyzes fight footage in real-time, identifying key actions like punches, blocks, and misses supporting fairer referee decisions and offering athletes accurate performance insights.

- **Why is this problem important in sports/media?**

  This issue matters because boxing lacks a standardized VAR system—unlike football or cricket—which has repeatedly led to controversial and biased decisions, like the infamous 2012 Pacquiao vs. Bradley fight. As a result, fans distrust outcomes and stakeholders face credibility challenges—highlighting an urgent need for accurate, AI-powered review tools in the sport .

Solution

- **Quick explanation of how your solution works**

  The solution captures body landmarks using MediaPipe, creates time-based sequences, and uses a trained LSTM model to classify motion gestures in real time, displaying the predicted label and confidence on screen.

- **Data sources and tools leveraged**

  Dataset: A CSV file based on the Olympic punch classification dataset, containing pose landmark coordinates and labels for different boxing motions.

  TensorFlow: Used to build and train the LSTM model for sequential motion classification.

  OpenCV: Handles real-time video capture (from webcam or file) and displays predictions on screen.

  MediaPipe: Extracts human body pose landmarks from video frames.

  NumPy, Pandas: Used for data loading, preprocessing, and numerical operations.

  Scikit-learn: Used for label encoding, train-test splitting, class weighting, and model evaluation metrics

Real World Application

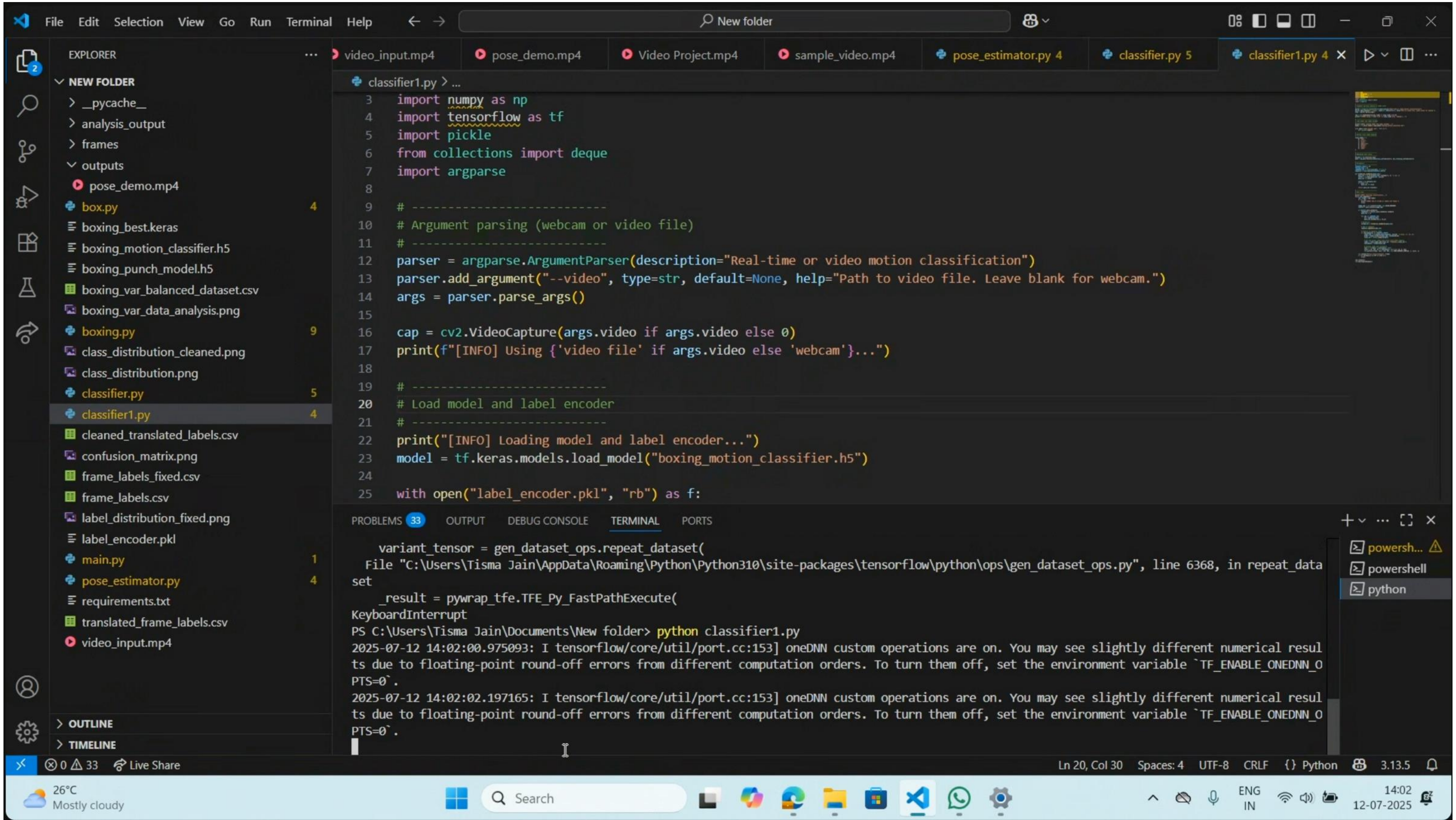
- **Where could this be applied in actual sports workflows?**

  This could be applied in ringside review systems, post-fight analysis, judging audits, or coaching sessions enhancing fairness, training, and storytelling in the sport. Additionally could be the basis of online spars.

- **Who benefits? (e.g., fans, analysts, broadcasters, athletes)**

  Athletes, judges, coaches, broadcasters, fans and even general public all gain from clearer decisions, richer analysis, and more engaging storytelling around every fight.

Demo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New folder
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analysis_output
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pose_demo.mp4
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boxing_best.keras
boxing_motion_classifier.h5
boxing_punch_model.h5
boxing_var_balanced_dataset.csv
boxing_var_data_analysis.png
boxing.py
class_distribution_cleaned.png
class_distribution.png
classifier.py
classifier1.py
cleaned_translated_labels.csv
confusion_matrix.png
frame_labels_fixed.csv
frame_labels.csv
label_distribution_fixed.png
label_encoder.pkl
main.py
pose_estimator.py
requirements.txt
translated_frame_labels.csv
video_input.mp4
OUTLINE
TIMELINE
video_input.mp4
pose_demo.mp4
Video Project.mp4
sample_video.mp4
pose_estimator.py 4
classifier.py 5
classifier1.py 4
classifier1.py > ...
import numpy as np
import tensorflow as tf
import pickle
from collections import deque
import argparse
# ---------------------------
# Argument parsing (webcam or video file)
# ---------------------------
parser = argparse.ArgumentParser(description="Real-time or video motion classification")
parser.add_argument("--video", type=str, default=None, help="Path to video file. Leave blank for webcam.")
args = parser.parse_args()
cap = cv2.VideoCapture(args.video if args.video else 0)
print(f"[INFO] Using {'video file' if args.video else 'webcam'}...")
# ---------------------------
# Load model and label encoder
# ---------------------------
print("[INFO] Loading model and label encoder...")
model = tf.keras.models.load_model("boxing_motion_classifier.h5")
with open("label_encoder.pkl", "rb") as f:
PROBLEMS 33
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
variant_tensor = gen_dataset_ops.repeat_dataset(
File "C:\Users\Tisma Jain\AppData\Roaming\Python\Python310\site-packages\tensorflow\python\ops\gen_dataset_ops.py", line 6368, in repeat_data
set
_result = pywrap_tfe.TFE_Py_FastPathExecute(
KeyboardInterrupt
PS C:\Users\Tisma Jain\Documents\New folder> python classifier1.py
2025-07-12 14:02:00.975093: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see slightly different numerical resul
ts due to floating-point round-off errors from different computation orders. To turn them off, set the environment variable `TF_ENABLE_ONEDNN_O
PTS=0`.
2025-07-12 14:02:02.197165: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see slightly different numerical resul
ts due to floating-point round-off errors from different computation orders. To turn them off, set the environment variable `TF_ENABLE_ONEDNN_O
PTS=0`.
powersh...
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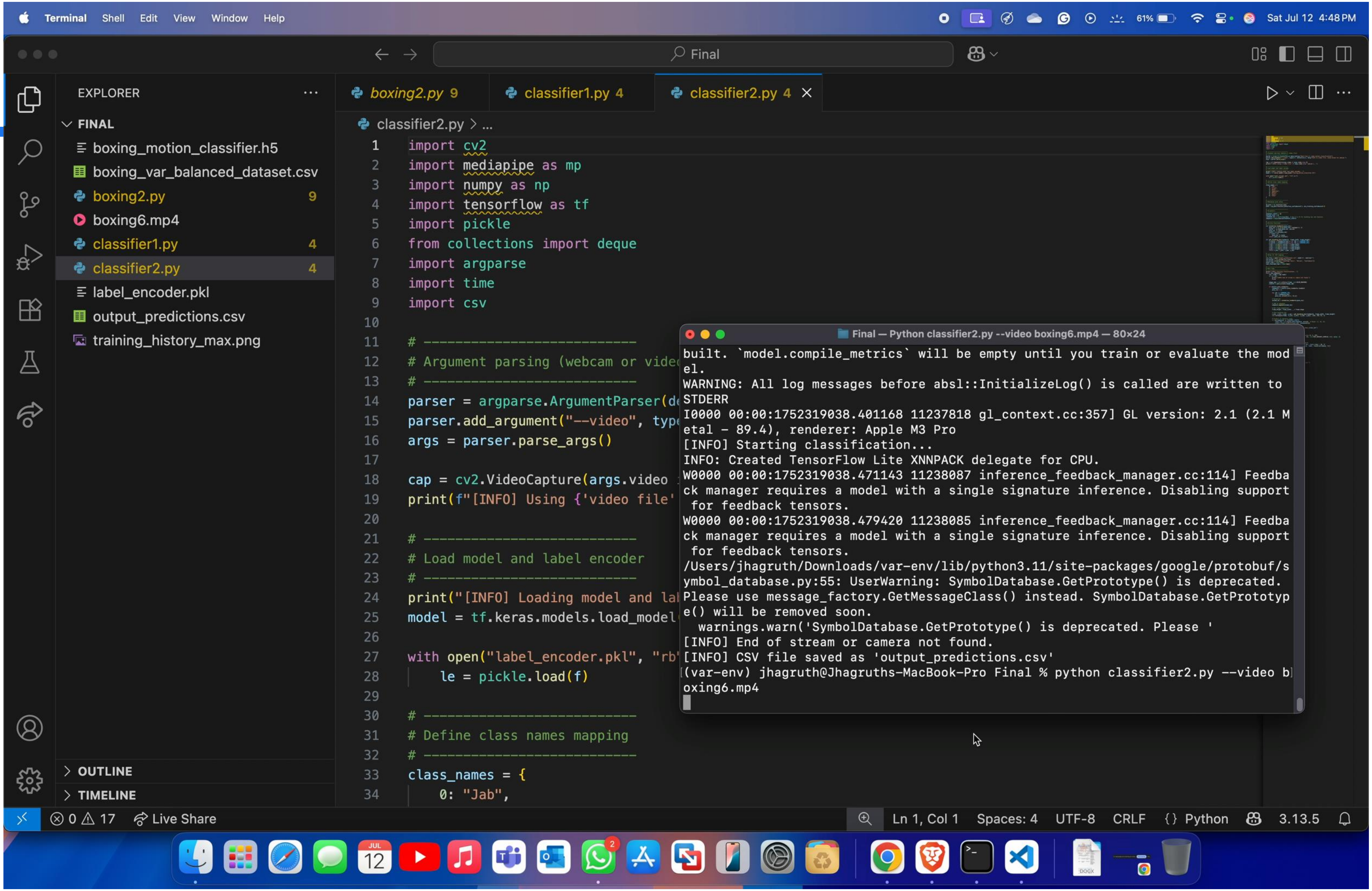

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Sat Jul 12 4:48 PM
Final
EXPLORER
FINAL
boxing_motion_classifier.h5
boxing_var_balanced_dataset.csv
boxing2.py 9
boxing6.mp4
classifier1.py 4
classifier2.py 4
label_encoder.pkl
output_predictions.csv
training_history_max.png
OUTLINE
TIMELINE
boxing2.py 9
classifier1.py 4
classifier2.py 4
classifier2.py > ...
import cv2
import mediapipe as mp
import numpy as np
import tensorflow as tf
import pickle
from collections import deque
import argparse
import time
import csv
# ---------------------------
# Argument parsing (webcam or vide
# ---------------------------
parser = argparse.ArgumentParser(de
parser.add_argument("--video", typ
args = parser.parse_args()
cap = cv2.VideoCapture(args.video
print(f"[INFO] Using {'video file'

Load model and label encoder
----
print("[INFO] Loading model and lal
model = tf.keras.models.load_model
with open("label_encoder.pkl", "rb'
le = pickle.load(f)
# ---------------------------
# Define class names mapping
# ---------------------------
class_names = {
0: "Jab",
Final — Python classifier2.py --video boxing6.mp4 — 80×24
built. `model.compile_metrics` will be empty until you train or evaluate the model.
WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
I0000 00:00:1752319038.401168 11237818 gl_context.cc:357] GL version: 2.1 (2.1 Metal - 89.4), renderer: Apple M3 Pro
[INFO] Starting classification...
INFO: Created TensorFlow Lite XNNPACK delegate for CPU.
W0000 00:00:1752319038.471143 11238087 inference_feedback_manager.cc:114] Feedback manager requires a model with a single signature inference. Disabling support for feedback tensors.
W0000 00:00:1752319038.479420 11238085 inference_feedback_manager.cc:114] Feedback manager requires a model with a single signature inference. Disabling support for feedback tensors.
/Users/jhagruth/Downloads/var-env/lib/python3.11/site-packages/google/protobuf/symbol_database.py:55: UserWarning: SymbolDatabase.GetPrototype() is deprecated. Please use message_factory.GetMessageClass() instead. SymbolDatabase.GetPrototype() will be removed soon.
warnings.warn('SymbolDatabase.GetPrototype() is deprecated. Please '
[INFO] End of stream or camera not found.
[INFO] CSV file saved as 'output_predictions.csv'
(var-env) jhagruth@Jhagruths-MacBook-Pro Final % python classifier2.py --video boxing6.mp4
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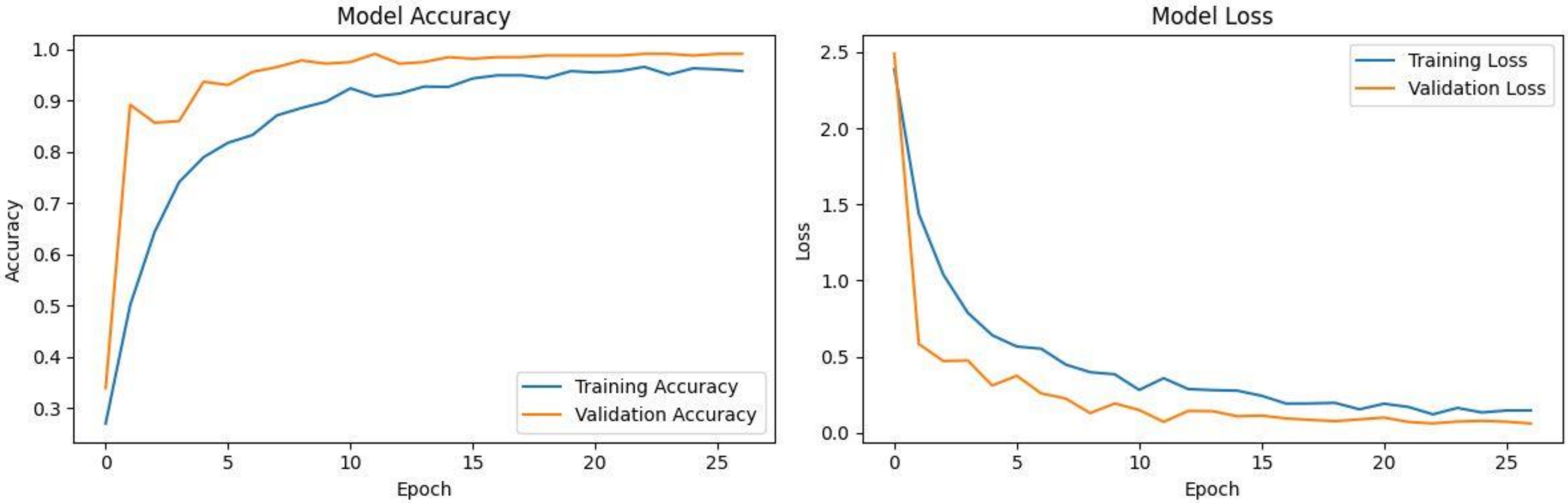
Model Accuracy
Accuracy
Epoch
Training Accuracy
Validation Accuracy
Model Loss
Loss
Epoch
Training Loss
Validation Loss

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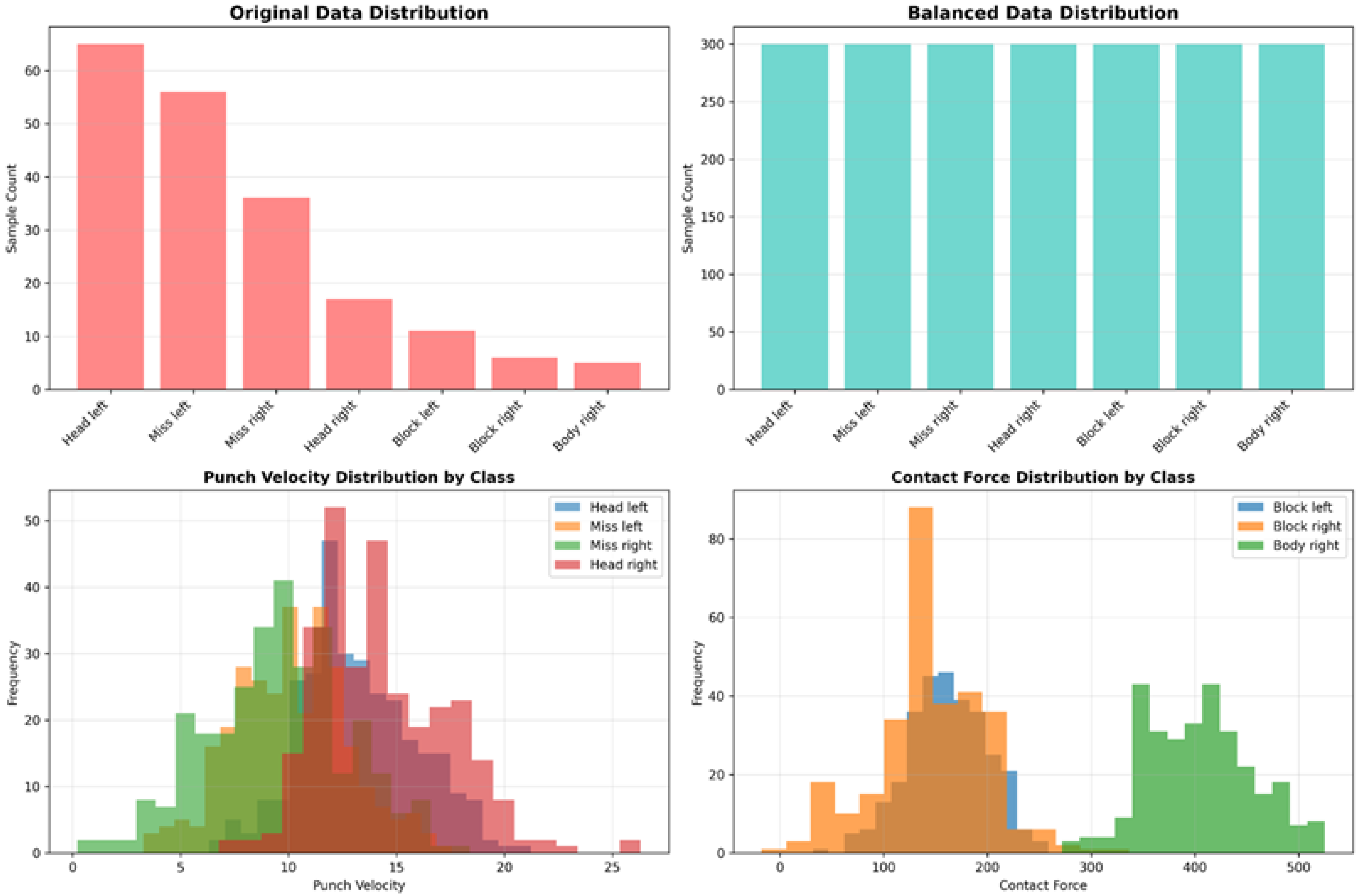
motion_log

Timestamp_Minutes	Motion_Type	Confidence
0.0089	Block	0.652
0.0178	Block	0.812
0.0267	Block	0.85
0.0356	Block	0.825
0.0444	Block	0.886
0.0533	Block	0.746
0.0622	Block	0.803
0.0711	Uppercut	0.368
0.08	Block	0.734
0.0889	Block	0.779
0.0978	Block	0.756
0.1067	Block	0.608
0.1156	Block	0.623
0.1244	Block	0.661
0.1333	Duck	0.906
0.1422	Duck	0.899
0.1511	Duck	0.476
0.16	Cross	0.453
0.1689	Cross	0.533
0.1778	Uppercut	0.256




Person 1: Idle (0.91)
Person 2: Uppercut (0.30)
gettyimages
685549039

What's Next?

- **How could your project be scaled or extended?**

  Our project is to be scaled by refining the model with more diverse data, adding real-time capabilities, and building modular tools that can be demoed to sports orgs, broadcasters, or tech partners for immediate feedback and piloting.

- **Ideas for future features, platforms, or integrations**

  Future extensions include real-time multi-camera analysis, integration with broadcast platforms for automated replays, and mobile tools for referees or fans to access instant, contextual insights during matches

- **Potential impact beyond the hackathon**

  Our project can be scaled by expanding to other combat sports like MMA or wrestling, integrating with live broadcast systems for real-time analysis, or building athlete-specific analytics dashboards. It can also be extended to training environments for performance feedback and coaching insights.