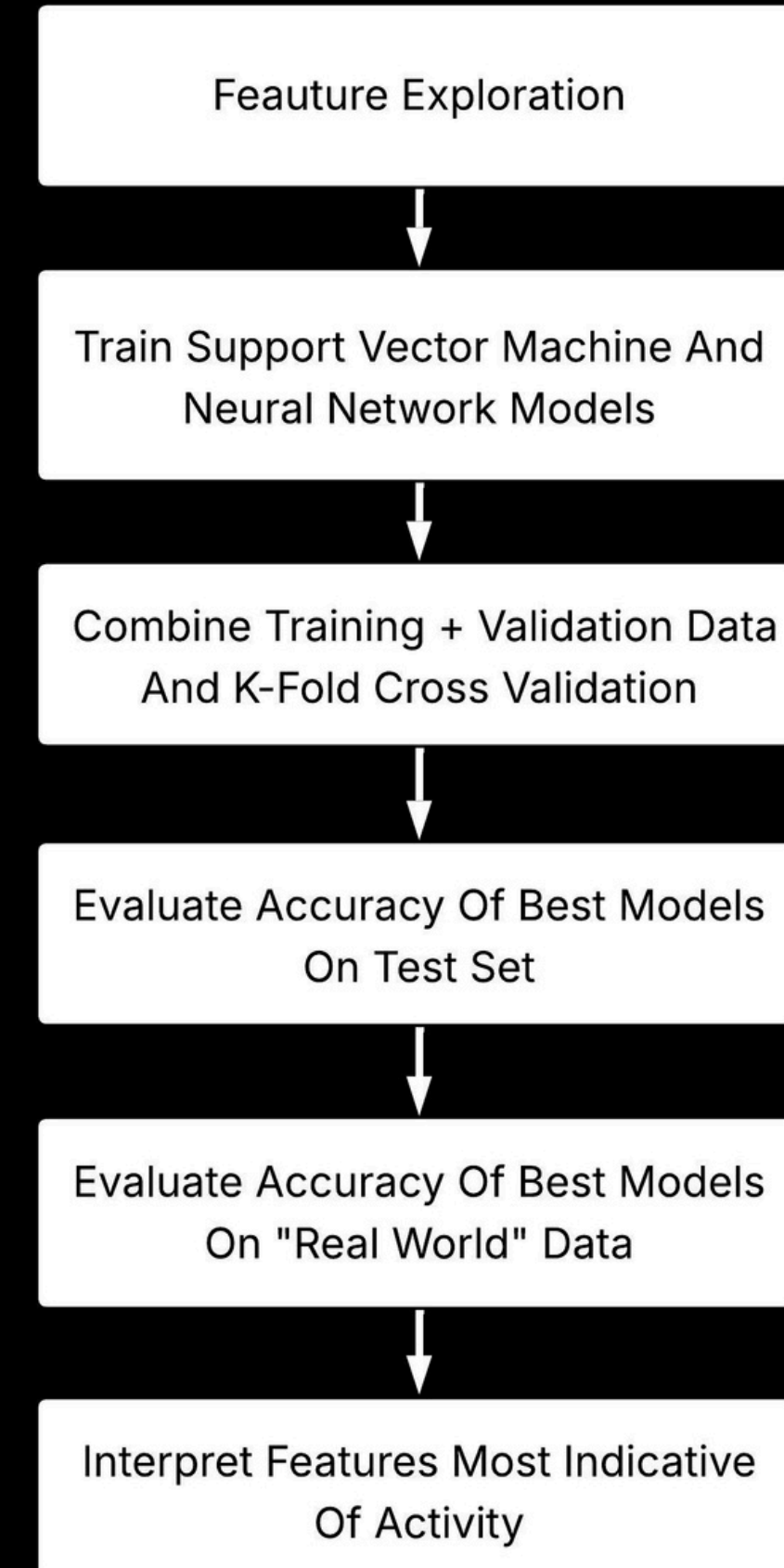Machine Learning

MOTION CLASSIFIER

CONTENT

- Motivation
- Feature Explanation
- Support Vector Machine (SVM) And Neural Network (NN) Models
- Features Most Indicative Of Activity
- Recap/Questions

Machine Learning Motion Classifier Work Flow

Feauture Exploration

↓

Train Support Vector Machine And Neural Network Models

↓

Combine Training + Validation Data And K-Fold Cross Validation

↓

Evaluate Accuracy Of Best Models On Test Set

↓

Evaluate Accuracy Of Best Models On "Real World" Data

↓

Interpret Features Most Indicative Of Activity

MOTIVATION
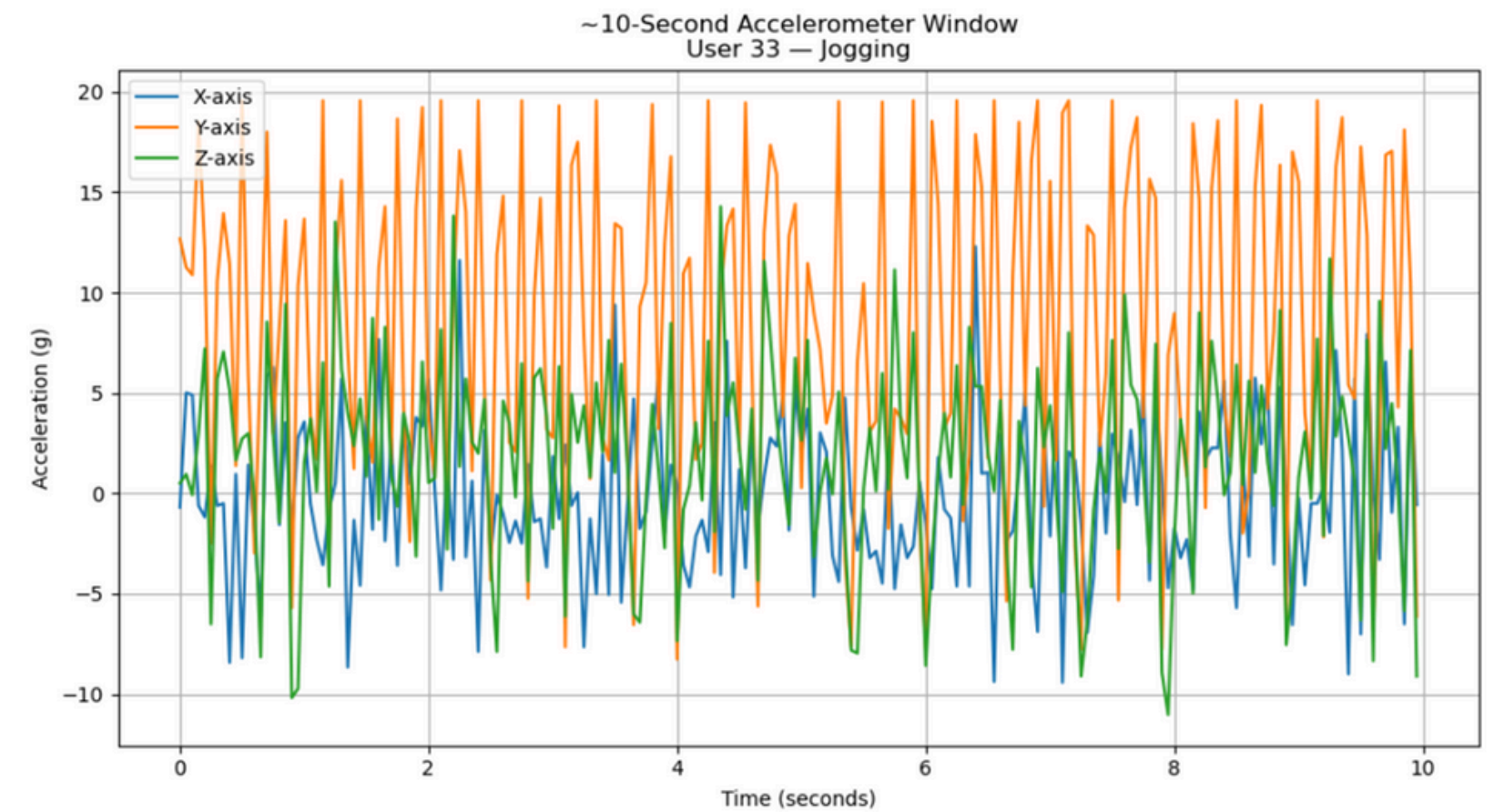
~10-Second Accelerometer Window
User 33 — Jogging

Applications:

- Healthcare
- Sports
- Robotics

Dataset:

- WISDM Lab At Fordham University
- Raw Accelerometer Transformed Into 43 Statistical Features

LABORATORY DATA CLASS DISTRIBUTION

Walking - 2,082 - 38.4%

Jogging - 1,626 - 30.0%

Upstairs - 633 - 11.7%
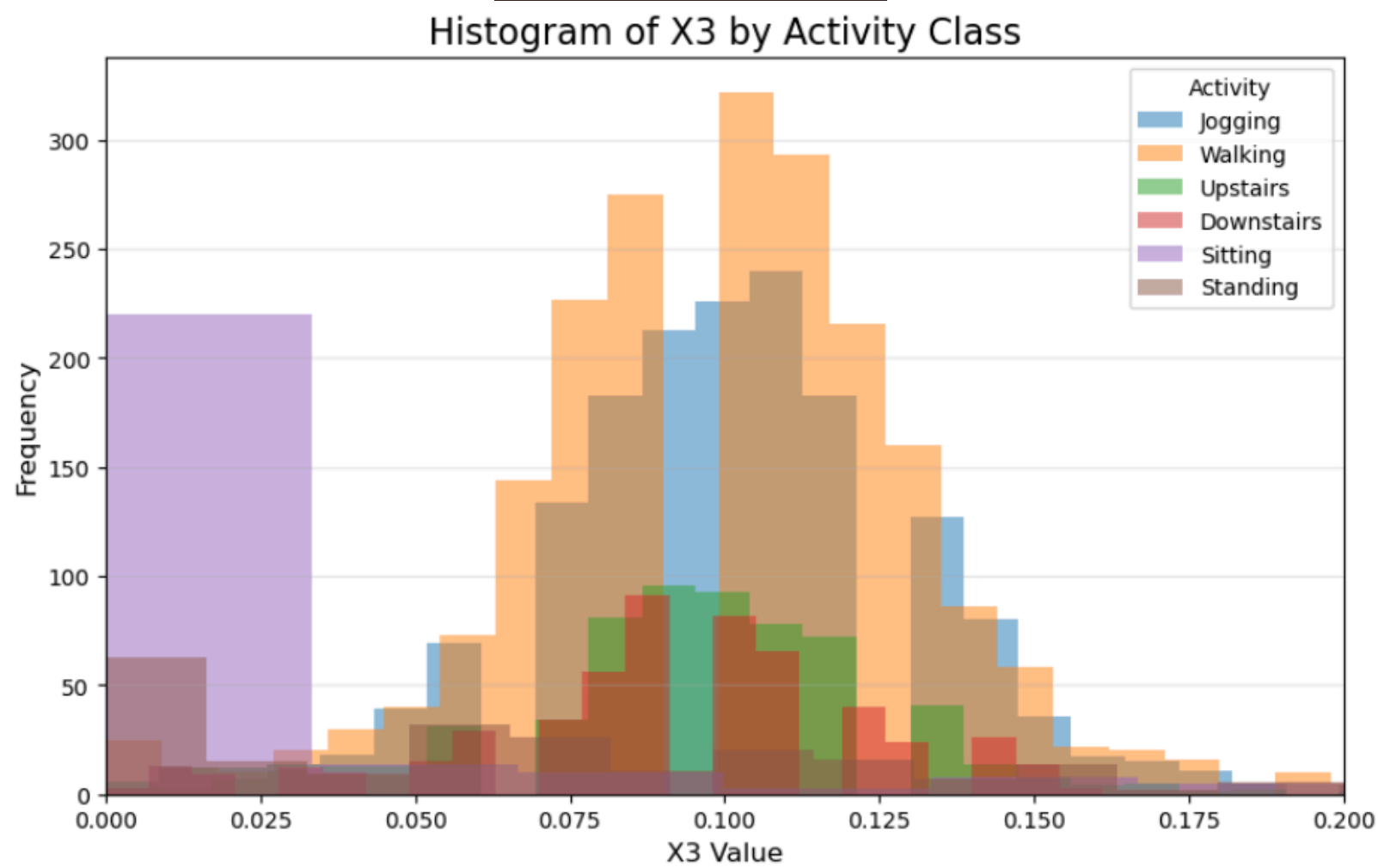
Downstairs - 529 - 9.8%
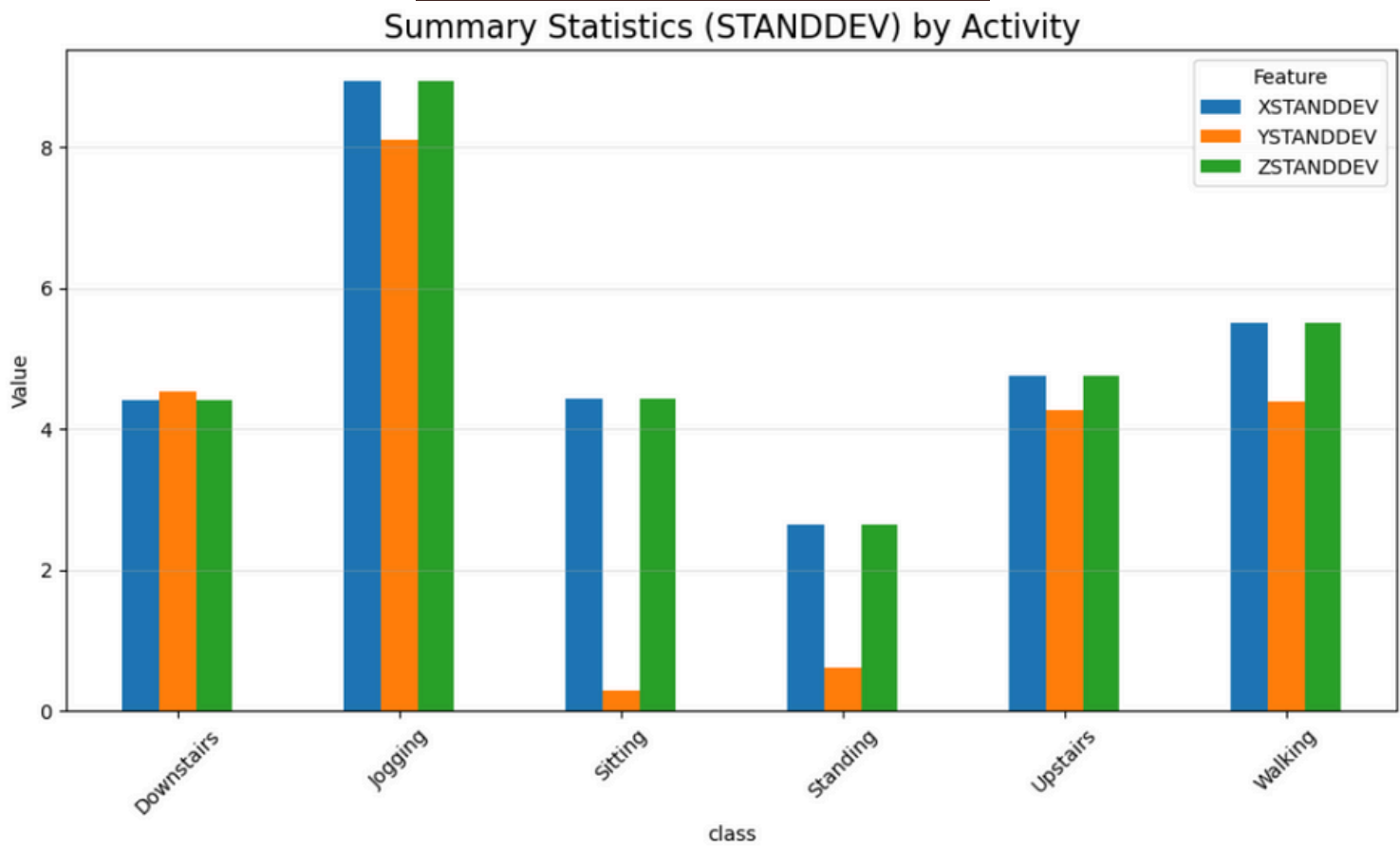
Sitting - 307 - 5.7%

Standing - 247 - 4.6%

FEATURE EXPLANATION

- Bins (X0-X9, Y0-Y9, Z0-Z9): Shape Of Motion Distribution
- Summary Stats X, Y, And Z (AVG, STANDEV, ABSDEV): Orientation And Intensity
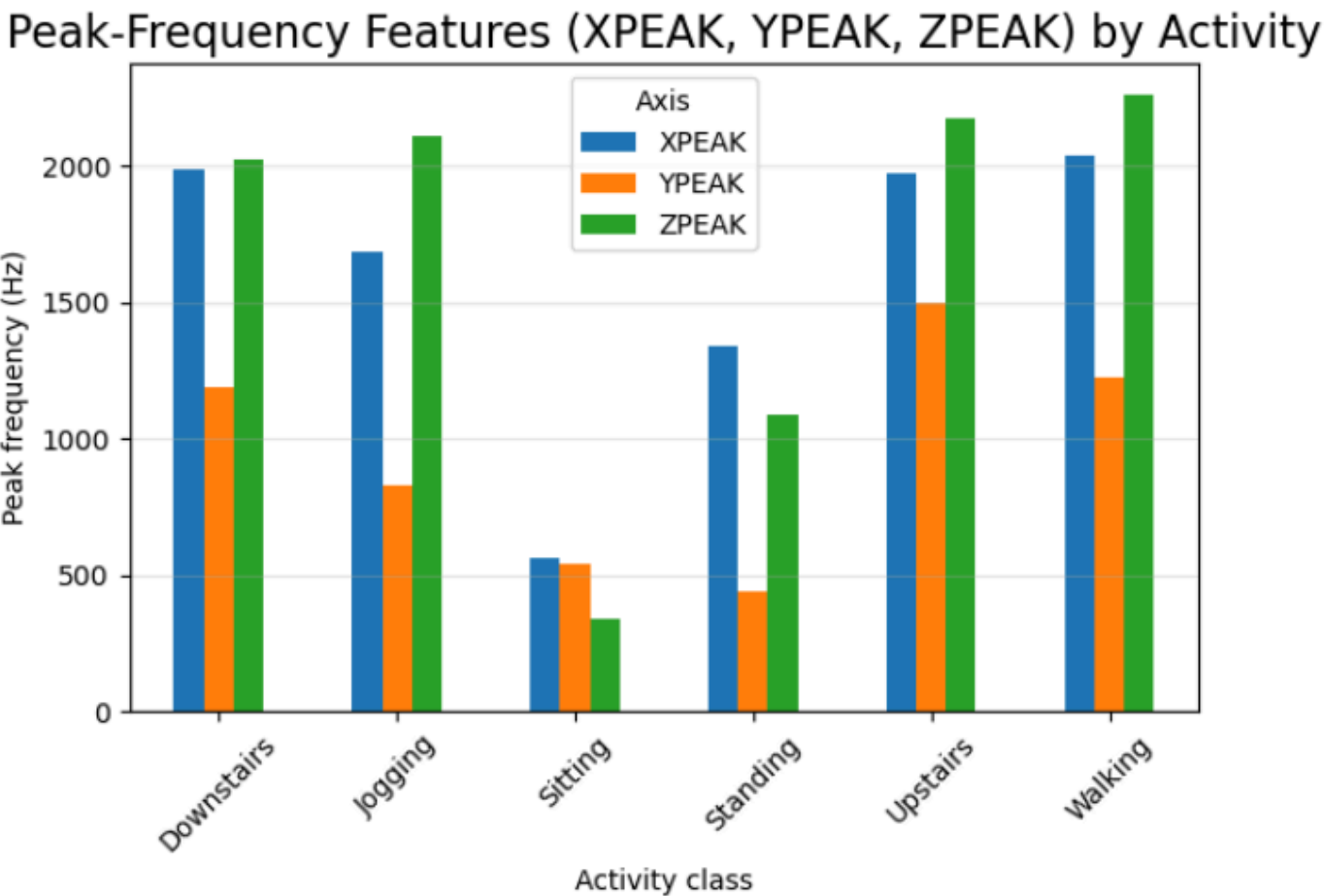- Peak Frequency (X-PEAK, Y-PEAK, Z-PEAK): Rhythmic Patterns

BAR CHART OF STANDEV

Summary Statistics (STANDDEV) by Activity

HISTOGRAM OF X3

Histogram of X3 by Activity Class

BAR CHART OF PEAK-FREQUENCY

Peak-Frequency Features (XPEAK, YPEAK, ZPEAK) by Activity

SVM AND NN MODELS

- SVM: Nonlinear And Locally Clustered Patterns
- MLP NN: Flexibility And Layered Nonlinear Feature Interactions

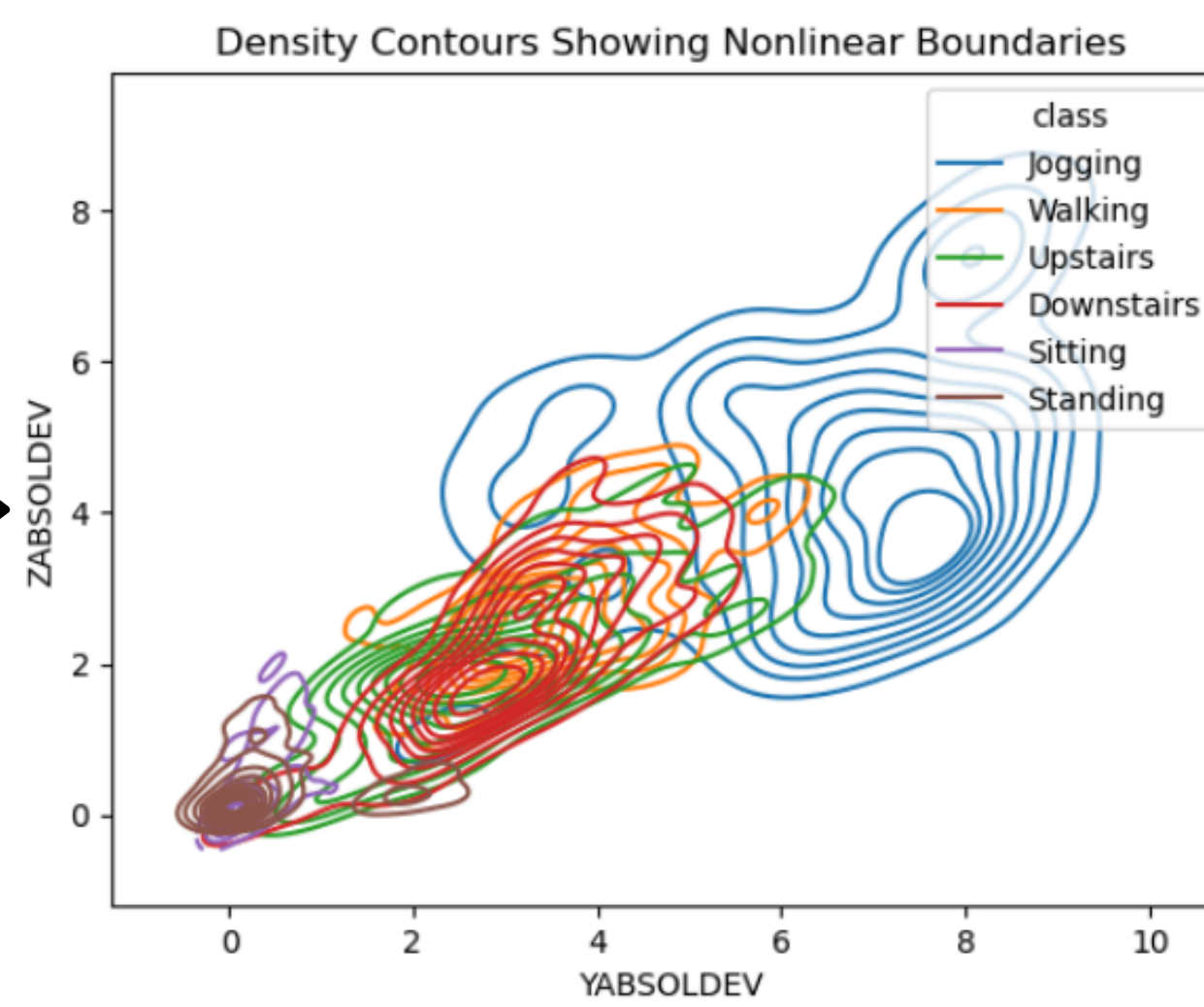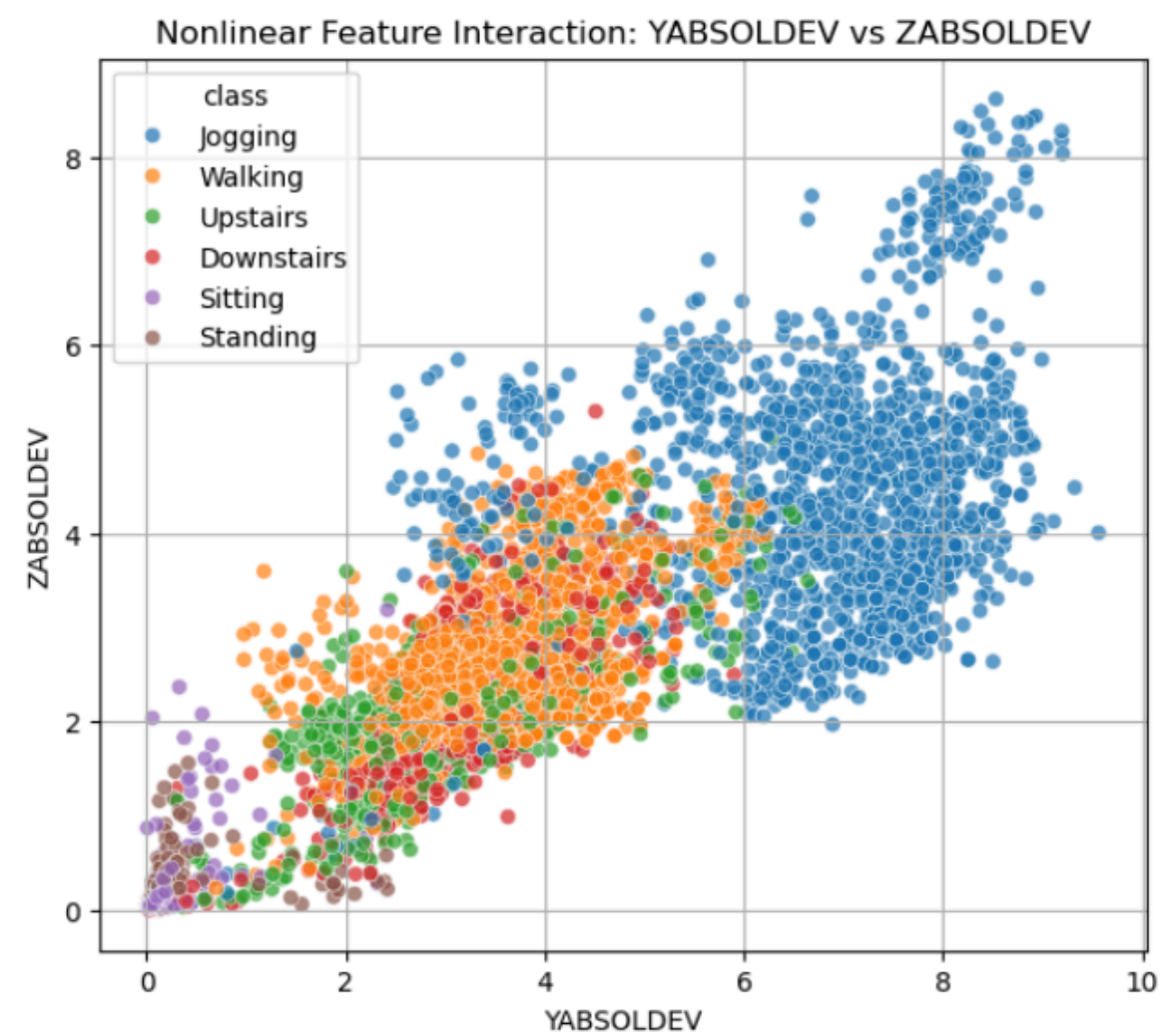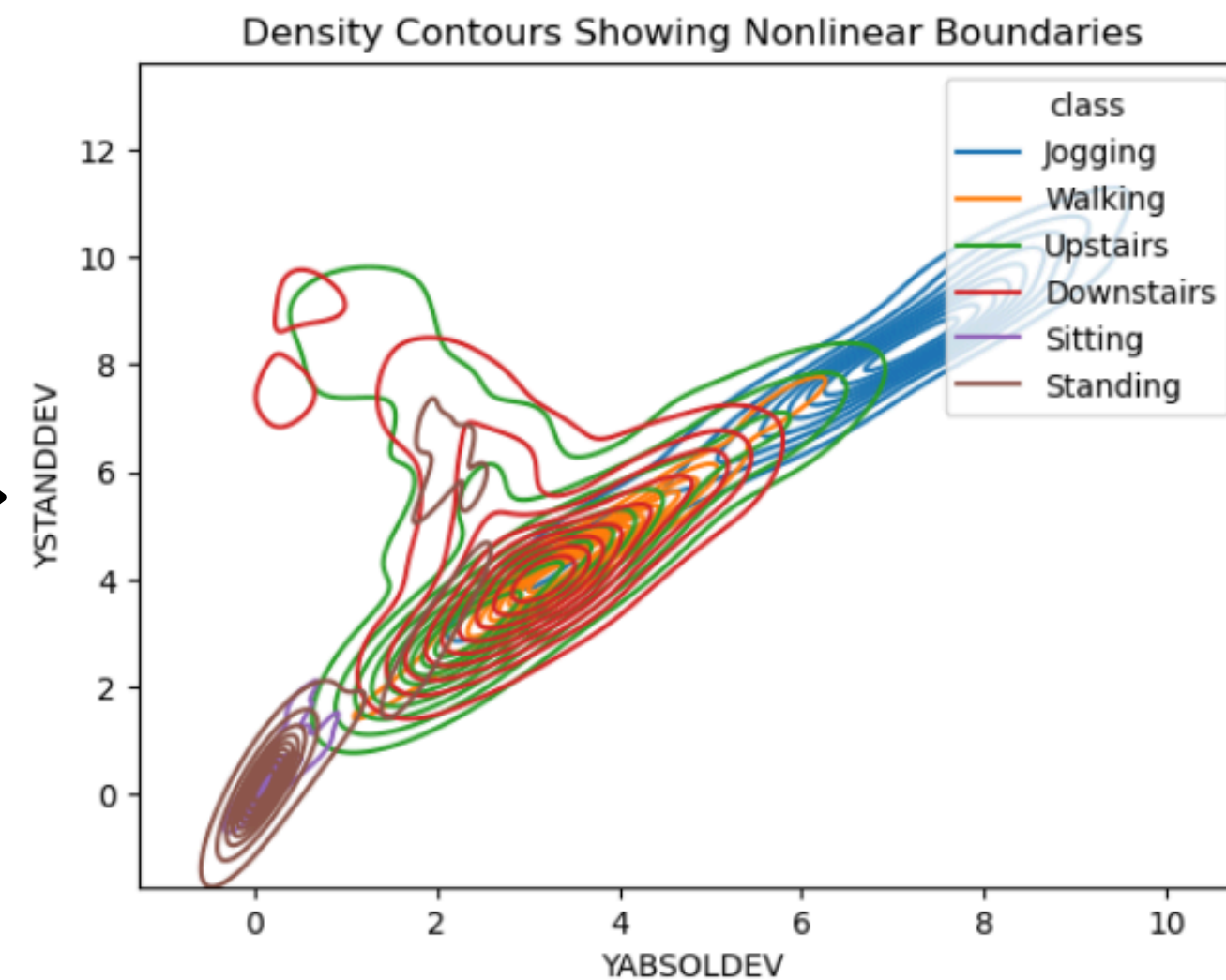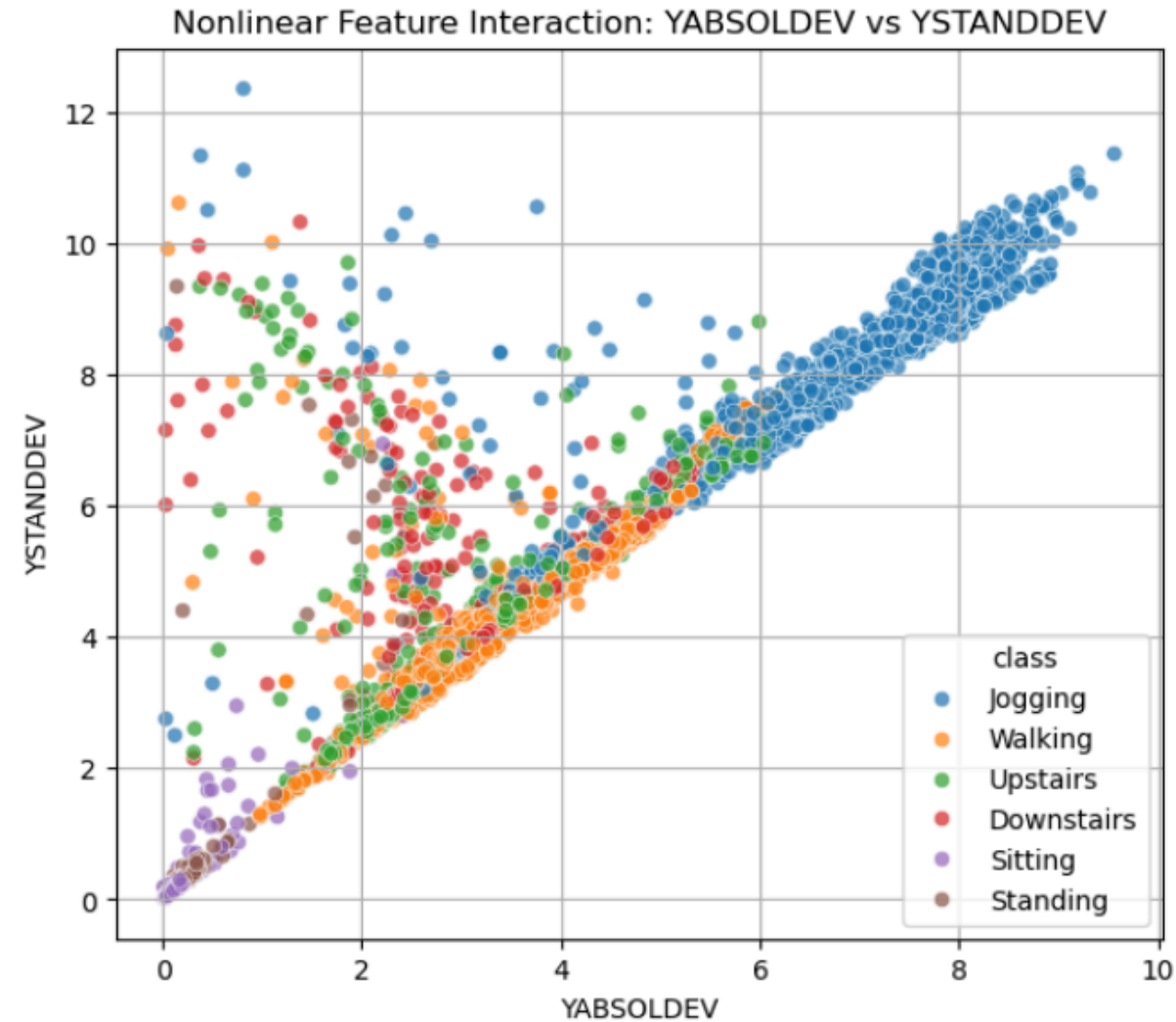| Best Performing Support Vector Machines	
Kernel	**Validation Accuracy (%)**
Linear	77.86
Polynomial	83.67
RBF	84.13

Best Performing Multi-Layer Perceptron Neural Networks	
Activation Function	**Validation Accuracy (%)**
ReLU	84.69
Leaky ReLU	81.37
Tanh	85.24
Sigmoid	85.24

Final Machine Learning Models		
Model	**Lab Data Accuracy (%)**	**Real World Data Accuracy (%)**
SVM-RBF Kernel	84.23	30.93
MLP NN-Tanh	86.35	27.25
MLP NN-Sigmoid	86.35	27.67

FEATURES MOST INDICATIVE OF ACTIVITY

1. YABSOLDEV (Vertical Acceleration Fluctuation)

2. YSTANDEV (Vertical Acceleration Fluctuation)

3. ZABSOLDEV (Tilt Acceleration Fluctuation)

4. YAVG (Intensity Of Vertical Acceleration)

5. RESULTANT(Magnitude Of Total Acceleration)

Nonlinear Feature Interaction: YABSOLDEV vs YSTANDDEV

Density Contours Showing Nonlinear Boundaries

Nonlinear Feature Interaction: YABSOLDEV vs ZABSOLDEV

Density Contours Showing Nonlinear Boundaries

RECAP/QUESTIONS

- MLP neural net models performed the best due to their increased complexity and layered nonlinear feature interactions
- Models trained on laboratory data did not perform well on real world data
- Feature most indicative of activity: YABSOLDEV