PREVENTIVE MAINTANENCE

DEEP LEARNING

APRIL 2024

Overview

- Importance of predictive maintenance in industry
- Objective: Develop a deep learning model to predict failures
- Benefit: Prevent costly downtime, optimize maintenance

Business Understanding

Objective

OBJECTIVE: DEVELOP A DEEP LEARNING MODEL TO PREDICT FAILURES

BENEFIT: PREVENT COSTLY DOWNTIME, OPTIMIZE MAINTENANCE

Goal

GOAL: ACCURATE PREDICTIONS TO ENABLE PROACTIVE MAINTENANCE

IMPACT: REDUCE BREAKDOWNS, EXTEND EQUIPMENT LIFE, OPTIMIZE SCHEDULES

Data Set

- Analyzed sensor data from industrial machines
- Identified key sensors with significant readings variability
- Detected patterns linked to machine health and potential faults

Data Insight

ATTRIBUTES

- Total Entries: 220.320
- Total Columns: 55
- Unnamed: 0Column:ID/Index
- Sensor 15 column: Removing

DISTRIBUTION

- Normal: 205,836
- Recovering: 14,477
- Broken: 7

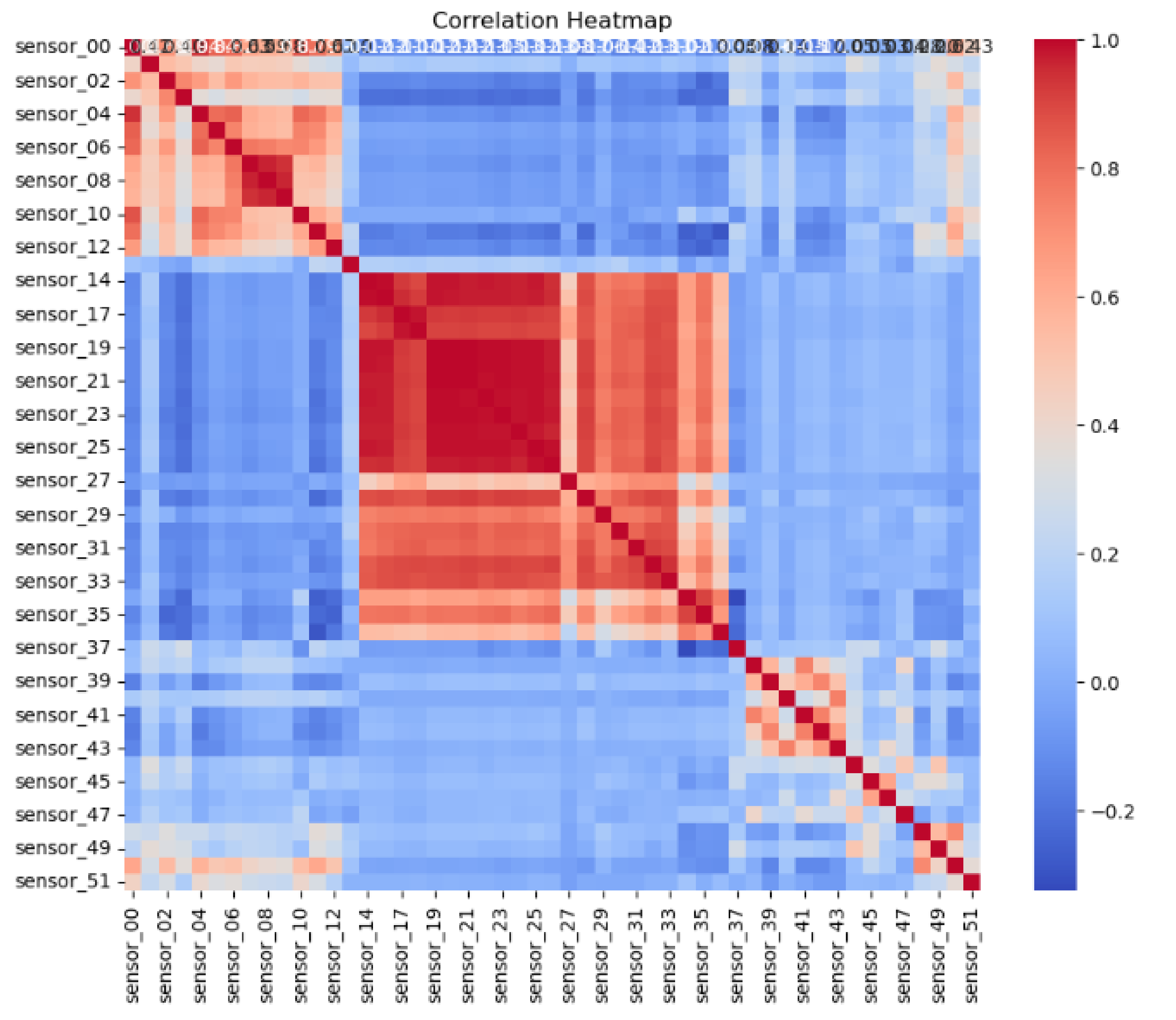
MISSING VALUES

- 77.017 and 220,320 missing
- Checked for duplicates

Data Prep

- Cleaned and preprocessed data for quality and consistency
- Merged similar machine statuses to simplify the target variable
- Visualized data distribution and sensor correlations
- Utilized exploratory data analysis for a deeper understanding of data

Data


Correlation Heatmap
sensor_00
sensor_02
sensor_04
sensor_06
sensor_08
sensor_10
sensor_12
sensor_14
sensor_17
sensor_19
sensor_21
sensor_23
sensor_25
sensor_27
sensor_29
sensor_31
sensor_33
sensor_35
sensor_37
sensor_39
sensor_41
sensor_43
sensor_45
sensor_47
sensor_49
sensor_51
1.0
0.8
0.6
0.4
0.2
0.0
−0.2

Model Process

01 Feedforward Neural Network(FNN)

- Developed a baseline neural network with dropout layers to prevent overfitting.

02 Tested ensemble machine learning models

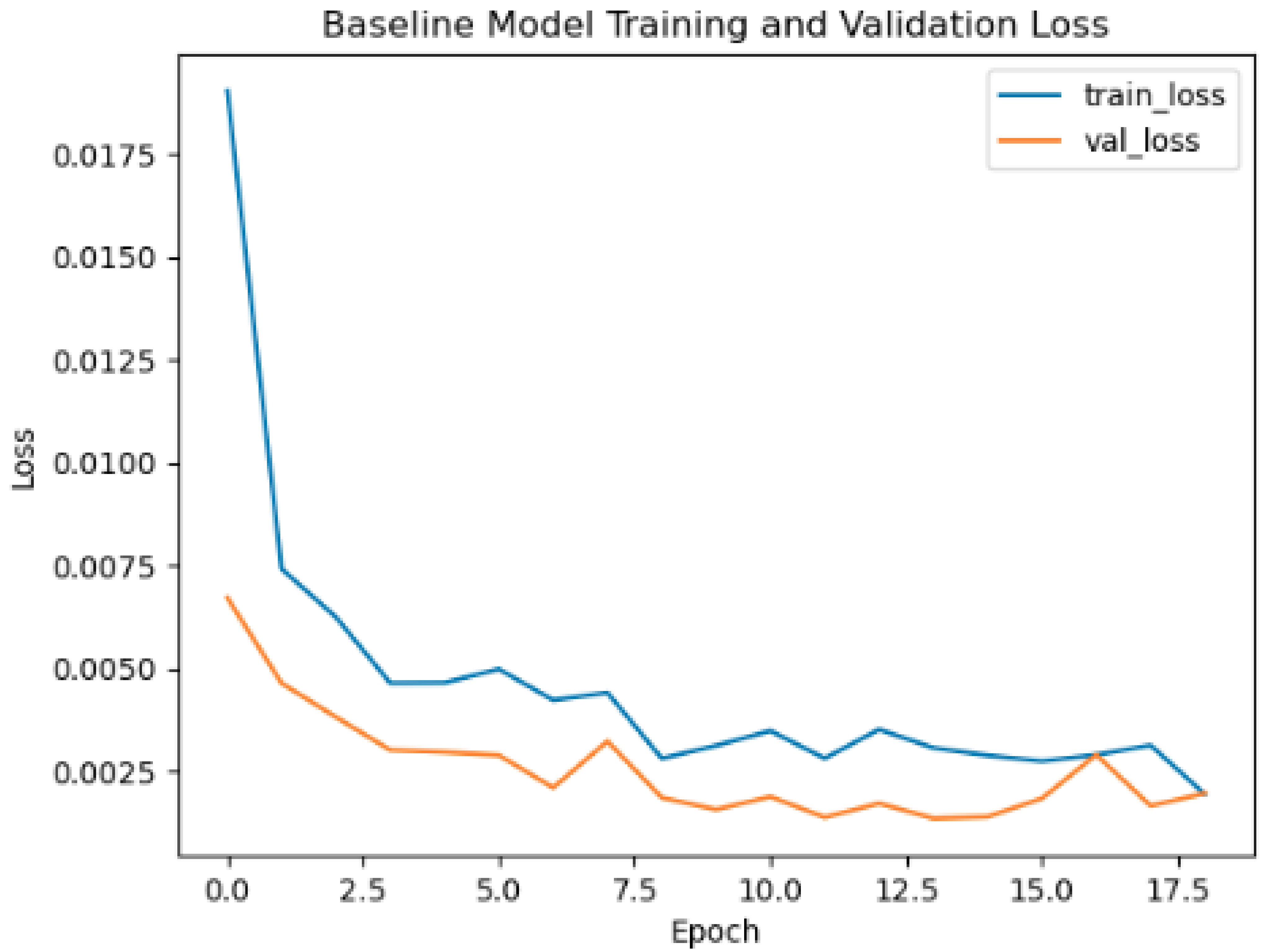
- Bagging, AdaBoost, Stacking, and Voting

03 Tuning

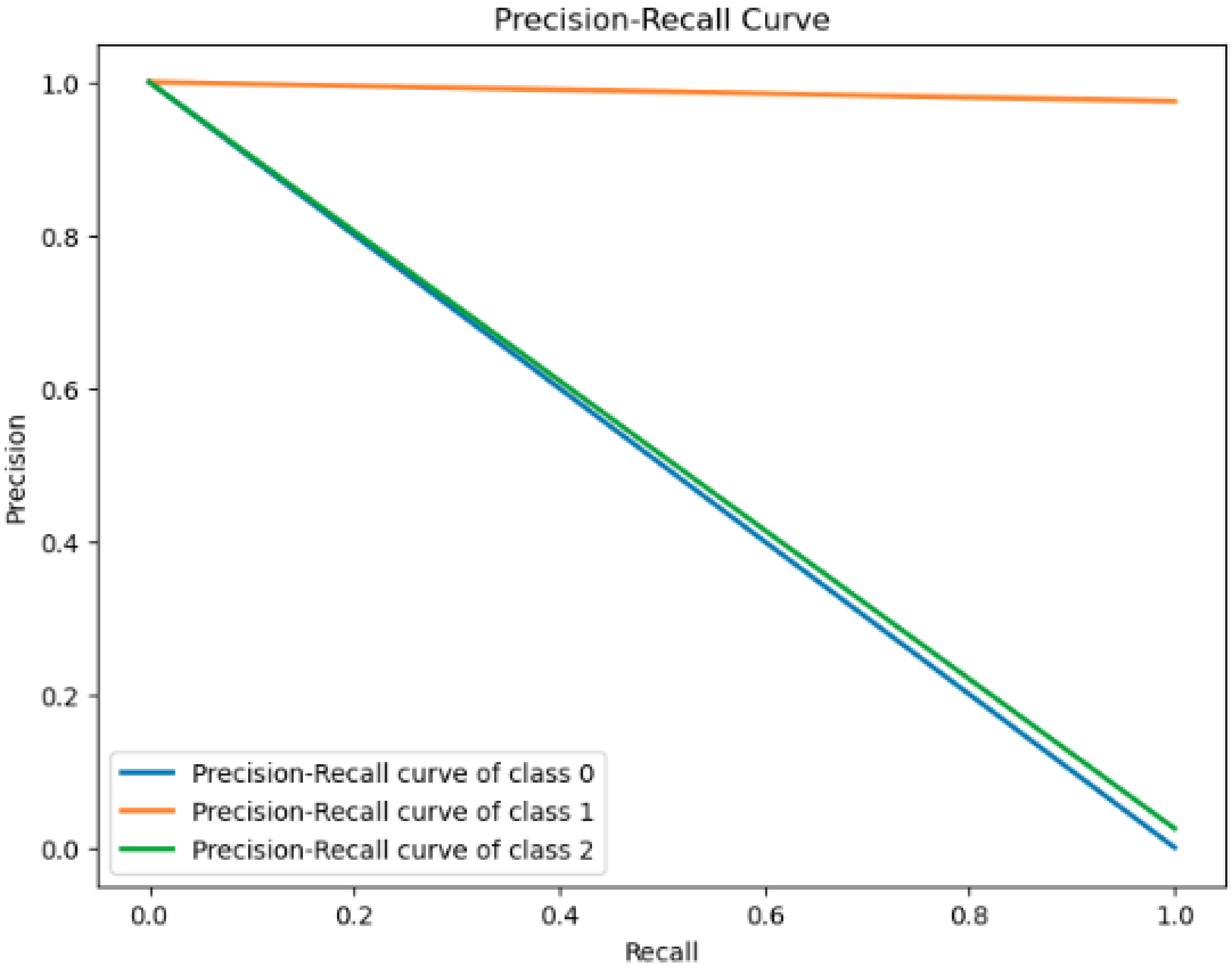
- Implemented cross-validation for robust model evaluation
- Optimized models for high accuracy and generalization

Data

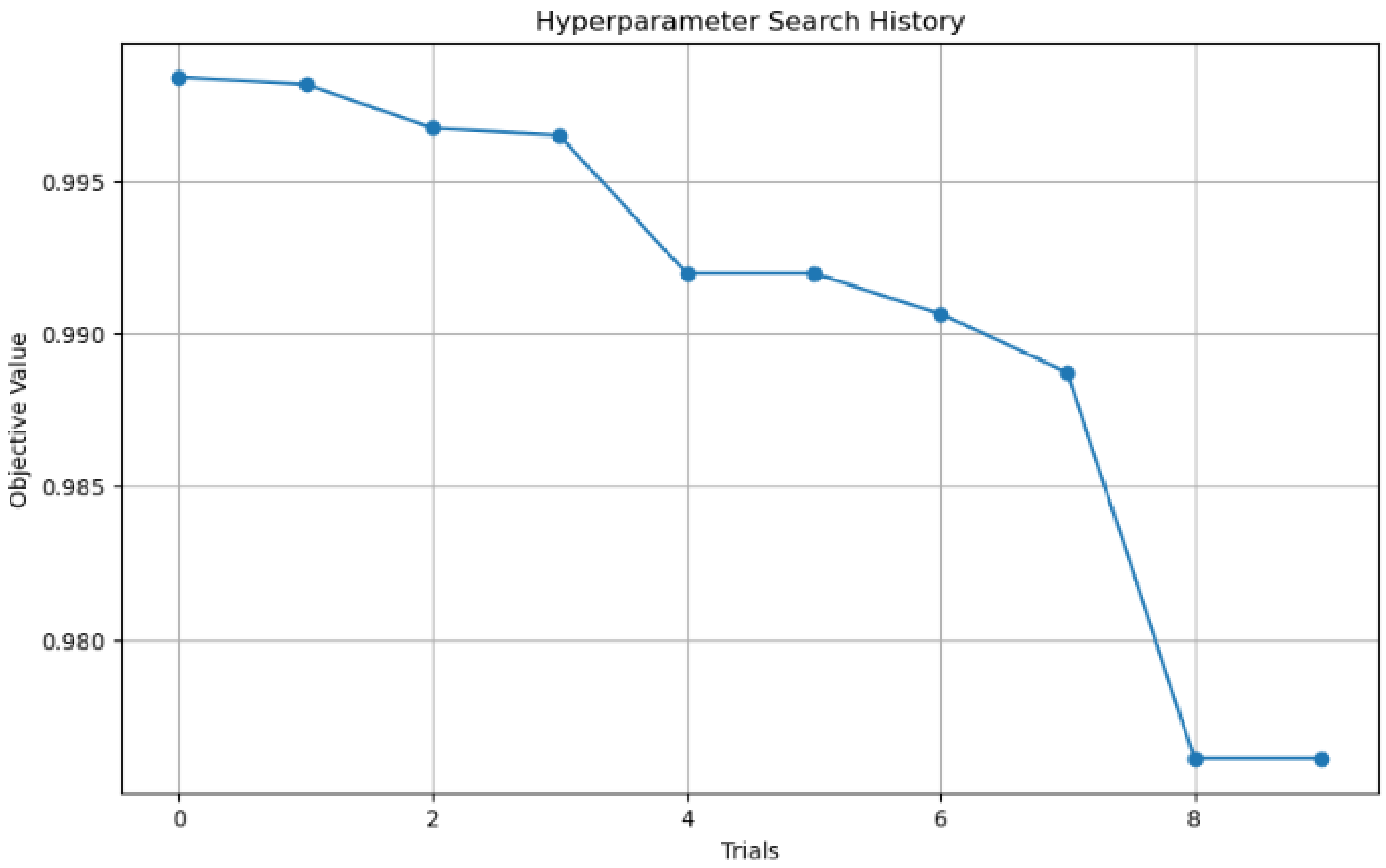
```
Test accuracy: 0.9996361732482291
```



Data

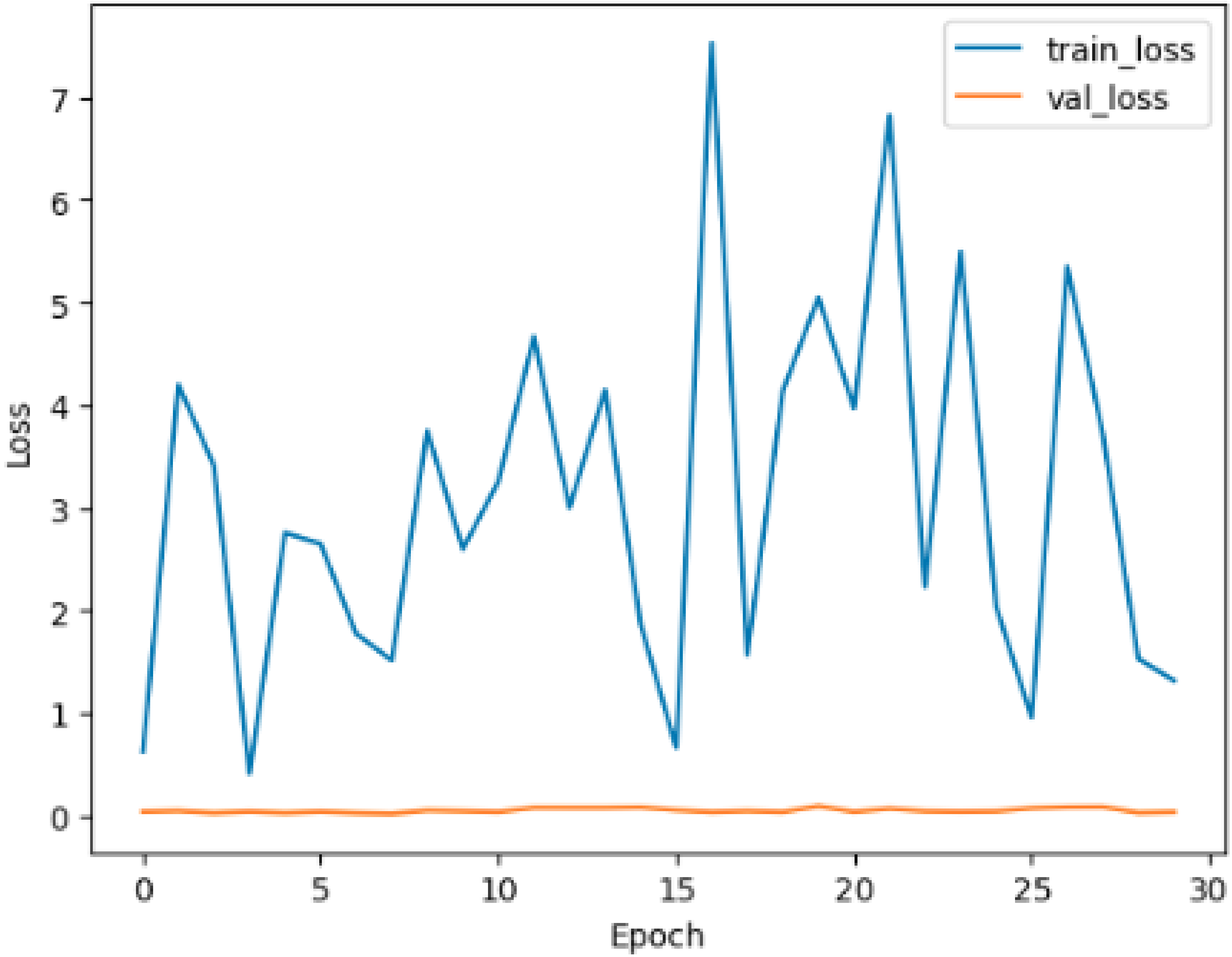

Precision-Recall Curve
Precision
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Recall
Precision-Recall curve of class 0
Precision-Recall curve of class 1
Precision-Recall curve of class 2

Data


Hyperparameter Search History
Objective Value
0.995
0.990
0.985
0.980
0
2
4
6
8
Trials

Data

```
Test loss: 0.04529045149683952
Test accuracy: 0.9972600936889648
```



Results

- Achieved high consistency and accuracy across cross-validation folds
- Near-perfect ROC AUC scores indicating excellent model performance
- SHAP analysis confirmed key sensors as strong predictors

Next Steps

01 Refine models

- Continuous monitoring of key sensors for real-time predictive maintenance

02 Deployment

- Implementation into production with a real-time analytics pipeline

03 More data insight

- Further investigation into high-impact sensors for targeted maintenance

04 Further experiment

- Regular retraining of models with new data to maintain performance

CONTACT

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THANK YOU