CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY USING MACHINE LEARNING

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OUTLINE

- **Problem Statement** (Should not include solution)
- **Proposed System/Solution**
- **System Development Approach** (Technology Used)
- **Algorithm & Deployment**
- **Result (Output Image)**
- **Conclusion**
- **Future Scope**
- **References**

PROBLEM STATEMENT

Develop a predictive maintenance model for a fleet of industrial machines to anticipate failures before they occur. This project will involve analyzing sensor data from machinery to identify patterns that precede a failure. The goal is to create a classification model that can predict the type of failure (e.g., tool wear, heat dissipation, power failure) based on real-time operational data. This will enable proactive maintenance, reducing downtime and operational costs.

PROPOSED SOLUTION

- Develop a machine learning-based predictive maintenance model that analyzes real-time sensor data (e.g., temperature, vibration, power) to classify potential failures (tool wear, heat dissipation, etc.). The system will predict failure types before they occur, enabling proactive maintenance to minimize downtime and costs. The model will be deployed for real-time monitoring, providing actionable alerts to prevent machine breakdowns
- **Data Collection: Use the Kaggle dataset on power system faults**
- **Data Preprocessing**: Clean and normalize sensor data.
- **Model Training**: Use algorithms like Random Forest, XGBoost, or LSTM (for time-series data) to classify failure types.
- **Deployment**: Integrate the model into a real-time monitoring system for proactive alerts.
- **Evaluation: Validate the model using accuracy, precision, recall and F1-score**

SYSTEM APPROACH

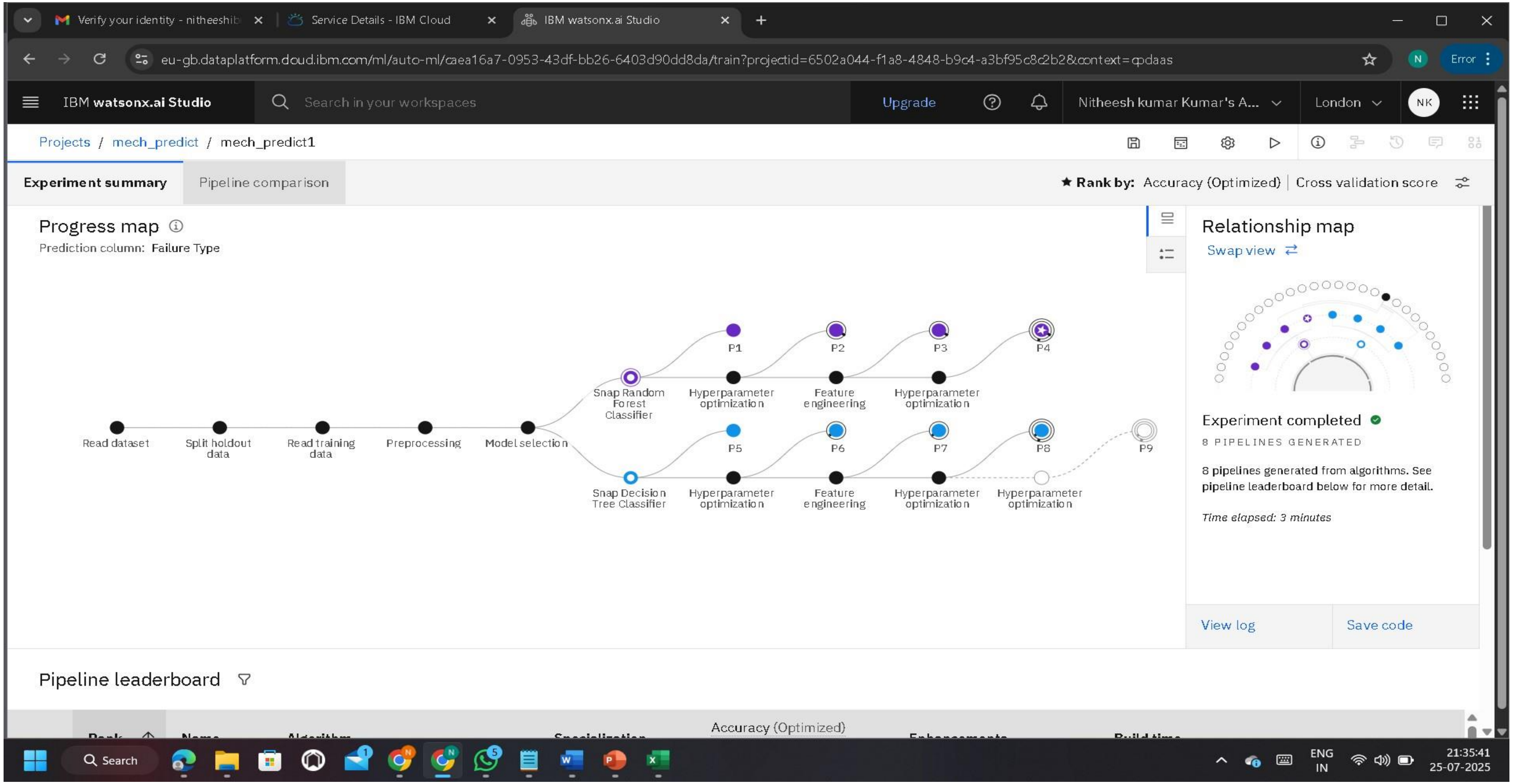
The "System Approach" section outlines the overall strategy and methodology for developing and implementing the Predictive Maintenance of Industrial Machinery. Here's a suggested structure for this section:

- System requirements :
- IBM Cloud (mandatory).
- IBM Watsonx.AI studio for model development and deployment.
- IBM cloud object storage for dataset handling.
- IBM Watsonx. Ai runtime for both software and hardware components.

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  - Use Random Forest/XGBoost for tabular sensor data or LSTM for time-series patterns to classify failure types.
- **Data Input:**
  - Collect real-time sensor data (temperature, vibration, power) and historical maintenance logs with labeled failures.
- **Training Process:**
  - Preprocess data, extract features, train model on labeled failures, and validate using precision/recall metrics.
- **Prediction Process:**
  - Deploy model as REST API or edge service to predict failures in real-time and trigger maintenance alerts.

RESULT



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Projects / mech_predict / mech_predict1
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Progress map
Prediction column: Failure Type
Read dataset
Split holdout data
Read training data
Preprocessing
Model selection
Snap Random Forest Classifier
Snap Decision Tree Classifier
Hyperparameter optimization
Feature engineering
P1
P2
P3
P4
P5
P6
P7
P8
P9
Relationship map
Swap view
Experiment completed
8 PIPELINES GENERATED
8 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 3 minutes
View log
Save code
Pipeline leaderboard
Accuracy (Optimized)
Search
ENG IN
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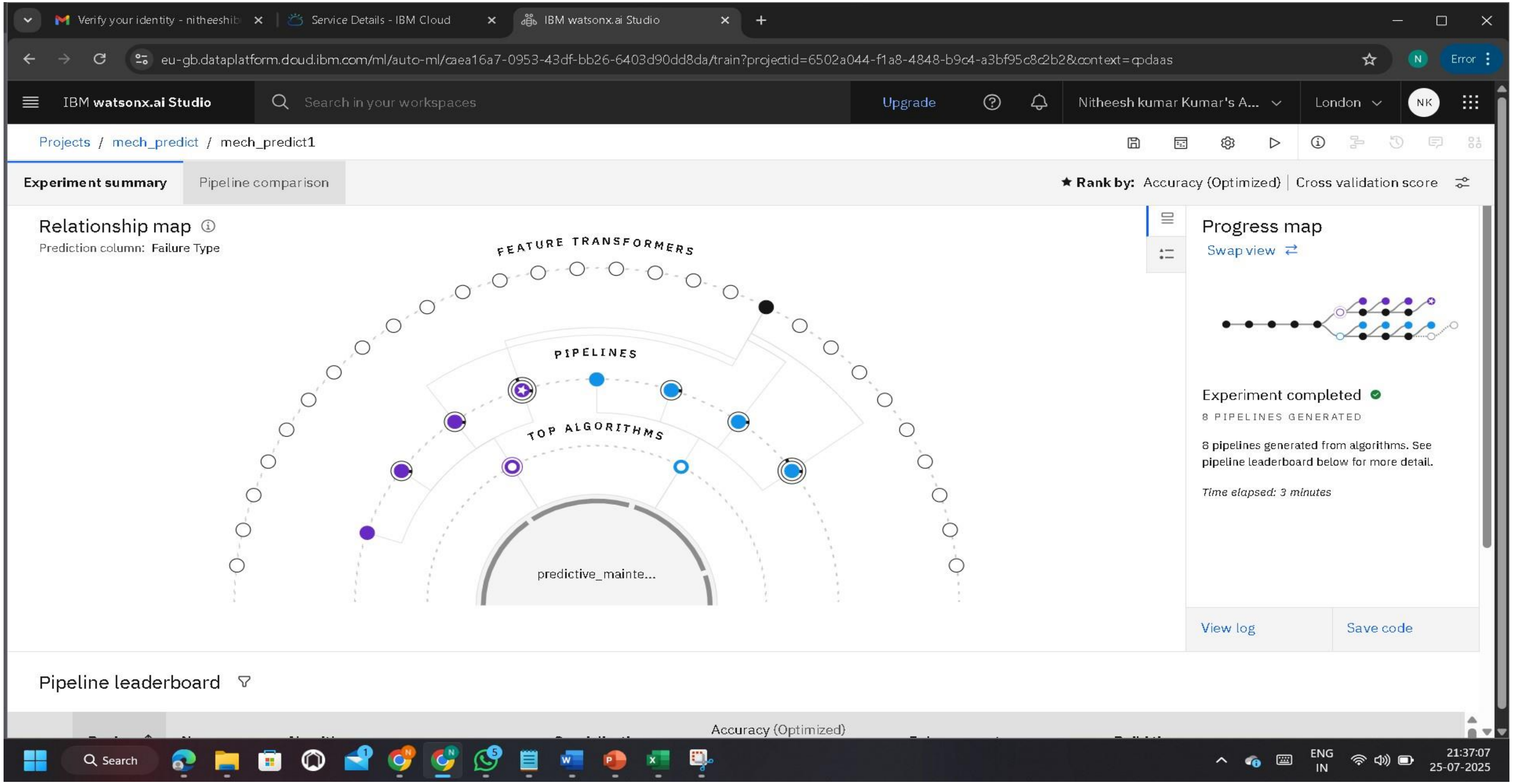
25-07-2025

RESULT



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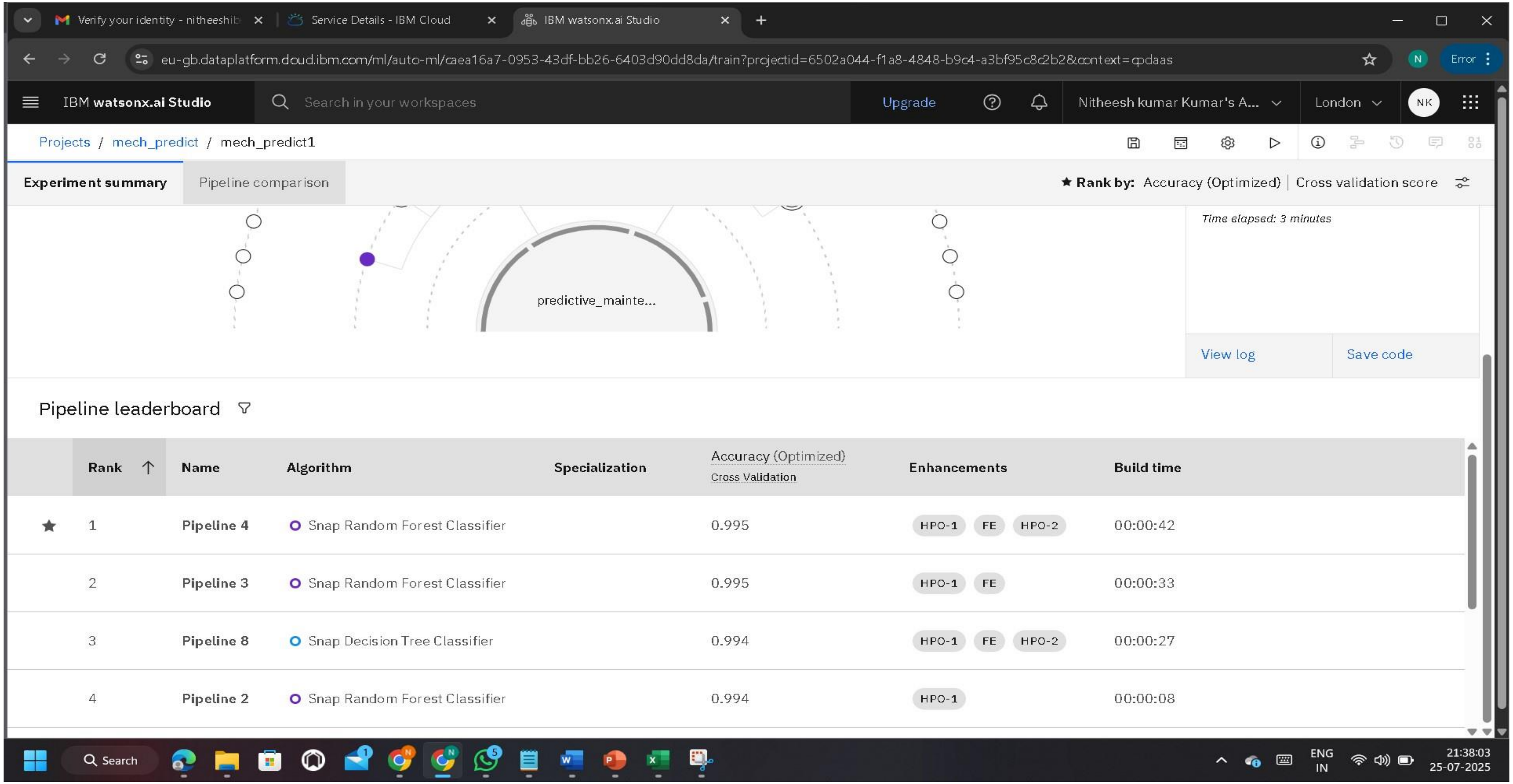
RESULT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Service Details - IBM Cloud
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predictive_mainte...
View log
Save code
Pipeline leaderboard
Rank
Name
Algorithm
Specialization
Accuracy (Optimized)
Cross Validation
Enhancements
Build time
1 Pipeline 4 Snap Random Forest Classifier 0.995 HPO-1 FE HPO-2 00:00:42
2 Pipeline 3 Snap Random Forest Classifier 0.995 HPO-1 FE 00:00:33
3 Pipeline 8 Snap Decision Tree Classifier 0.994 HPO-1 FE HPO-2 00:00:27
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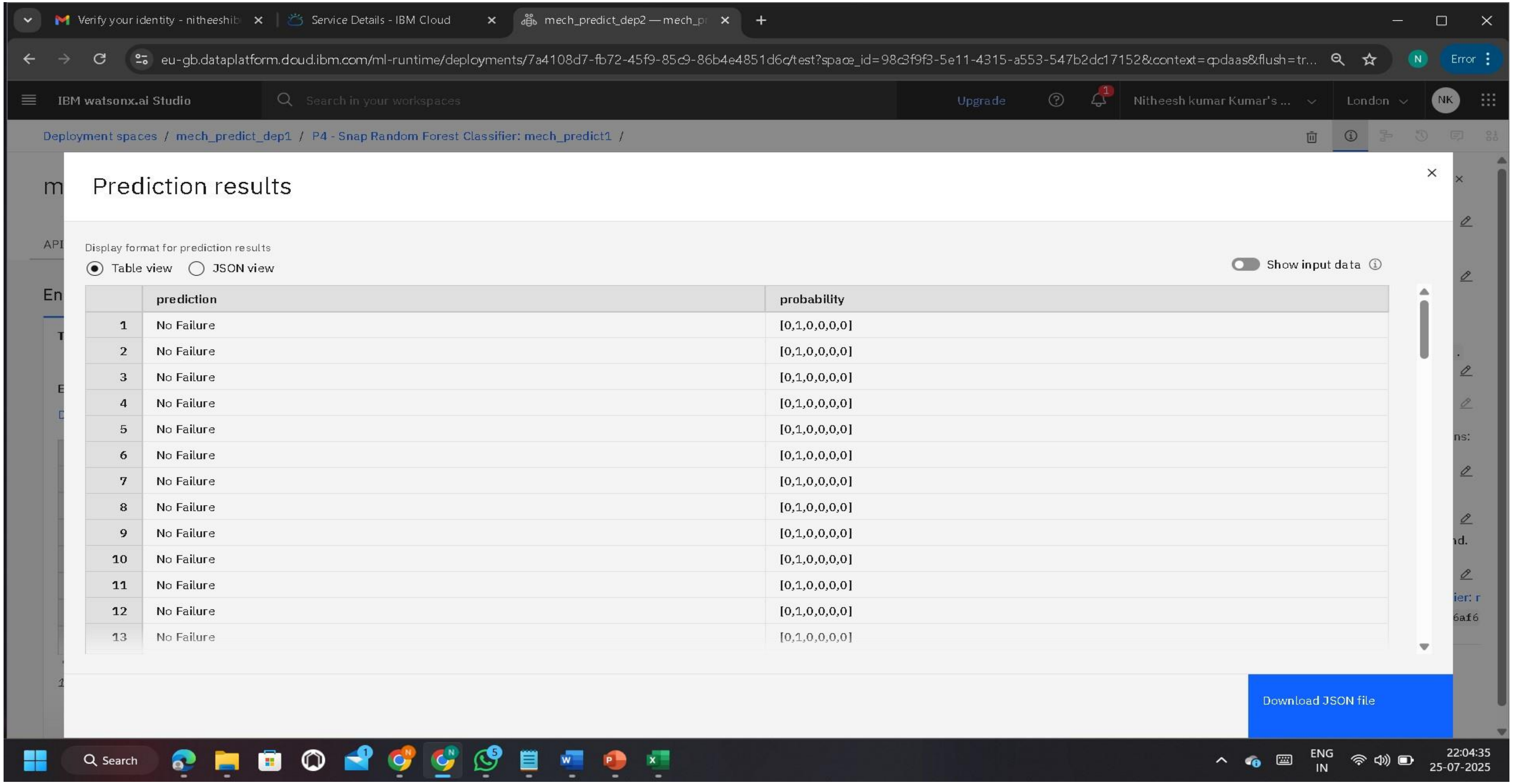
25-07-2025

RESULT


Verify your identity - nitheeshib
Service Details - IBM Cloud
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Deployment spaces / mech_predict_dep1 / P4 - Snap Random Forest Classifier: mech_predict1 /
Prediction results
Display format for prediction results
Table view
JSON view
Show input data
prediction
probability
1 No Failure [0,1,0,0,0,0]
2 No Failure [0,1,0,0,0,0]
3 No Failure [0,1,0,0,0,0]
4 No Failure [0,1,0,0,0,0]
5 No Failure [0,1,0,0,0,0]
6 No Failure [0,1,0,0,0,0]
7 No Failure [0,1,0,0,0,0]
8 No Failure [0,1,0,0,0,0]
9 No Failure [0,1,0,0,0,0]
10 No Failure [0,1,0,0,0,0]
11 No Failure [0,1,0,0,0,0]
12 No Failure [0,1,0,0,0,0]
13 No Failure [0,1,0,0,0,0]
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Search
ENG
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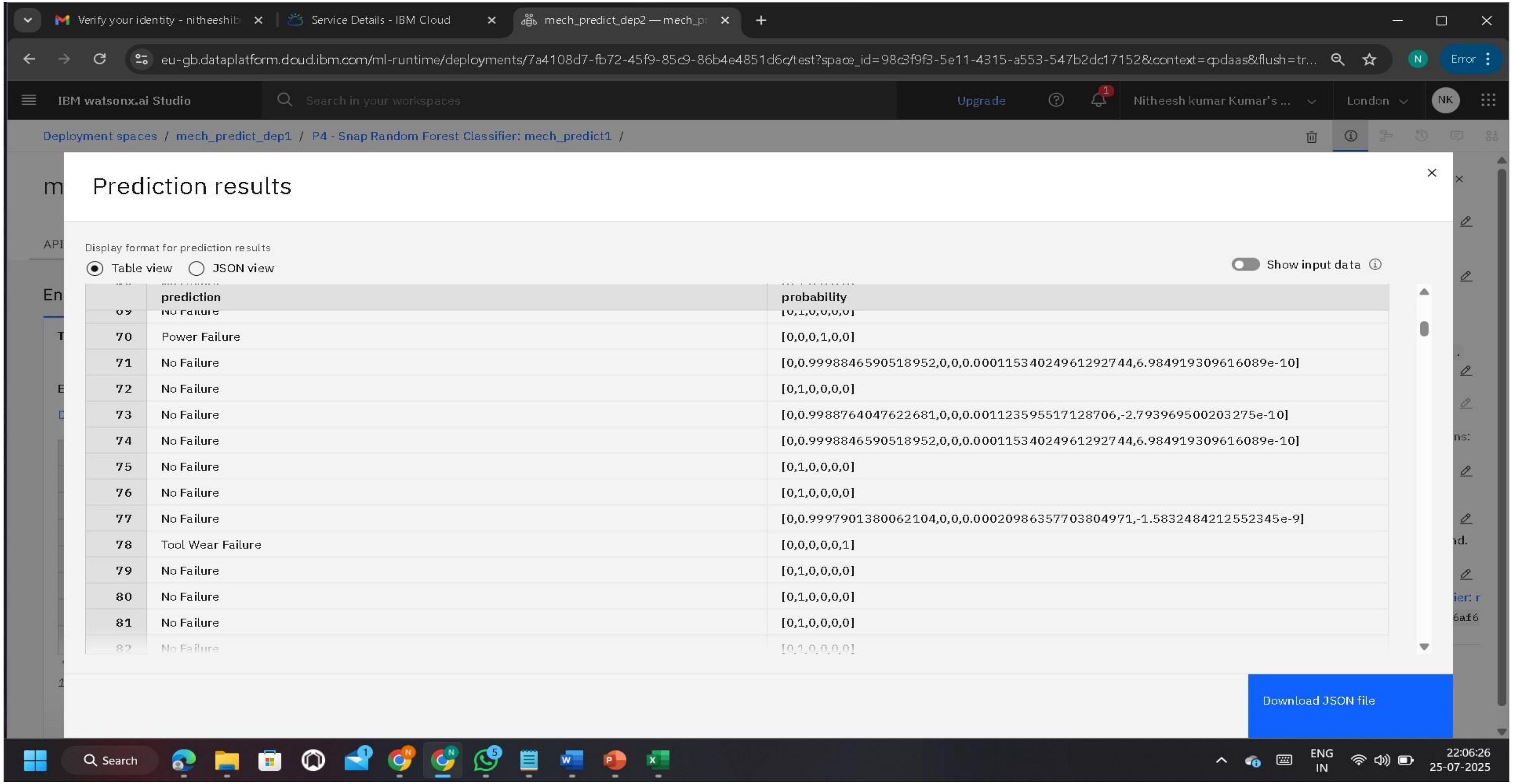
22:04:35
25-07-2025

RESULT



Verify your identity - nitheeshib
Service Details - IBM Cloud
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Deployment spaces / mech_predict_dep1 / P4 - Snap Random Forest Classifier: mech_predict1 /
Prediction results
Display format for prediction results
Table view
JSON view
Show input data
prediction
probability
70 Power Failure [0,0,0,1,0,0]
71 No Failure [0,0.9998846590518952,0,0,0.00011534024961292744,6.984919309616089e-10]
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76 No Failure [0,1,0,0,0,0]
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78 Tool Wear Failure [0,0,0,0,0,1]
79 No Failure [0,1,0,0,0,0]
80 No Failure [0,1,0,0,0,0]
81 No Failure [0,1,0,0,0,0]
Download JSON file
Search
ENG
IN
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CONCLUSION

- This predictive maintenance system leverages machine learning to analyze real-time sensor data, accurately forecasting equipment failures before they occur. By deploying an optimized classification model (Random Forest/XGBoost/LSTM) through cloud or edge computing, it enables proactive maintenance—significantly reducing downtime, cutting costs, and enhancing operational efficiency in industrial settings. The solution's scalable architecture ensures continuous improvement through periodic model retraining, making it a robust, data-driven approach for modern industrial maintenance.

FUTURE SCOPE

- The system can be enhanced with IoT integration for real-time analysis, deep learning for better accuracy, and explainable AI (XAI) for transparency. Adding more failure modes, using digital twins for simulations, and implementing reinforcement learning for adaptive scheduling could further improve predictions and scalability.

REFERENCES

- Kaggle dataset link – https://www.kaggle.com/datasets/shivamb/machine predictive-maintenance-classification

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According to the Adobe Learning Manager system of record

Completion date: 24 Jul 2025 (GMT)

Learning hours: 20 mins

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