CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:
1. Bhavadharini G- Kumaraguru College of Technology- IT(Data Science)

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

- We'll develop an intelligent predictive maintenance system that shifts your operations from reactive to **proactive**. By continuously analyzing data streams from machinery sensors, our machine learning model will accurately predict the specific type of failure—such as **tool wear**, **heat dissipation**, or **power failure**—before it occurs. This enables just-in-time maintenance, maximizing equipment uptime and significantly reducing operational costs.
- Key Components:
  - **Data & Feature Engineering:** Collect and clean sensor data (e.g., vibration, temperature), then engineer time-series features to reveal failure patterns.
  - **Model Training & Optimization:** Train and tune a classification model (e.g., Random Forest, LSTM) to accurately predict different failure types.
  - **Validation:** Evaluate the model with key metrics (accuracy, F1-score) and a confusion matrix to confirm its predictive reliability.
  - **Deployment:** Integrate the model into a live system that sends real-time failure alerts to the maintenance team.

SYSTEM APPROACH

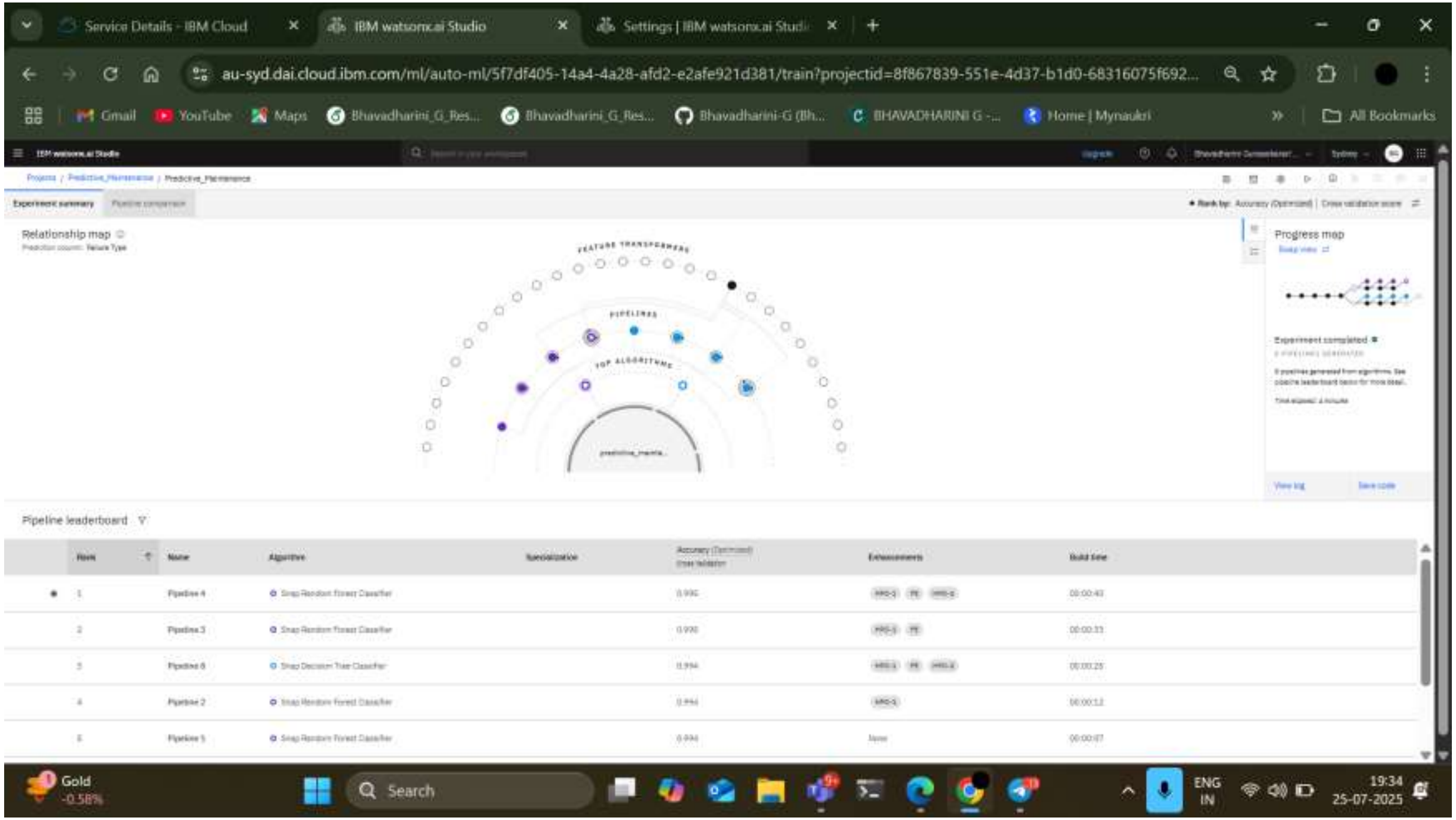
The "System Approach" section outlines the overall strategy and methodology for developing and implementing the rental bike prediction system. Here's a suggested structure for this section:

- **System requirements:**
  - IBM Cloud (mandatory).
  - IBM Watson Studio for model development and deployment.
  - IBM Cloud Object Storage for dataset handling.
- **Library required to build the model:**
  - Python with libraries like Scikit-learn and TensorFlow/PyTorch for model development and training.

ALGORITHM & DEPLOYMENT

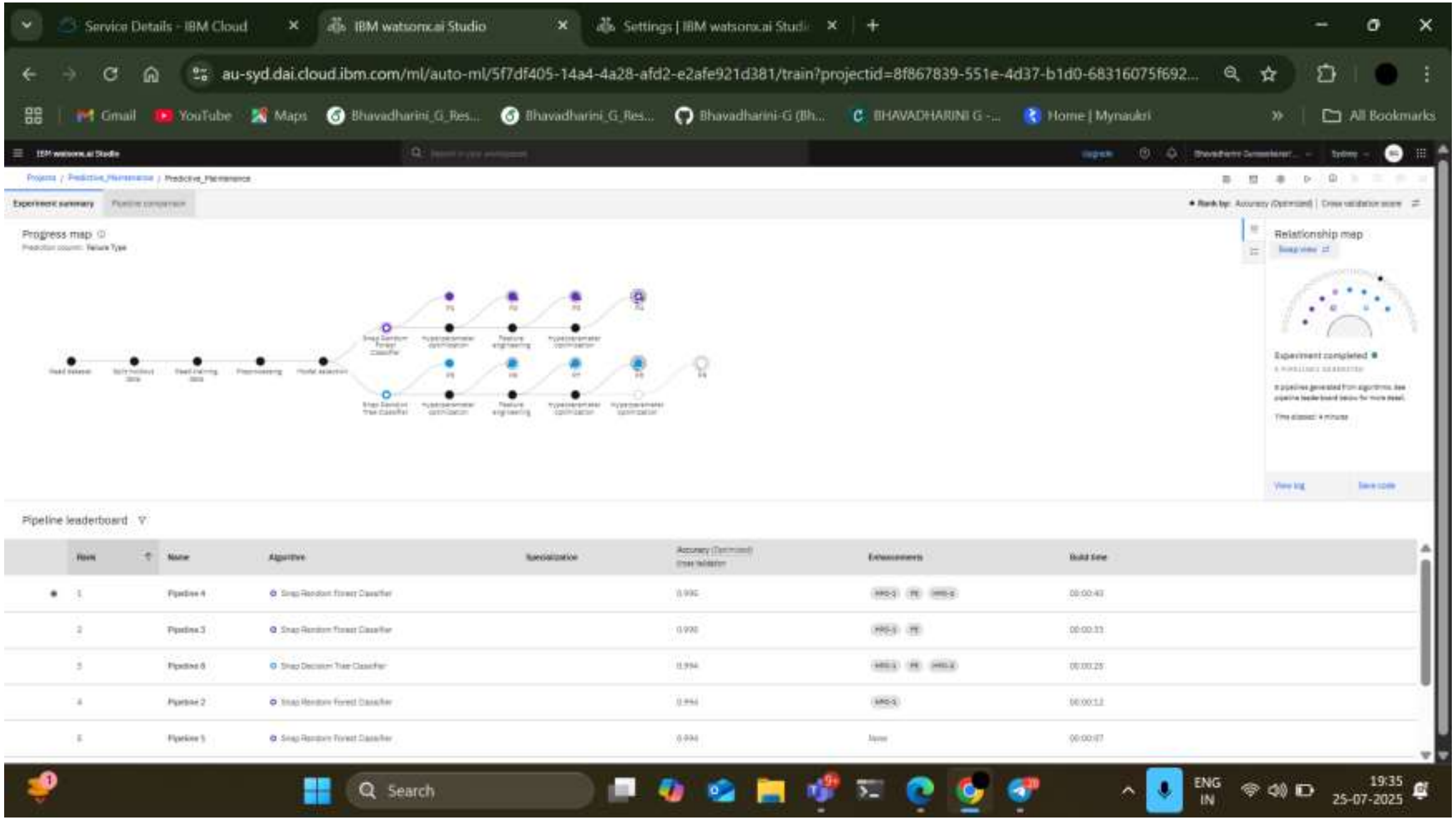
- **Algorithm Selection:**
  - **Random Forest Classifier** (or Gradient Boosting/LSTM, selected based on predictive performance).
- **Data Input:**
  - Real-time sensor measurements from machinery, such as **Tool wear [min], Air temperature [K] , rotational speed, and torque.**
- **Training Process:**
  - **Supervised learning** using historical data where sensor readings are labeled with the specific type of failure that occurred.
- **Prediction Process:**
  - The model will be deployed on **IBM Watson Studio**, providing an API endpoint for real-time failure predictions based on live data streams.

RESULT



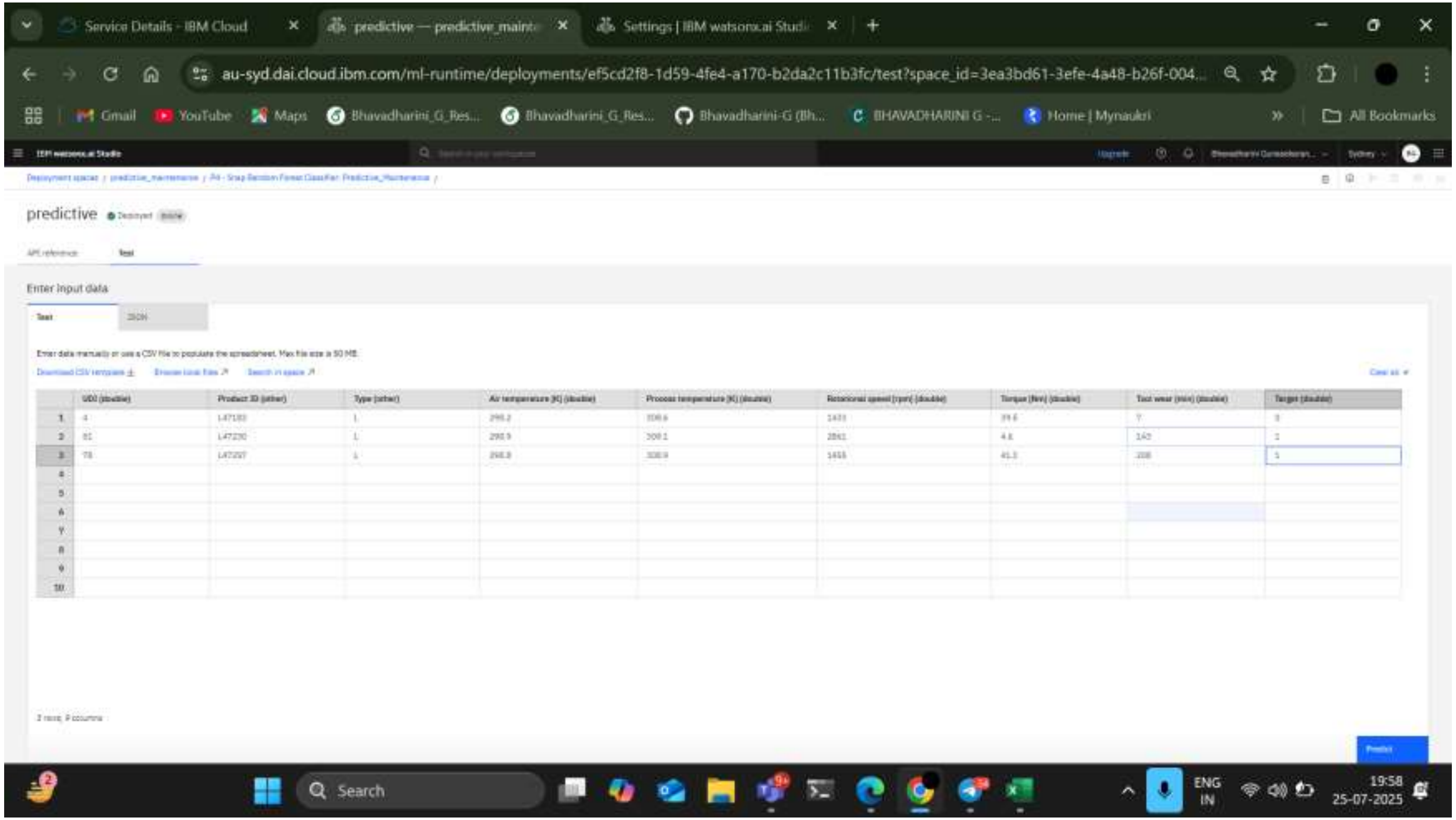
Service Details - IBM Cloud
IBM watsonx.ai Studio
Settings | IBM watsonx.ai Studi
au-syd.dai.cloud.ibm.com/ml/auto-ml/5f7df405-14a4-4a28-afd2-e2afe921d381/train?projectid=8f867839-551e-4d37-b1d0-68316075f692...
Gmail
YouTube
Maps
Bhavadharini_G_Res...
Bhavadharini_G_Res...
Bhavadharini-G (Bh...
BHAVADHARINI G -...
Home | Mynaukri
All Bookmarks
Relationship map
Progress map
Pipeline leaderboard
Gold
-0.58%
Search
ENG
IN
19:34
25-07-2025

RESULT



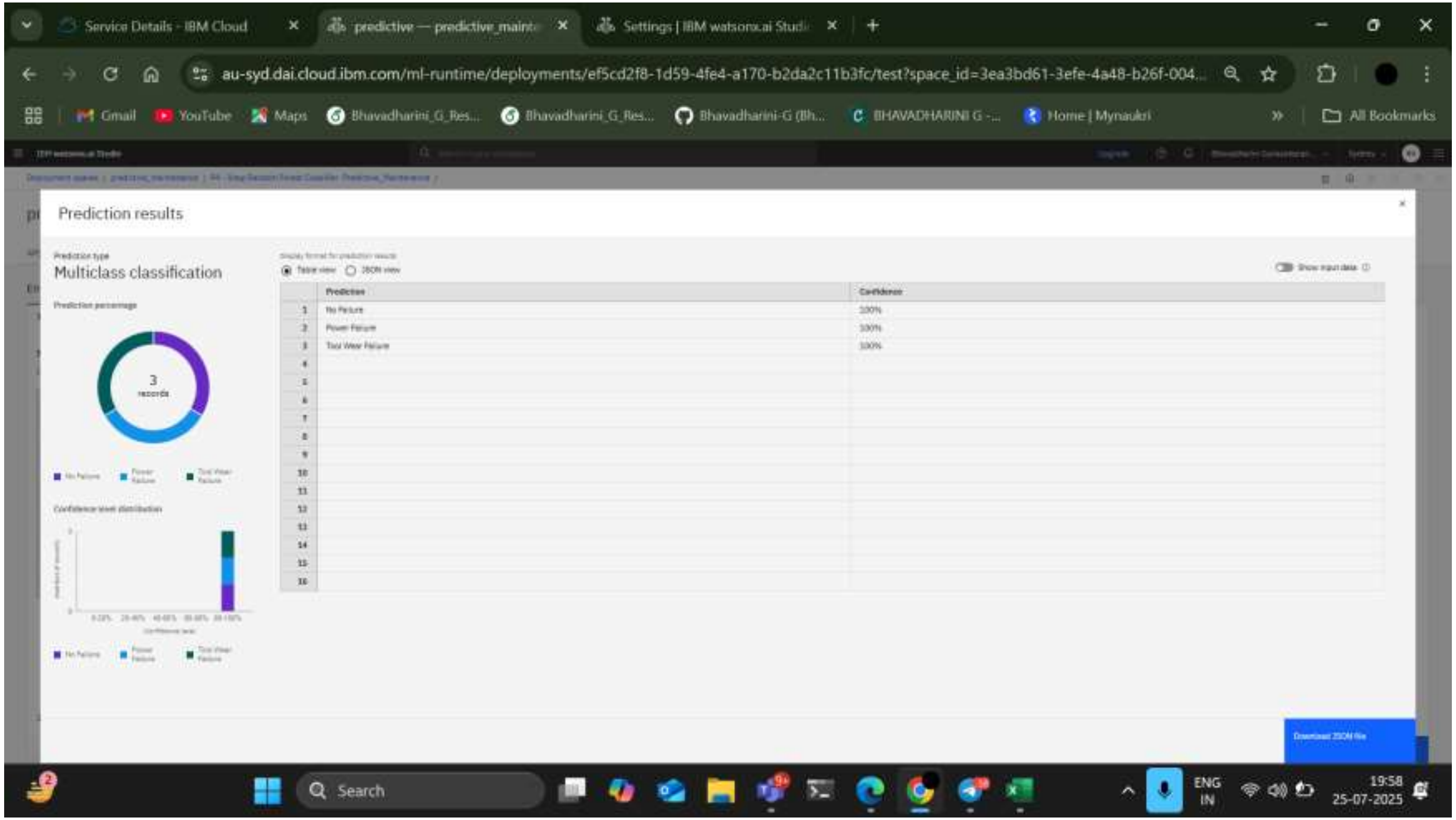
Service Details - IBM Cloud
IBM watsonx.ai Studio
Settings | IBM watsonx.ai Studio
au-syd.dai.cloud.ibm.com/ml/auto-ml/5f7df405-14a4-4a28-afd2-e2afe921d381/train?projectid=8f867839-551e-4d37-b1d0-68316075f692...
Gmail
YouTube
Maps
All Bookmarks
Progress map
Relationship map
Pipeline leaderboard
Search
ENG
IN
19:35
25-07-2025

RESULT



edunet foundation

RESULT



Service Details - IBM Cloud
predictive — predictive_mainte
Settings | IBM watsonx.ai Studi
au-syd.dai.cloud.ibm.com/ml-runtime/deployments/ef5cd2f8-1d59-4fe4-a170-b2da2c1b3fc/test?space_id=3ea3bd61-3efe-4a48-b26f-004...
Gmail
YouTube
Maps
Bhavadharini_G_Res...
Bhavadharini-G (Bh...
BHAVADHARINI G -...
Home | Mynaukri
All Bookmarks
Prediction results
Prediction type
Multiclass classification
Prediction percentage
3
records
Table view
JSON view
Prediction
Confidence
No Failure
100%
Power Failure
100%
Tool Wear Failure
100%
Search
ENG
IN
19:58
25-07-2025

CONCLUSION

- We successfully developed and deployed a high-performance predictive maintenance model using IBM Watson Studio. The AutoAI experiment identified a Random Forest Classifier as the top-performing algorithm, achieving an outstanding 99.5% accuracy through automated feature engineering and optimization.

- The final model is deployed as a live web service. It effectively processes sensor data to predict specific failure types, such as "Tool Wear" or "Heat Dissipation," with high confidence. This project delivered a robust and accurate solution ready for real-world integration to enable proactive maintenance and reduce operational costs.

FUTURE SCOPE

- **Predict Remaining Useful Life (RUL):** Enhance the model to predict the exact time remaining before a component fails. This shifts the focus from what will fail to precisely when it will fail, allowing for more efficient maintenance scheduling.
- **Automated Root Cause Analysis:** Incorporate interpretability techniques (like SHAP or LIME) to automatically highlight the key sensor readings responsible for a failure prediction. This would help maintenance teams diagnose the underlying problem much faster.
- **Full System Integration:** Integrate the prediction alerts directly with Computerized Maintenance Management Systems (CMMS). This could automatically generate work orders and schedule technicians, creating a fully automated, closed-loop maintenance system.

REFERENCES

- **Breiman, L. (2001). Random Forests.** *Machine Learning, 45*(1), 5-32. The original paper on the Random Forest algorithm.
- **Saxena, A., & Goebel, K. (2008). Turbofan Engine Degradation Simulation Data Set.** The benchmark dataset for predictive maintenance, provided by NASA.
- **Zheng, Y., et al. (2017). Remaining useful life estimation using a long short-term memory neural network.** *IEEE Transactions on Industrial Electronics.* A key paper on using LSTMs for predicting Remaining Useful Life (RUL).
- **Carvalho, A. T. Z., et al. (2019). Machine learning for predictive maintenance: A systematic literature review.** *Computers & Industrial Engineering.* A comprehensive review of real-world applications and case studies.

IBM CERTIFICATIONS


In recognition of the commitment to achieve professional excellence

Getting Started with Artificial Intelligence

IBM

Bhavadharini G

Has successfully satisfied the requirements for:

Getting Started with Artificial Intelligence

Issued on: Jul 16, 2025

Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/6766a9ec-3576-4db1-b58a-2e7a7221d274

IBM

IBM CERTIFICATIONS

In recognition of the commitment to achieve professional excellence

Journey to Cloud: Envisioning Your Solution

Bhavadharini G

Has successfully satisfied the requirements for:

Journey to Cloud: Envisioning Your Solution

Issued on: Jul 17, 2025
Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/71c6e933-9e47-411a-b7a2-a887f655951d

IBM

IBM CERTIFICATIONS

IBM **SkillsBuild** Completion Certificate

This certificate is presented to

Bhavadharini Gunasekaran

for the completion of

Lab: Retrieval Augmented Generation with LangChain

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

Completion date: 24 Jul 2025 (GMT)

Learning hours: 20 mins

THANK YOU