# CAPSTONE PROJECT

## PROBLEM STATEMENT NO.39:PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

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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

Example: 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

- The proposed system aims to address the challenge of predicting the Type of Failure in the industrial machinery. The solution will consist of the following components:
- Data Collection:
- Connect industrial machinery to IBM Watson IoT Platform.
- Collects data such as UDI, Product ID ,Type ,Air Temperature(K),Process Temperature ,Rotational Speed ,Torque ,Tool Wear , Target. Real-time streaming data sent securely to IBM Cloud.
- Data Preprocessing:
  - Clean the data: handle missing values, outliers, noise.
  - Split into train/test sets with appropriate labels (failure types).
  - Store the real time data in the form of CSV or JSON file in Cloud Object Storage
- Machine Learning Algorithm:
  - Implement a machine learning algorithm, such as Random Forest Algorithm which uses regression and classification.
  - Consider incorporating other factors like weather conditions, day of the week, and special events to improve prediction accuracy.
- Deployment:
  - Use AutoAI to build and compare multiple classification models (e.g., Random Forest, XGBoost, Neural Networks) using IBM Watson AI Studio and Watson Runtime Service.
  - Deploy the trained model as an API endpoint.
- Evaluation:
  - Evaluate on the test dataset. By giving the other parameter values and verify the type of failure in the industrial machinery(Tool wear,Heat dissipation,Power Failure or no failure. Fine-tune the model based on feedback and continuous monitoring of prediction accuracy.

# SYSTEM APPROACH

This Project aims at predicting the type of failure that is prevailing in the industrial machinery by analyzing and examining the air temperature,process tempereature,UDI and target.This project requires:

- IBM Watson AI Studio
- IBM Watson Runtime Service
- IBM Cloud Object storage
- CSV Data Set(Kaggle Dataset)

# ALGORITHM & DEPLOYMENT

- Data Preprocessing:

  Load and clean data (remove noise, nulls, outliers).
  Label encoding.

- Bootstrapping (Sampling):

  Randomly sample with replacement from the original dataset.
  Each sample is used to train one decision tree.
  This technique is known as **bagging** (Bootstrap Aggregating).

- Decision Tree Construction:

  Use a **random subset of features** at each split.
  Build a decision tree until a stopping condition is met.

- Read Dataset:

  The dataset (with sensor and failure data) is loaded into the environment.

- Split Holdout Data:

  The dataset is split into training and holdout (test) sets for model evaluation.

- Read Training Data:

  The training set is read for use in model building.

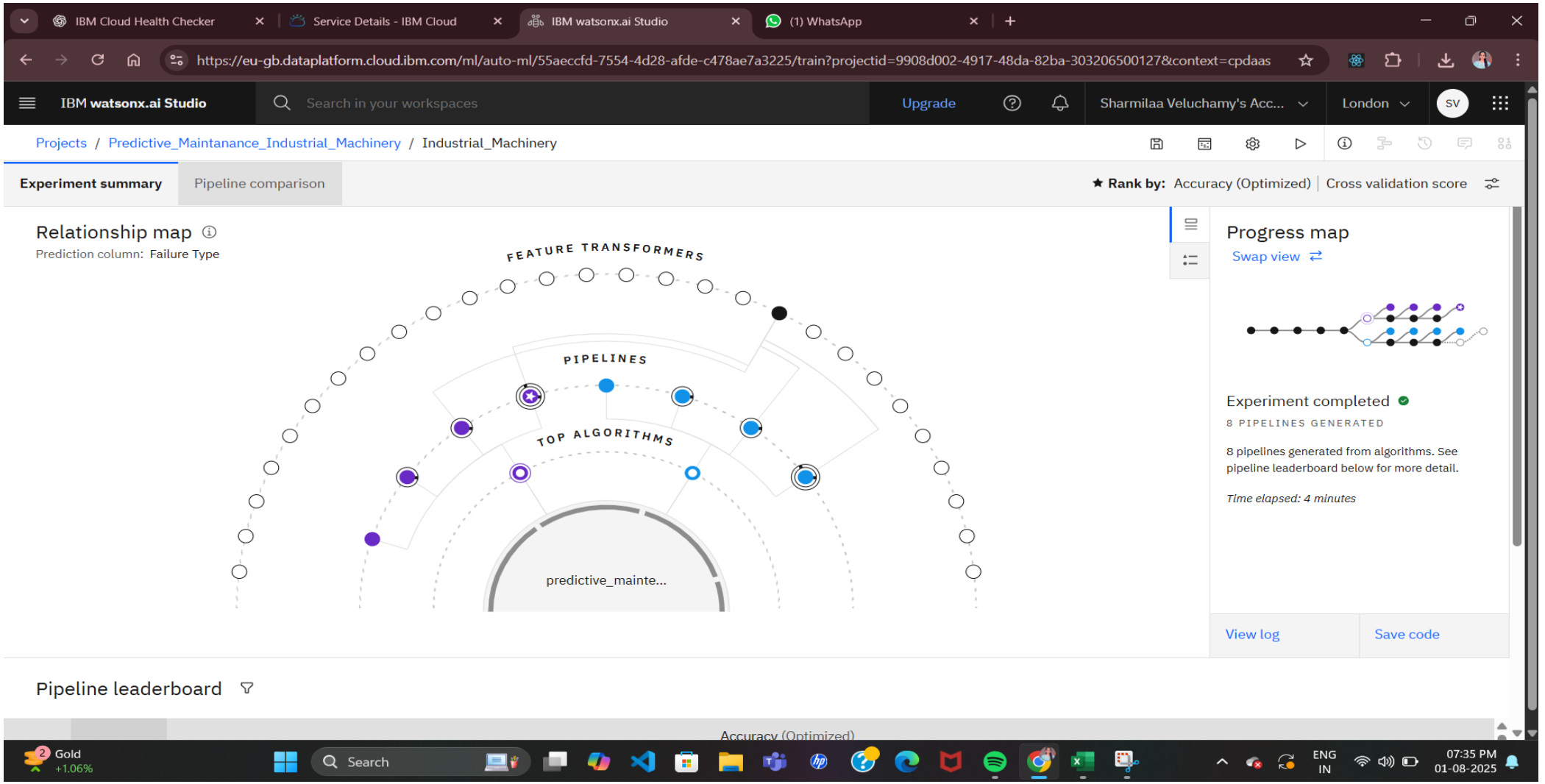
- Preprocessing:

  Data cleaning, scaling, and encoding are automatically handled.

- Model Selection:

  Initial algorithms are selected — e.g., Random Forest and Decision Tree classifiers.

# RESULT

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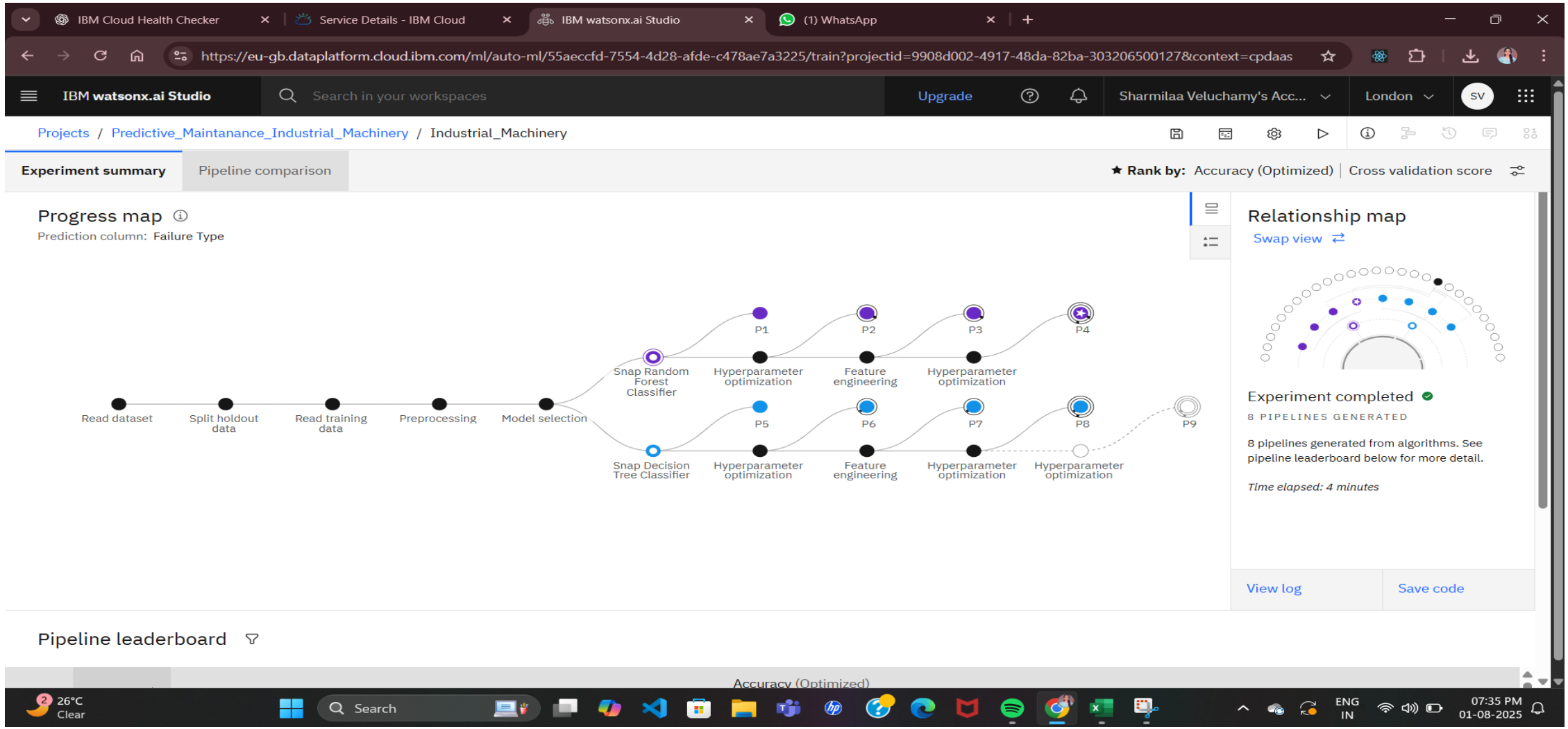
# RESULT

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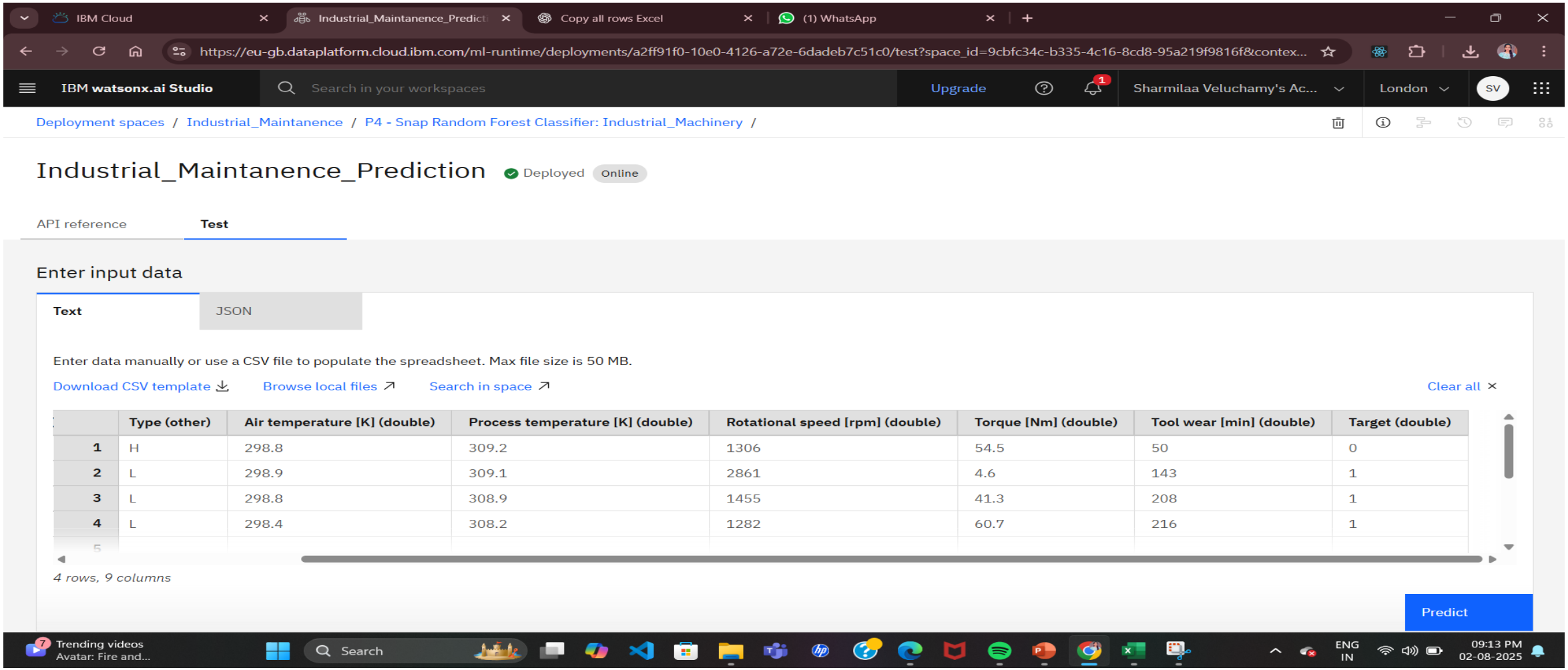
# RESULT

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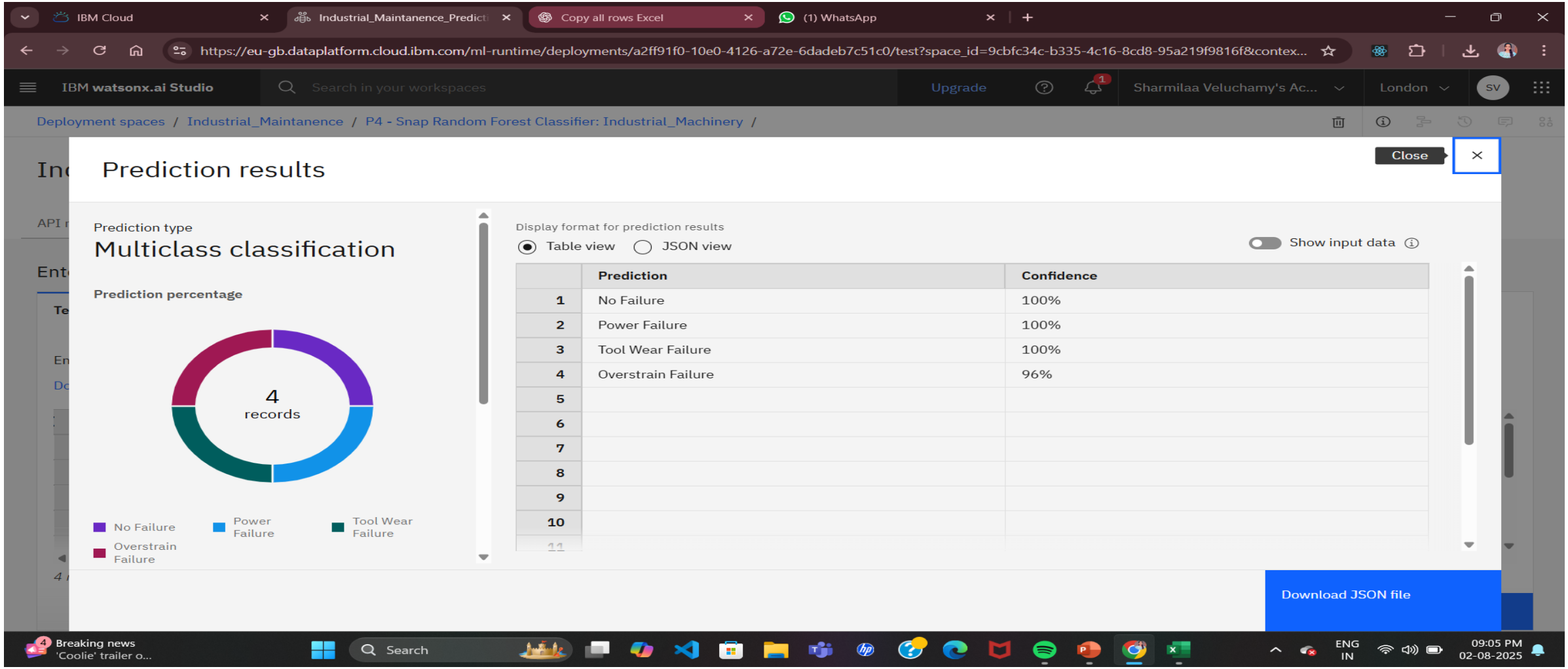
# RESULT

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# CONCLUSION

- The predictive maintenance model developed for a fleet of industrial machines using IBM Cloud successfully leverages real-time sensor data to anticipate machinery failures. By implementing a machine learning classification model, the system is capable of predicting various types of failures — such as tool wear, heat dissipation issues, and power failures — before they occur. This enables proactive maintenance, significantly reducing unplanned downtime, improving asset utilization, and minimizing operational costs.
- IBM Cloud services like IBM Watson Studio, IBM Cloud Object Storage, and IBM AutoAI have played a pivotal role in building and deploying this solution. The platform's robust infrastructure supports data ingestion, preprocessing, model training, evaluation, and deployment within a seamless, scalable, and secure environment.

# FUTURE SCOPE

- **Integration with IoT Platforms:**
  Integrate the model with IBM Watson IoT or Edge Devices for real-time, on-site analytics and instant decision-making without latency.
- **Model Refinement with Deep Learning:**
  Use deep learning models like LSTMs or CNNs to capture complex time-series patterns for improved prediction accuracy.
- **Predictive + Prescriptive Maintenance:**
  Extend the model to not only predict failures but also recommend corrective actions, spare parts inventory, and technician scheduling.
- **Multi-Asset Learning:**
  Train a generalized model across multiple machine types to handle heterogeneous equipment in a single predictive framework.
- **Visualization Dashboards:**
  Use IBM Cognos Analytics or Watson Studio dashboards for real-time visualization of machine health, maintenance alerts, and predictive insights.

# REFERENCES


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- Mobley, R. K. (2002). *An Introduction to Predictive Maintenance* (2nd ed.). Elsevier Science.
- https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification

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