CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:

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OUTLINE

- **Problem Statement**
- **Proposed System/Solution**
- **System Development Approach** (Technology Used)
- **Algorithm & Deployment**
- **Result (Output Image)**
- **Conclusion**
- **Future Scope**
- **References**

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PROBLEM STATEMENT

•The goal is to develop a predictive maintenance model for a fleet of industrial machines to **anticipate failures before they occur**.

•The system must analyze **sensor data from machinery** to identify patterns preceding failures.

•The model should predict the **type of failure** (e.g., tool wear, heat dissipation failure, power failure) based on **real-time operational data**.

•The solution aims to support **proactive maintenance**, reduce downtime, and lower operational costs.

PROPOSED SOLUTION

The proposed system aims to address the challenge of predicting machine failures in industrial machinery. This involves leveraging data analytics and machine learning techniques to identify failure patterns and enable proactive maintenance. The solution consists of the following components:

- **Data Collection:**

  Gather historical sensor data from machinery, including temperature, rotational speed, torque, and tool wear.

  Store and access the data securely using **IBM Cloud Object Storage**.

- **Data Preprocessing:**

  Clean and preprocess the collected data to handle missing values, outliers, and inconsistencies.

  Perform feature engineering to create new variables indicating failure conditions.

- **Machine Learning Algorithm:**

  Implement a **Random Forest Classifier** with class weighting to handle imbalanced failure classes.

  Use **SMOTE (Synthetic Minority Oversampling Technique)** to balance minority failure categories.

  Train the model on processed features and validate its performance.

- **Deployment:**

  Host the trained model on **IBM Watson Machine Learning** for scalable predictions.

  Integrate with real-time data pipelines to enable continuous monitoring and prediction.

- **Evaluation:**

  Evaluate the model using classification metrics such as precision, recall, and F1-score.

  Analyze feature importance to understand critical factors influencing failures.

SYSTEM APPROACH

Languages & Libraries:
•Python
•Pandas, NumPy
•scikit-learn
•Matplotlib, Seaborn

•Cloud Services:
•IBM Cloud Object Storage
•IBM watsonx.ai Studio
•IBM Watson Machine Learning

•Machine Learning Techniques:
•Random Forest Classifier
•Class Weight Balancing
•SMOTE Oversampling for minority classes

ALGORITHM & DEPLOYMENT

- **Algorithm:**

  Random Forest Classifier:

  Ensemble of decision trees

  Balanced class weights to mitigate imbalance

  Feature importances computed

  SMOTE:

  Synthetic Minority Oversampling Technique to balance class distribution before training

- **Deployment:**

  Model trained in **IBM watsonx.ai Studio**

  Data stored in **IBM Cloud Object Storage**

  Model hosted via **IBM Watson Machine Learning API**

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RESULT

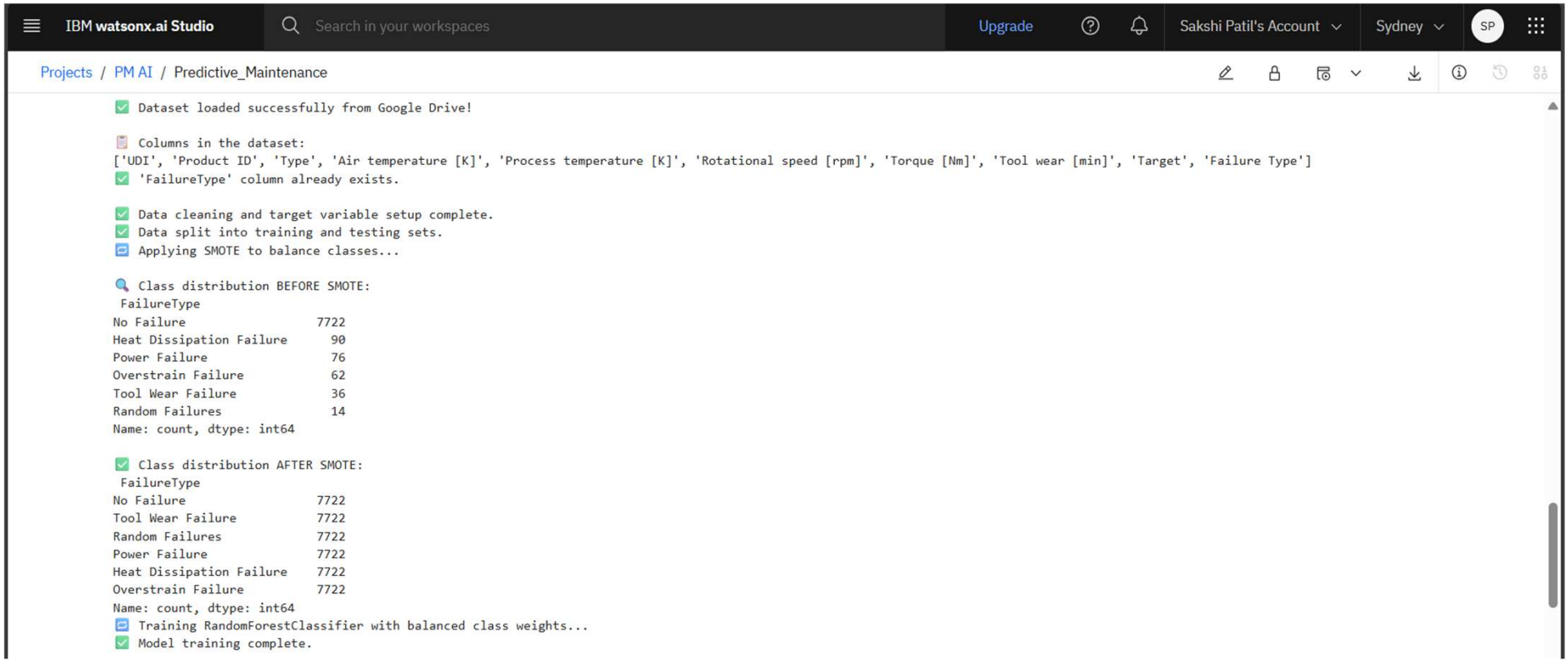
- Classification Report Highlights:

  High accuracy across most failure types

  Effective handling of class imbalance

  Key features contributing most to prediction: Torque, Tool Wear, Rotational Speed

RESULT IMAGES



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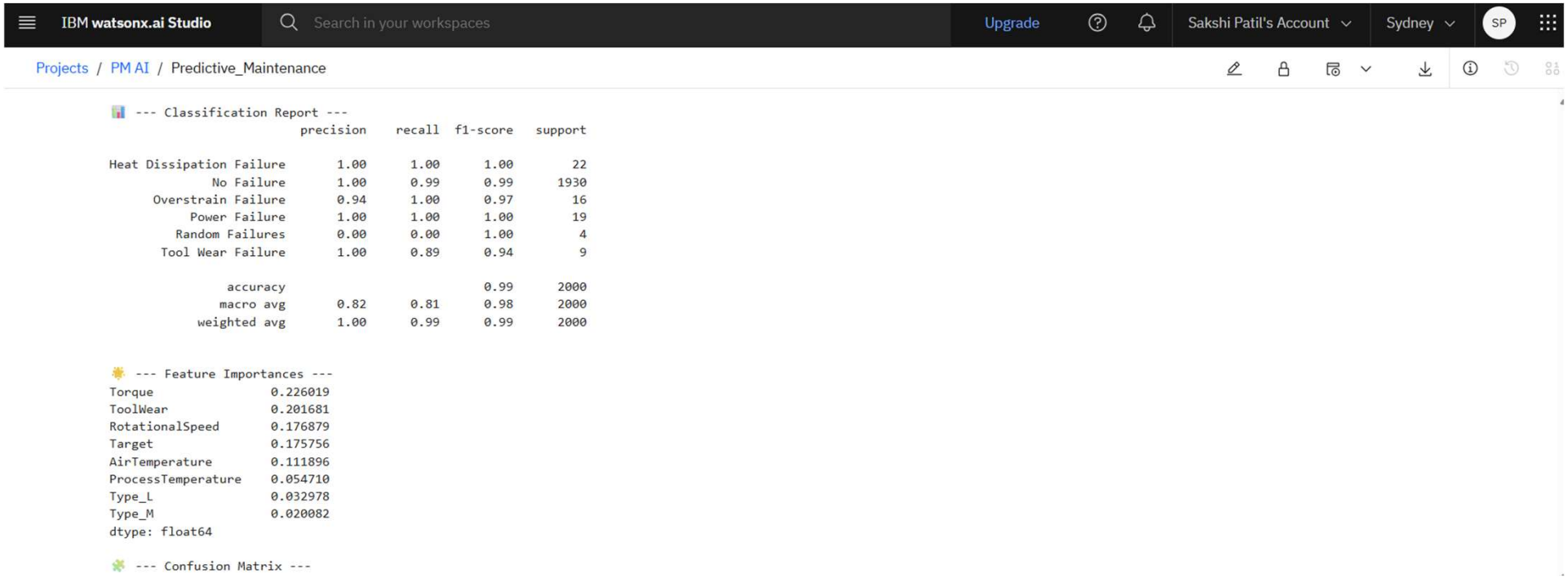

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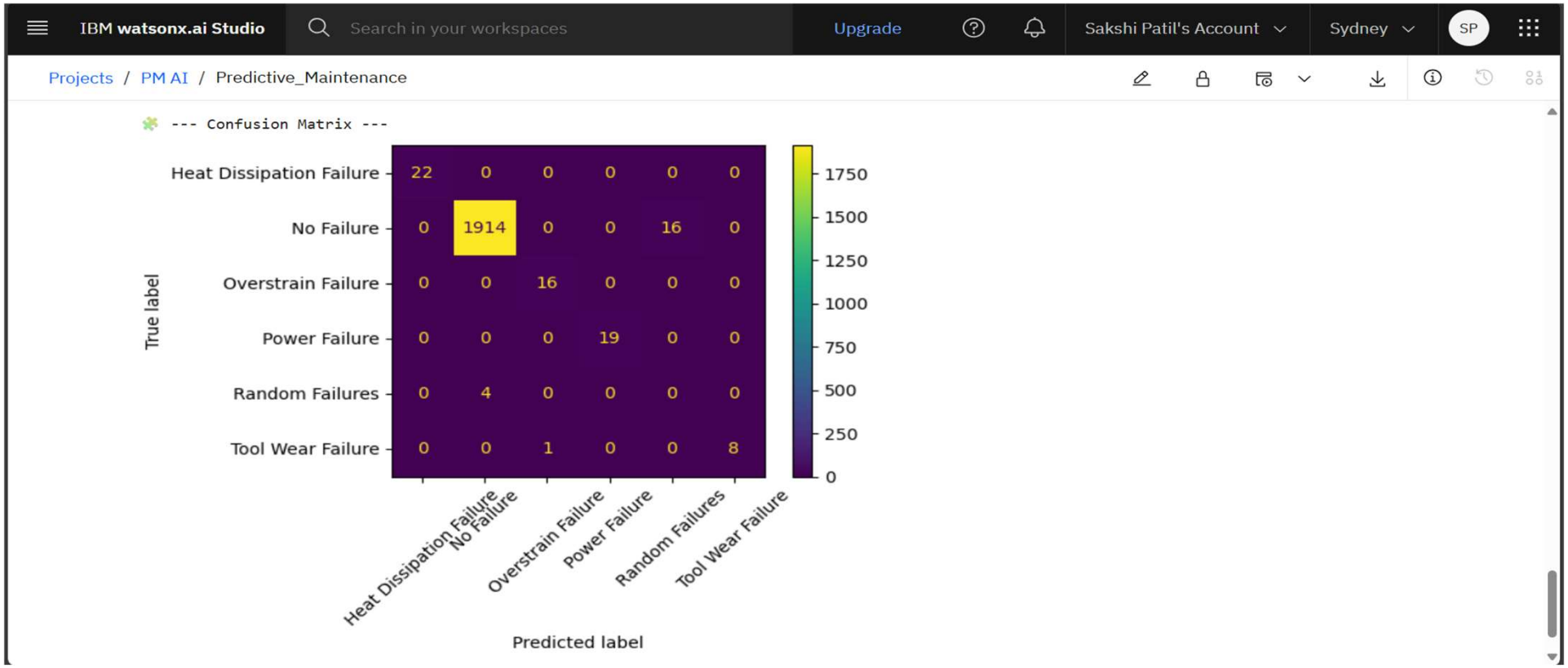
RESULT IMAGES



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CONCLUSION

- Successfully developed a **predictive maintenance system** using machine learning.
- The model can reliably predict multiple types of machine failures.
- Integration with IBM Cloud ensures **scalable deployment and real-time inference**.
- Implementation of **SMOTE** significantly improved prediction performance on minority classes.

FUTURE SCOPE

- Incorporate **real-time streaming data pipelines** for live prediction.
- Experiment with other advanced algorithms (e.g., XGBoost, Neural Networks).
- Develop a **web dashboard** to visualize predictions for maintenance teams.
- Extend the system to **predict failure severity and maintenance recommendations**.

REFERENCES

•Kaggle Dataset :-
https://drive.google.com/file/d/1QQ67oHcgYZTpqrJ05EmSpImAYXN_nc2Y/view?usp=sharing

•IBM Cloud Lite Documentation

•scikit-learn Documentation

•imbalanced-learn Documentation

PROJECT LINK

Project Link :- https://github.com/Sakshi2004-29/Machine_Maintenance

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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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