CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:

A.SARA FATHIMA – AALIM MUHAMMED SALEGH COLLEGE OF ENGINEERING – B.TECH ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

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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

Industrial machinery is prone to unexpected failures such as tool wear, overheating, or power issues, leading to unplanned downtime, increased maintenance costs, and reduced operational efficiency. Traditional maintenance methods are often reactive rather than preventive. This project aims to develop a **predictive maintenance model** that leverages real-time sensor data to anticipate potential machine failures. By analyzing patterns in operational data, the model will classify and predict the type of failure in advance, enabling **proactive maintenance** and significantly reducing downtime and costs across the fleet.

PROPOSED SOLUTION

- **The proposed system aims to address the challenge of predicting potential failure in industrial machines to enable timely maintenance and minimize downtime.**
- **Data Collection:**
  - Gather historical and real-time sensor data from machines, including temperature, vibration, power usage, and operating hours.
  - Integrate additional contextual data such as machine work load, usage frequency, and environmental conditions to improve prediction accuracy.
- **Data Preprocessing:**
  - Clean and preprocess the collected data to handle missing values, outliers, and inconsistencies.
  - Perform feature engineering to extract meaningful features (e.g., abnormal vibration levels, heat trends) that may indicate potential failures.
- **Machine Learning Algorithm:**
  - Implement a machine learning classification model (e.g., Random Forest, SVM, or Neural Network) to predict the type of failure (e.g., tool wear, overheating, power failure)..
  - Incorporate influential factors like sensor trends, machine runtime, and load levels to enhance model performance.
- **Deployment:**
  - Develop a user-friendly interface or dashboard to show real-time predictions and alerts to the maintenance team.
  - Deploy the solution on a scalable platform using IBM Cloud (Free Tier) to ensure accessibility, uptime, and performance.
- **Evaluation:**
  - Assess the model's performance using appropriate classification metrics such as Accuracy, Precision, Recall, and F1-Score.
  - Continuously monitor and fine-tune the model based on performance feedback and real-time results to maintain high prediction reliability.

SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the predictive maintenance system.

- **System requirements**
  - IBM Cloud account
  - IBM Watson Studio for model development and deployment
  - IBM Cloud Object Storage for storing datasets
  - IBM Watson Machine Learning service for training and deploying models
- **Library required to build the model**
  - pandas, numpy – Data handling & computation
  - matplotlib, seaborn – Data visualization
  - scikit-learn, xgboost/lightgbm – Model building
  - ibm_watson_machine_learning – Model deployment
  - joblib – Model saving/loading

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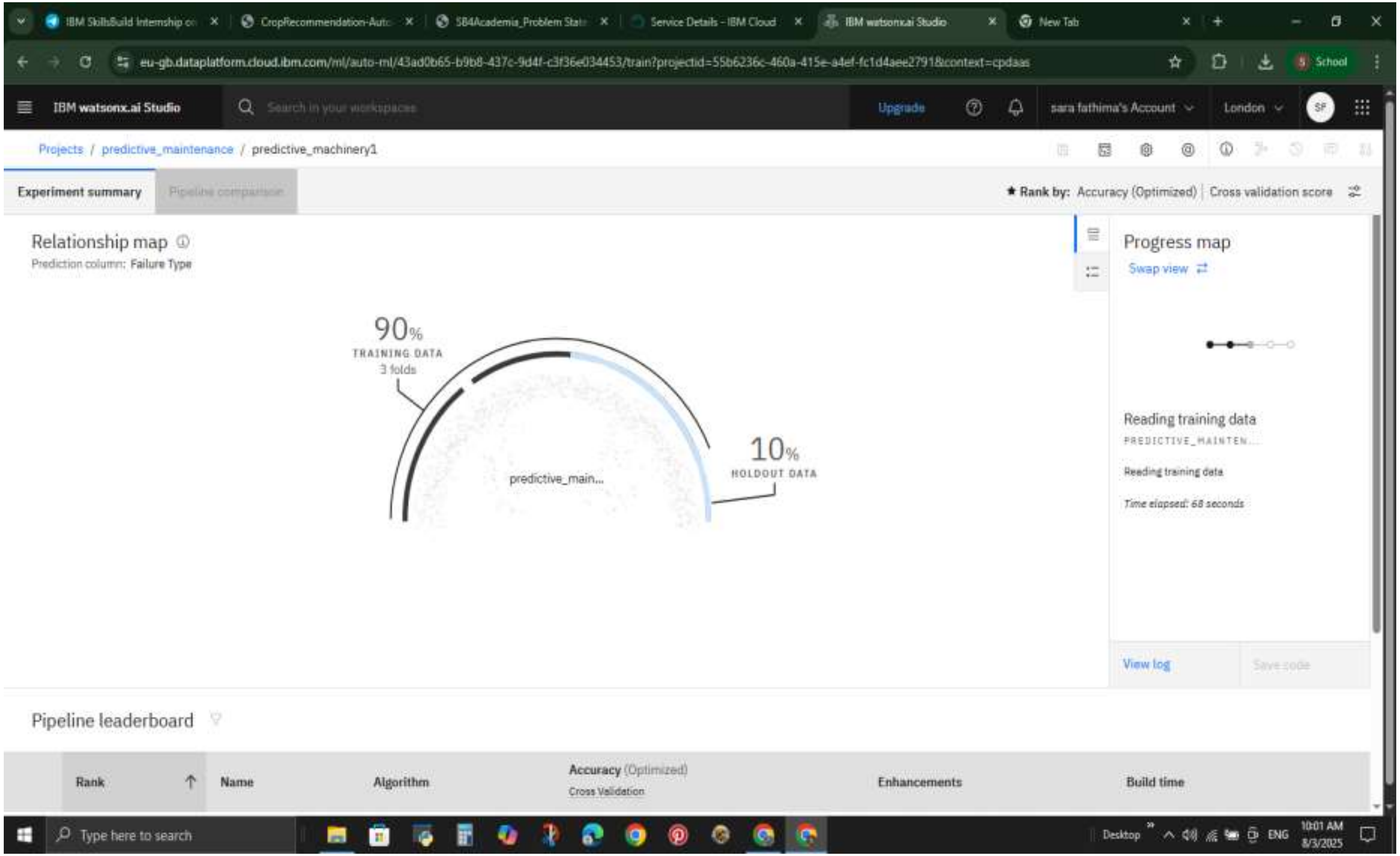
ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  A Random Forest classifier is used for predicting the type of machine failure (e.g., tool wear, overheating). It was selected for its high accuracy, ability to handle structured sensor data, and robustness to noise.
- **Data Input:**
  The model uses real-time and historical sensor data such as temperature, vibration, power consumption, machine runtime, and maintenance logs to detect failure patterns.
- **Training Process:**
  The model is trained using labeled historical data. Techniques like train-test split, cross-validation, and hyperparameter tuning (using GridSearchCV) are applied to improve performance and generalization.
- **Prediction Process:**
  After training, the model processes incoming sensor data to predict failure types in real-time, allowing timely alerts and preventive maintenance to avoid costly downtimes.

RESULT



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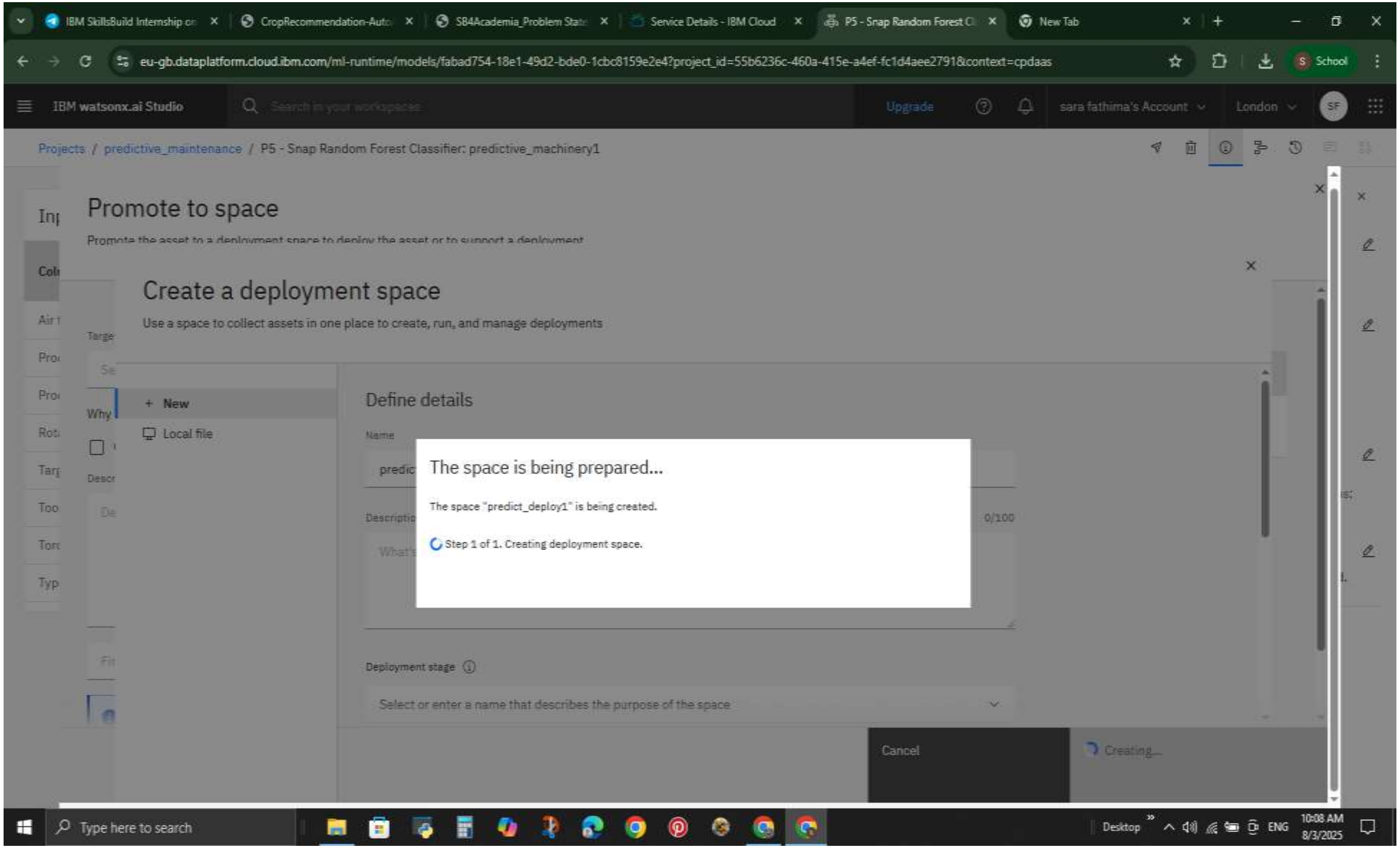

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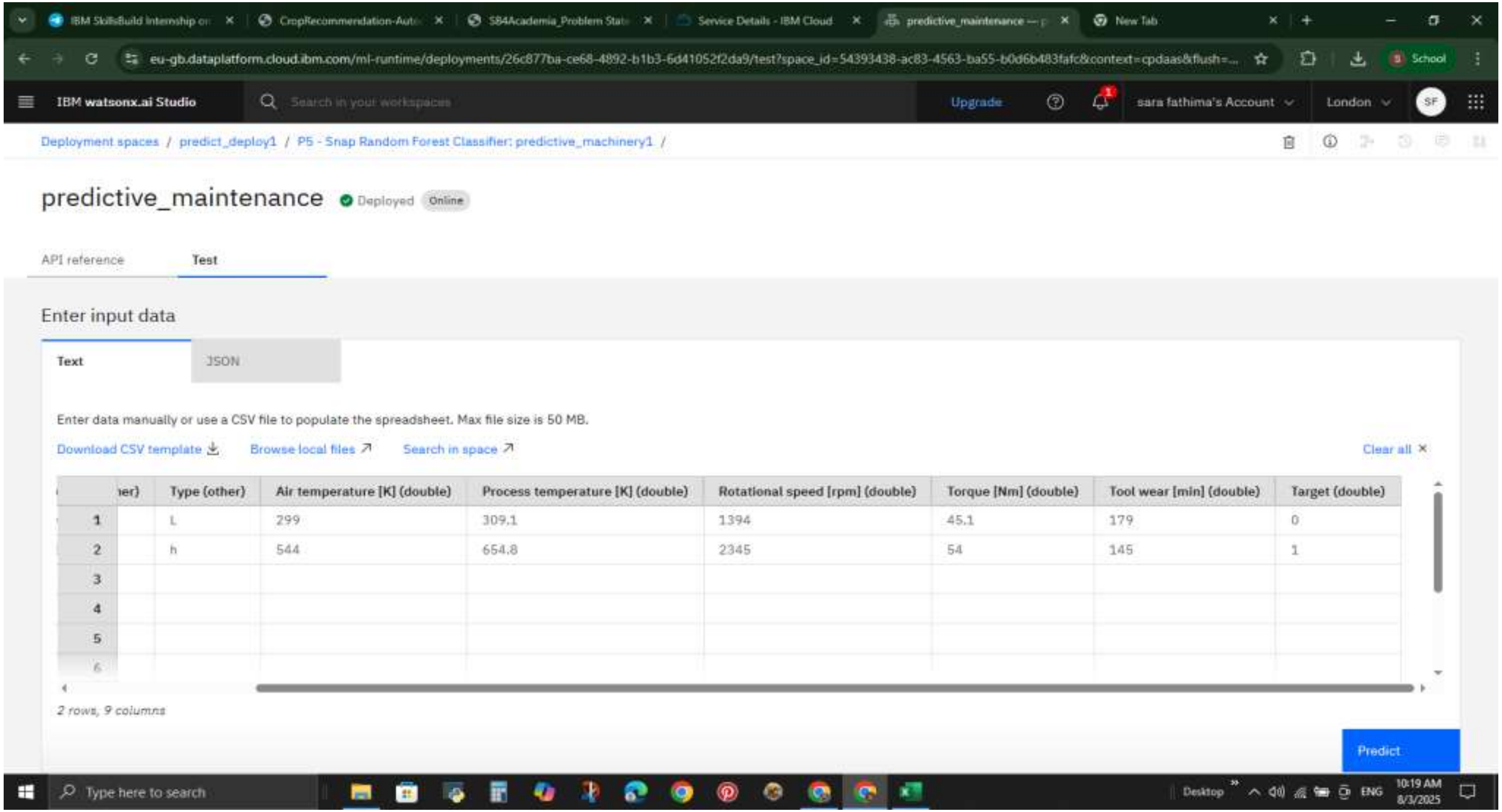
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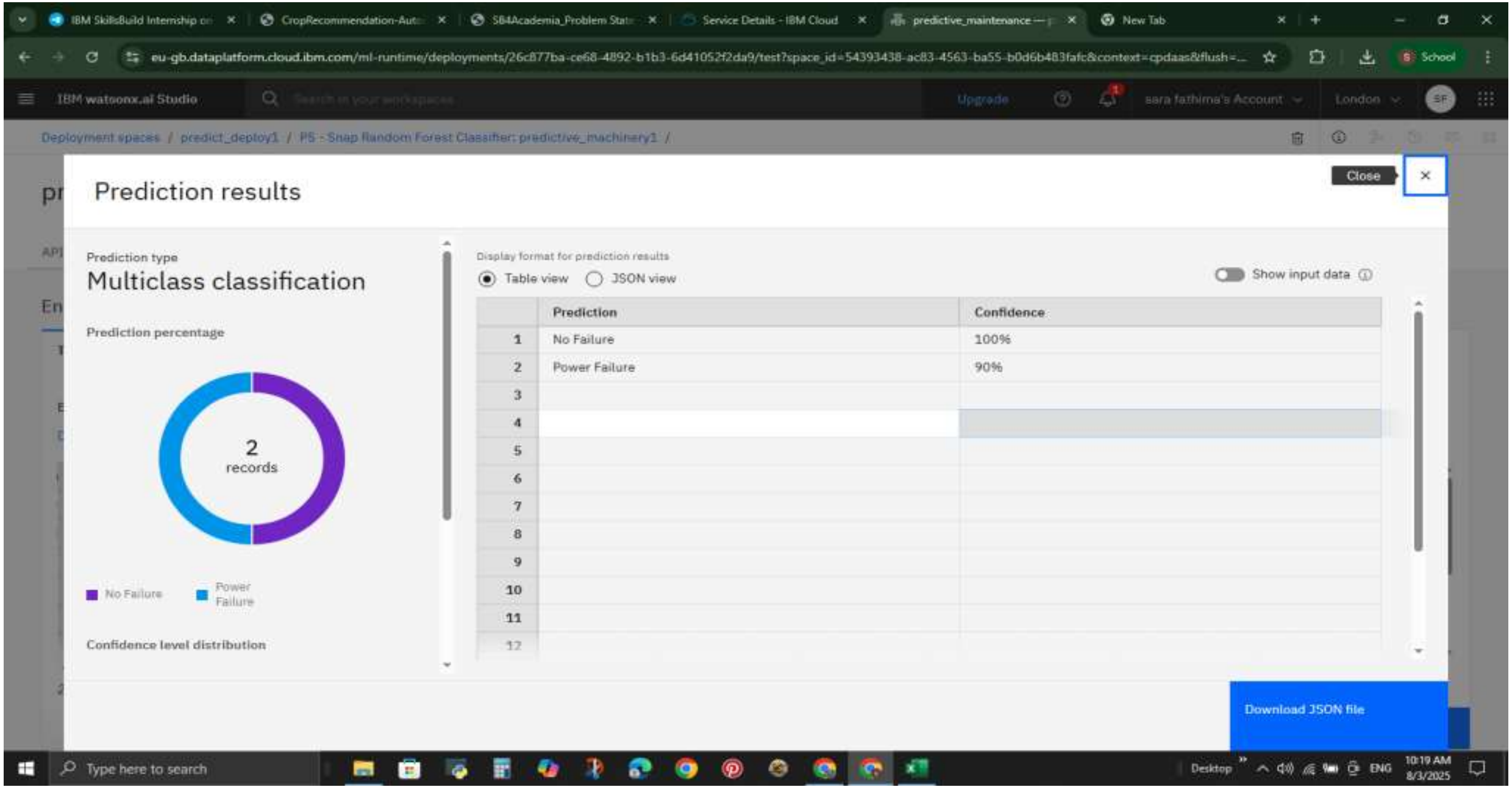
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CONCLUSION

- The IBM Watsonx.ai platform enabled accurate failure prediction using a Random Forest Classifier. The model achieved high precision in identifying power failures and no-failure cases. This approach enhances maintenance efficiency and reduces downtime. Future work can include real-time data integration and broader failure coverage.

FUTURE SCOPE

- Add more data sources (e.g., environment, operator logs)
- Use advanced ML models (e.g., XGBoost, LSTM)
- Enable real-time prediction with edge computing
- Expand system to multiple locations/factories
- Automate model retraining with new data
- Improve dashboard with insights and alerts

REFERENCES

- Susto, G. A. et al. (2015). *Machine Learning for Predictive Maintenance*, IEEE.
- Zhang, W. et al. (2019). *Data-driven Methods for Predictive Maintenance*, IEEE Systems Journal.
- Breiman, L. (2001). *Random Forests*, Machine Learning.
- IBM Cloud Docs – *Watson Machine Learning*.
- Scikit-learn Documentation – *Modeling & Preprocessing*.
- Tsai, C. F. et al. (2010). *Feature Selection Methods*, Decision Support Systems.

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