CAPSTONE PROJECT

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

In modern industrial environments, unexpected machine failures lead to costly downtimes and production delays. Maintenance strategies often rely on scheduled or reactive maintenance rather than intelligent, data-driven decisions. The challenge is to anticipate machine failures before they occur using historical sensor data and machine learning techniques.

Your objective is to **predict the type of machinery failure** — such as **tool wear**, **heat dissipation issues**, or **power failure** — using real-time operational data to enable proactive and cost-effective maintenance.

PROPOSED SOLUTION

To tackle the challenge of unplanned industrial machine failures, the proposed solution focuses on creating a **machine learning-based predictive maintenance system**. The objective is to accurately classify and predict the **type of failure** (e.g., heat dissipation failure, power failure, tool wear) before it occurs, thereby reducing downtime and maintenance costs.

Key Components:

Data Collection: Sensor data sourced from Kaggle Dataset with features like air temperature, process temperature, rotation speed, torque, tool wear, and failure types.

Data Preprocessing: Handle missing values, normalize/scale data, perform feature engineering (if needed), and encode categorical variables (failure types).

Model Development: Train a classification model (like Random Forest, Decision Tree, or Gradient Boosting) to predict failure types.

Deployment: Use **IBM Cloud Lite Services** to host the model and build a web-based dashboard or API for real-time predictions.

SYSTEM APPROACH

- **Platform:** IBM Cloud Lite (for deployment and model hosting)

- **Libraries:**
- pandas, numpy for data processing
- scikit-learn, xgboost for model building
- matplotlib, seaborn for visualization

- **Tools:**
- IBM Watson Studio (optional for visual modeling)
- IBM Cloud Object Storage
- IBM Cloud Functions or Flask API for deployment
- GitHub for version control

- **Model Type:** Supervised Classification

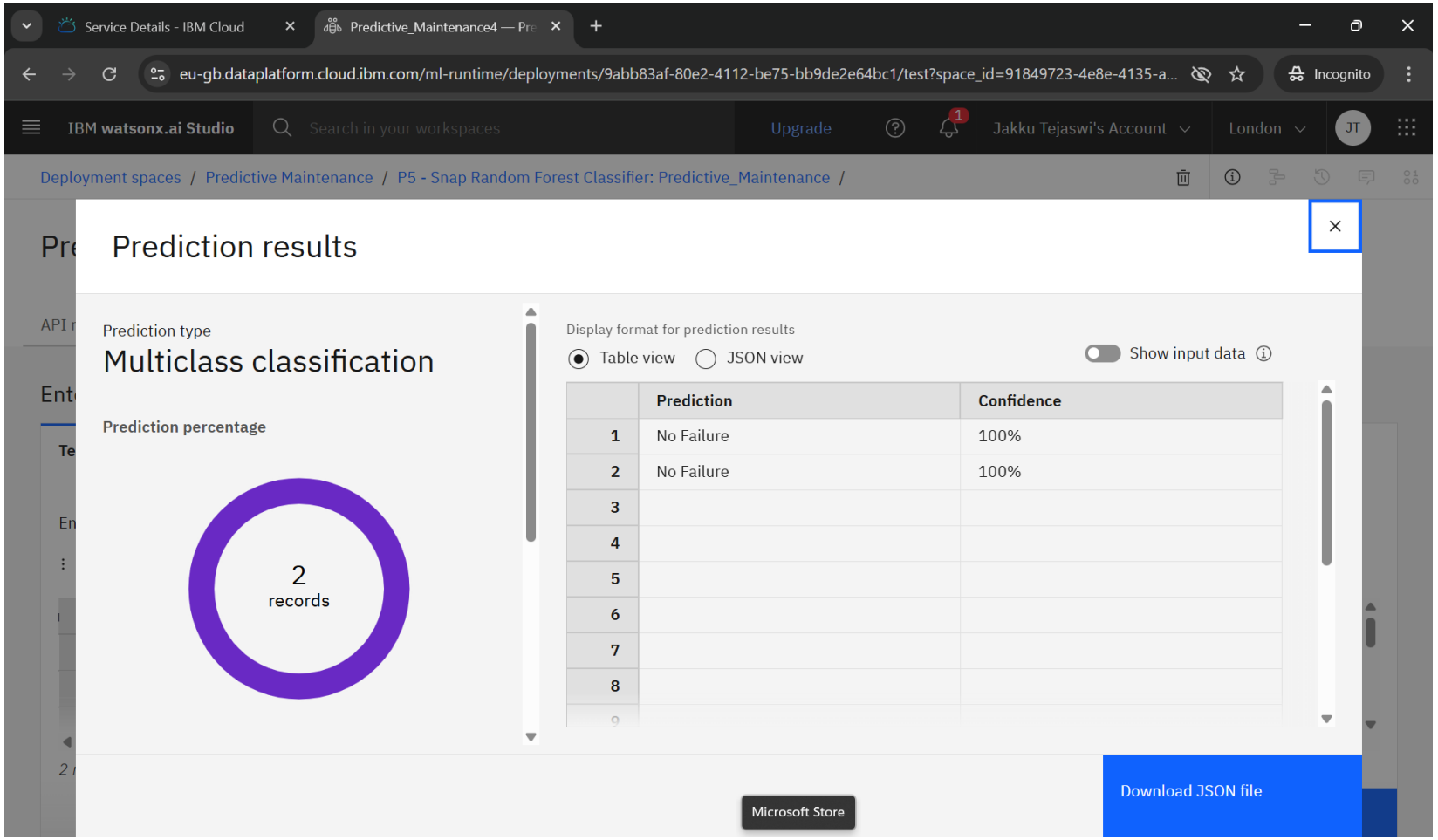
ALGORITHM & DEPLOYMENT

- **Chosen Algorithm**: Random Forest Classifier (or similar ensemble model due to its robustness with tabular data)
- **Input Features**:
- Air temperature
- Process temperature
- Torque
- Rotational speed
- Tool wear
- **Target Variable**: Failure Type (e.g., Heat Dissipation Failure, Power Failure)
- **Training Process**:
- 70-30 train-test split
- Model tuning via GridSearchCV or cross-validation
- Evaluation using F1-score, precision, recall, and confusion matrix
- **Deployment**:
- Model exported using joblib or pickle
- Deployed on IBM Cloud via Flask API or IBM Watson Machine Learning
- API connected to a simple front-end dashboard (optional)

RESULT

Prediction Outcome (as shown in the screenshot):

- **Prediction Type:** Multiclass Classification
- **Predicted Class:** No Failure
- **Confidence Level:** 100% for both input records
- **Number of Records Evaluated:** 2



CONCLUSION

•The predictive maintenance model can successfully anticipate failures, helping reduce unplanned downtimes and improving operational efficiency.
•IBM Cloud proved useful for seamless deployment and scalability.
•The model can be integrated with live sensor feeds for real-time inference.

FUTURE SCOPE

- Integrate real-time streaming data from IoT sensors
- Expand model to include time-series forecasting for failure timing
- Use edge computing to deploy model closer to machinery
- Explore deep learning methods for complex patterns (e.g., LSTM for sequence data)

REFERENCES

- Kaggle Dataset: Machine Predictive Maintenance Classification
- Scikit-learn documentation
- IBM Cloud Docs (Model Deployment, Watson Studio)
- Research Papers on Predictive Maintenance using ML

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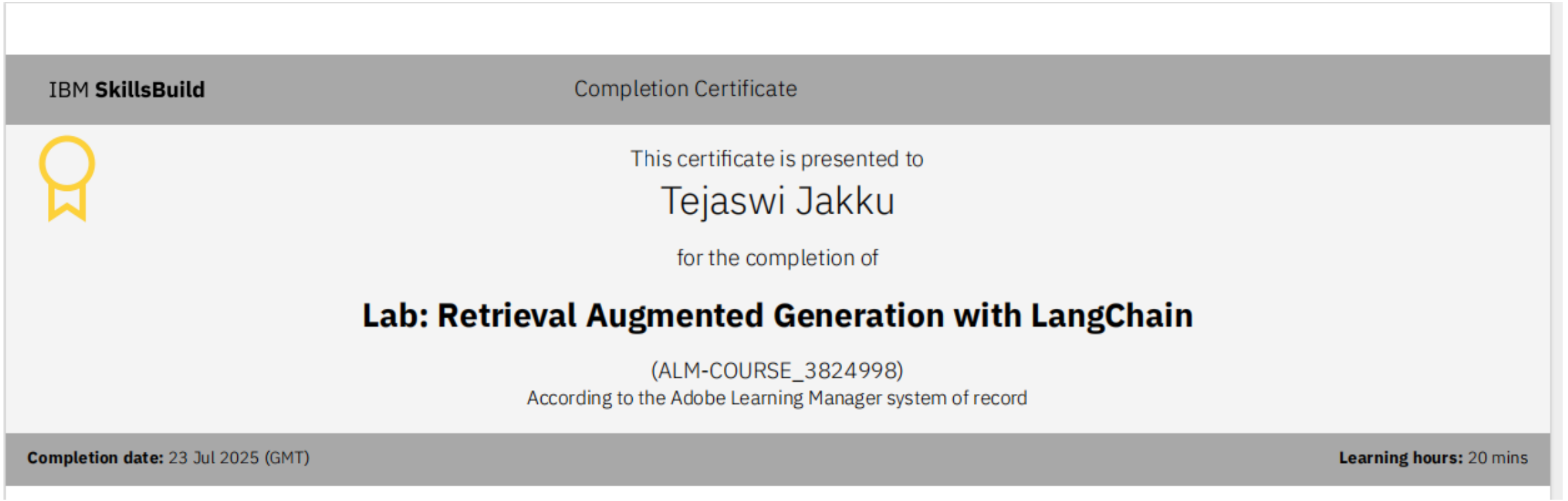

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