CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:

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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

- Develop a predictive maintenance model for a fleet of industrial machines to anticipate failures before they occur.
- This project will involve analysing 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 proactively detect potential machine failures and minimize downtime by leveraging machine learning techniques and cloud-based deployment. It utilizes sensor data analytics to predict different types of failures before they occur. The solution will consist of the following components:
- Data Collection:
  - Gather real-time and historical sensor data from machines, including temperature, pressure, vibration, and operational cycles.
  - Include failure logs for labeled training data indicating the type of failure (e.g., tool wear, heat dissipation, etc.).
- Data Pre-processing:
  - Clean and normalize sensor readings to remove noise, missing values, and anomalies.
  - Conduct feature engineering to extract predictive indicators such as rolling averages, deltas, and frequency-domain metrics.
- Machine Learning Model:
  - Implement a supervised classification algorithm (e.g., Random Forest, SVM, or XG-Boost) to classify the type of potential machine failure.
  - Use IBM Watson Studio Auto-AI to automate model selection and pipeline optimization.
- Deployment:
  - Deploy the trained model using IBM Cloud Lite services such as Watson Machine Learning and Cloud Functions.
  - Build a simple monitoring dashboard that alerts operators about predicted failures in advance.
- Evaluation:
  - Assess the model using accuracy, precision, recall, and F1-score to ensure high reliability in predictions.
  - Continuously improve the model with retraining on new sensor data and feedback from actual maintenance events.
- Result:
  - Reduced machine downtime, optimized maintenance schedules, and lower operational costs due to timely detection of issues.

SYSTEM APPROACH

This section presents the approach, requirements, and recommended tools tailored for developing and deploying your rental bike prediction system on IBM Cloud.System Requirements

1) System Requirements

- **Cloud Platform:** IBM Cloud Lite
- **Storage Service:**
  - **Cloud Object Storage-lq** (Global, Active)
  - Used for securely storing training data, model artefacts, and result outputs
- **AI / Machine Learning Services:**
  - **watsonx.ai Runtime-dx** (London region): Executes model training and inference tasks
  - **watsonx.ai Studio-g2** (London region): Used for AutoAI, model development, and pipeline orchestration
- **Environment Definition:**
  - **Large Configuration** – 8 vCPU and 32 GB RAM
  - Ensures efficient processing of large datasets and fast model training performance

2) Libraries Required to Build the Model

- **autoai** – For automated model selection and optimization in IBM watsonx.ai
- **ibm_watson_machine_learning** – For integration with IBM Cloud services and deployment

ALGORITHM & DEPLOYMENT

In the Algorithm section, describe the machine learning algorithm chosen for predicting bike counts. Here's an example structure for this section:

- **Algorithm Selection:**
  - We implemented a **classification model** (e.g., Random Forest or XG-Boost) suitable for detecting different types of machinery failures based on sensor data.
- **Data Input:**
  - Input features include **sensor readings** like temperature, torque, vibration, tool wear, and operational settings collected in real-time.
- **Training Process:**
  - The model was trained on historical sensor data using **IBM watsonx.ai Studio**, with **Cloud Object Storage** used for data handling and pipeline integration.
- **Prediction Process:**
  - Once deployed, the model continuously analyses incoming machine data and **predicts potential failures**, enabling timely maintenance actions and reducing unexpected downtime.

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RESULT

- The machine learning model achieved high accuracy in classifying potential machinery failures, enabling timely maintenance actions.
- Visual comparisons of predicted vs. actual failure types showed strong alignment, confirming the model's reliability and effectiveness.

CONCLUSION

- The proposed predictive maintenance solution effectively identified machinery failures before occurrence, reducing downtime and operational disruptions.
- While minor challenges were faced in handling sensor noise and class imbalance, the model demonstrated strong performance.

FUTURE SCOPE

- The system can be enhanced by integrating real-time IoT sensor data and expanding coverage across diverse machinery types and industries.
- Future improvements include optimizing models with deep learning, enabling edge computing for on-device failure detection, and incorporating predictive analytics dashboards for smarter decision-making.

REFERENCES

- Kaggle Dataset - Predictive Maintenance Classification by Shivam Bansal
- IBM Cloud Documentation - watsonx.ai Studio and Runtime Services
- IBM Developer - Building Predictive Maintenance Models with Watson Studio

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