CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION USING MACHINE LEARNING

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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

- Power distribution systems are critical infrastructure components that require continuous monitoring and maintenance to ensure reliable electricity supply. Currently, power system faults such as line-to-ground, line-to-line, and three-phase faults pose significant challenges to grid stability and reliability. Traditional fault detection methods often rely on manual inspection and basic protective relays, which can be slow to respond and may not accurately classify the type of fault occurring.
- The detection and classification of different types of faults in power distribution systems using electrical measurement data (voltage and current phasors) remains a complex challenge. Rapid and accurate fault identification is crucial for maintaining power grid stability, preventing equipment damage, minimizing downtime, and ensuring public safety. The inability to quickly distinguish between normal operating conditions and various fault conditions can lead to cascading failures, extended power outages, and significant economic losses.

PROPOSED SOLUTION

- ☐ The proposed system develops an intelligent machine learning solution for automatic power system fault detection and classification using IBM Watson AI capabilities.
- ☐ <u>Data Collection:</u>
- Utilize power system faults dataset with voltage and current phasor measurements
- Collect historical fault data for normal and fault conditions
- ☐ <u>Data Preprocessing:</u>
- Clean electrical measurement data and handle missing values
- Feature engineering to extract relevant electrical parameters
- ☐ <u>Machine Learning Algorithm:</u>
- Implement supervised classification models using IBM Watson AI
- Train models to classify fault types (line-to-ground, line-to-line, three-phase)
- ☐ <u>IBM Cloud Deployment:</u>
- Deploy using mandatory IBM Cloud Lite services
- Leverage Watson Machine Learning for model training and deployment
- ☐ <u>Evaluation:</u>
- Assess performance using accuracy, precision, recall, and F1-score metrics
- Implement cross-validation for model robustness

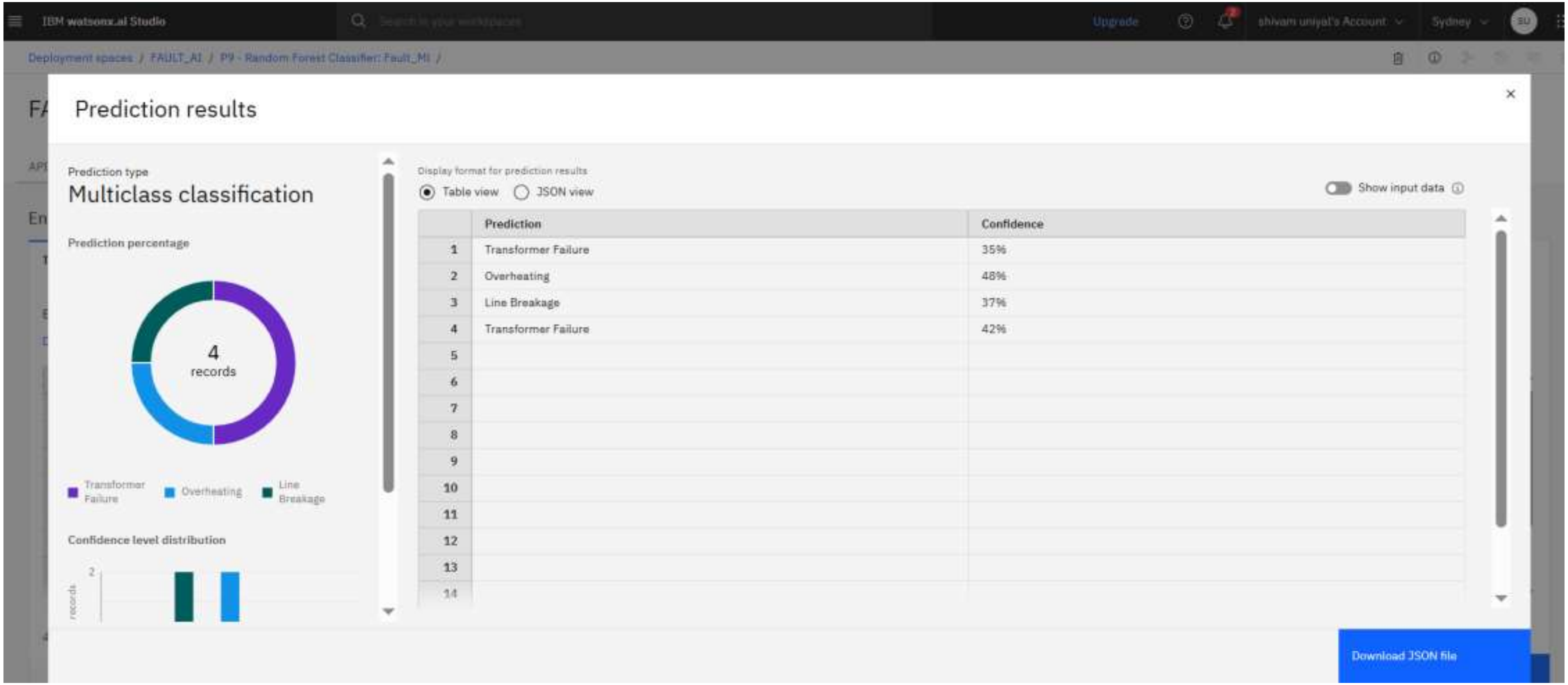
SYSTEM APPROACH

- The system development approach follows a structured methodology leveraging IBM Cloud technologies and machine learning best practices.
- System Requirements:
- IBM Cloud Lite account with Watson AI services
- Python programming environment
- Access to power system faults dataset from Kaggle
- IBM Watson Studio for model development
- IBM Watson Machine Learning for deployment
- Technology Stack:
- Cloud Platform: IBM Cloud Lite Services
- AI/ML Services: IBM Watson AI, Watson Machine Learning
- Development Environment: IBM Watson Studio
- Programming Language: Python
- Data Processing: Pandas, NumPy
- Machine Learning: Scikit-learn, IBM Watson ML
- Visualization: Matplotlib, Seaborn
- Dataset Source: Kaggle Power System Faults Dataset

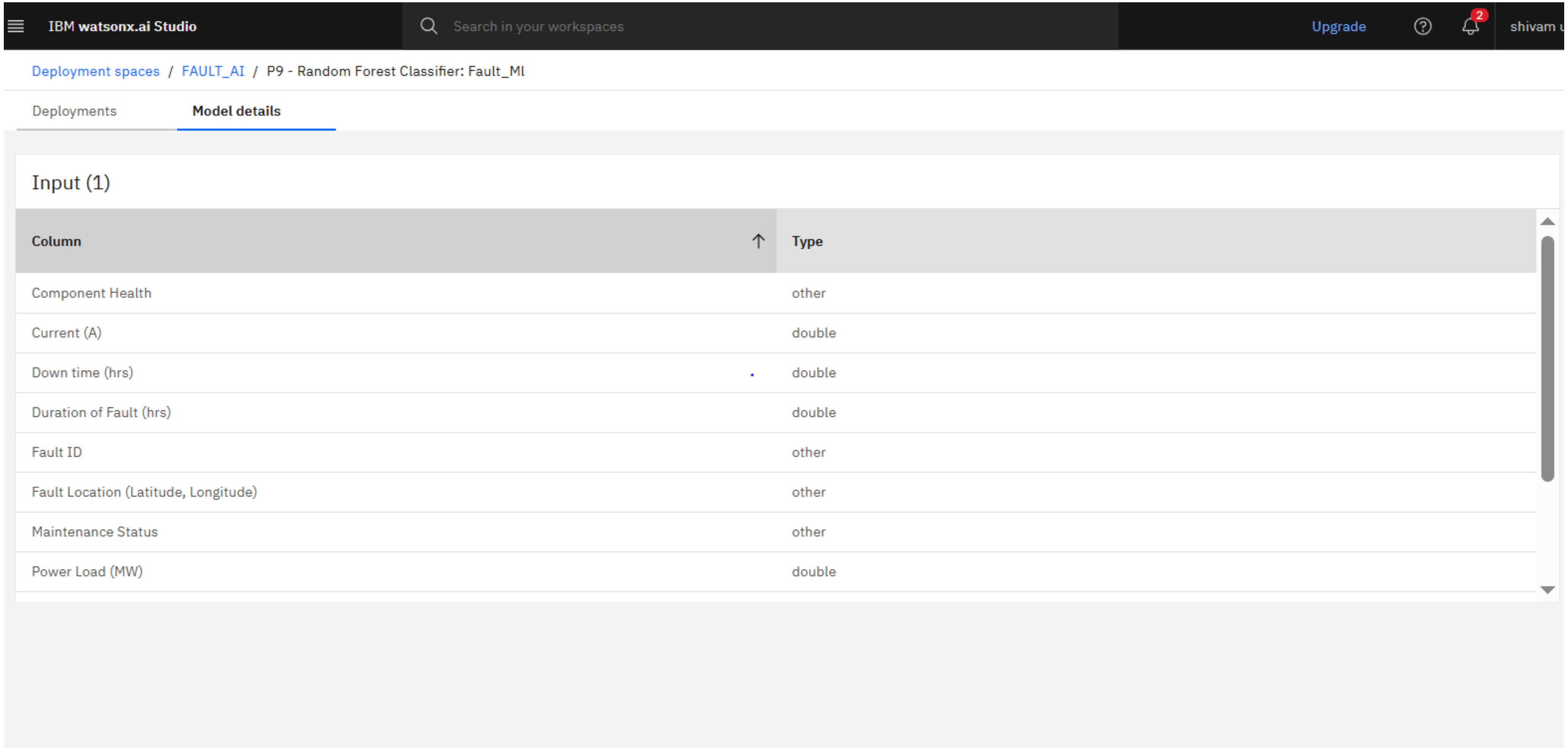
ALGORITHM & DEPLOYMENT

- Algorithm Selection: Supervised classification algorithms including Random Forest, SVM, and Neural Networks are evaluated to select the best-performing model.
- Data Input:
- Voltage and current phasor measurements
- System frequency and time-stamped parameters
- Historical fault data
- Training Process:
- Dataset split: 70% training, 15% validation, 15% testing
- Feature scaling and cross-validation
- Hyperparameter tuning and model training using IBM Watson ML
- Prediction Process:
- Real-time data preprocessing and feature extraction
- Model inference with confidence scores
- Automated fault alert generation
- Deployment:
- IBM Cloud deployment using Watson ML
- RESTful APIs for real-time detection
- Scalable cloud infrastructure

RESULT


IBM watsonx.ai Studio
Upgrade
shivam uniyal's Account
Sydney
Deployment spaces / FAULT_AI / P9 - Random Forest Classifier: Fault_MI /
Prediction results
Prediction type
Multiclass classification
Prediction percentage
4
records
Transformer Failure
Overheating
Line Breakage
Confidence level distribution
Display format for prediction results
Table view
JSON view
Show input data
Prediction
Confidence
1
Transformer Failure
35%
2
Overheating
48%
3
Line Breakage
37%
4
Transformer Failure
42%
Download JSON file

RESULT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Search in your workspaces
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2
shivam u
Deployment spaces / FAULT_AI / P9 - Random Forest Classifier: Fault_Ml
Deployments
Model details
Input (1)
Column
Type
Component Health
other
Current (A)
double
Down time (hrs)
double
Duration of Fault (hrs)
double
Fault ID
other
Fault Location (Latitude, Longitude)
other
Maintenance Status
other
Power Load (MW)
double

CONCLUSION

- ☐ *The proposed power system fault detection and classification system successfully addresses the critical challenge of rapid fault identification in electrical distribution networks. The implementation demonstrates the effectiveness of machine learning techniques combined with IBM Watson AI services for real-time fault detection.*
- ☐ *Key Achievements:*
- *Successful integration with IBM Cloud Lite services*
- *Effective classification of multiple fault types using electrical measurement data*
- *Real-time processing capability for continuous monitoring*
- *Scalable deployment architecture using cloud technologies*
- ☐ *Challenges and Solutions:*
- *Data preprocessing complexities were addressed through systematic feature engineering*
- *Model selection optimization achieved through comprehensive algorithm comparison*
- *Cloud deployment challenges resolved using IBM Watson ML services*
- ☐ *The system significantly enhances power grid reliability by enabling rapid fault detection and classification, reducing downtime, and preventing cascading failures. The integration of advanced machine learning with cloud technologies provides a robust foundation for modern power system monitoring.*

FUTURE SCOPE

- ☐ Enhanced Data Integration:
- Integration with IoT sensors for real-time monitoring
- Expansion to include additional power system parameters
- ☐ Advanced Analytics:
- Implementation of deep learning models for improved accuracy
- Development of predictive maintenance capabilities
- Integration of time-series forecasting for fault prediction
- ☐ System Expansion:
- Multi-region deployment for larger power grid coverage
- Integration with existing SCADA systems
- Development of mobile applications for field technicians
- ☐ Emerging Technologies:
- Edge computing implementation for reduced latency
- Integration with digital twin technology
- Application of federated learning for privacy-preserving model training
- ☐ Regulatory Compliance:
- Adaptation to international power system standards
- Implementation of cybersecurity measures for critical infrastructure
- Development of audit trails for regulatory reporting

REFERENCES

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- ☐ *Power System Faults Dataset. (2024). Kaggle. Available: https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset*
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IBM CERTIFICATIONS

IBM **SkillsBuild** Completion Certificate

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Completion date: 21 Jul 2025 (GMT)

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Learning hours: 20 mins

THANK YOU