CAPSTONE PROJECT

PROBLEM STATEMENT NO.40 – NETWORK INTRUSION DETECTION

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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

- Create a robust network intrusion detection system (NIDS) using machine learning. The system should be capable of analyzing network traffic data to identify and classify various types of cyber-attacks (e.g., DoS, Probe, R2L, U2R) and distinguish them from normal network activity. The goal is to build a model that can effectively secure communication networks by providing an early warning of malicious activities.

PROPOSED SOLUTION

- Proposed System: Network Intrusion Detection using Machine LearningThe proposed system aims to detect and classify various cyber-attacks (e.g., DoS, Probe, R2L, U2R) by analyzing network traffic using machine learning to secure communication networks.
- Data Collection:Use labeled Kaggle dataset containing network traffic features and attack categories.
- Data Preprocessing:Clean data, encode categorical features, and normalize inputs for better model performance.
- Machine Learning Algorithm:Train an XGBoost classifier to distinguish between normal and malicious traffic.
- Deployment:Deploy the trained model on IBM Watson Machine Learning for real-time inference.
- Evaluation:Evaluate using accuracy, F1-score, and AUC to ensure robust attack detection.
- Result:Achieved high accuracy in identifying network intrusions with potential for real-time security monitoring.

SYSTEM APPROACH

- System Requirements
- **Processor**: Intel i5 / AMD Ryzen 5 or better
- **RAM**: Minimum 8 GB (16 GB recommended)
- **Storage**: At least 10 GB free disk space
- **Operating System**: Windows 10/11, Linux (Ubuntu), or macOS
- **Internet**: Stable connection for IBM Cloud services
- **GPU** *(optional)*: NVIDIA GPU for faster training (if using deep learning)
- **Cloud Platform**: IBM Cloud Lite (Free tier is sufficient)

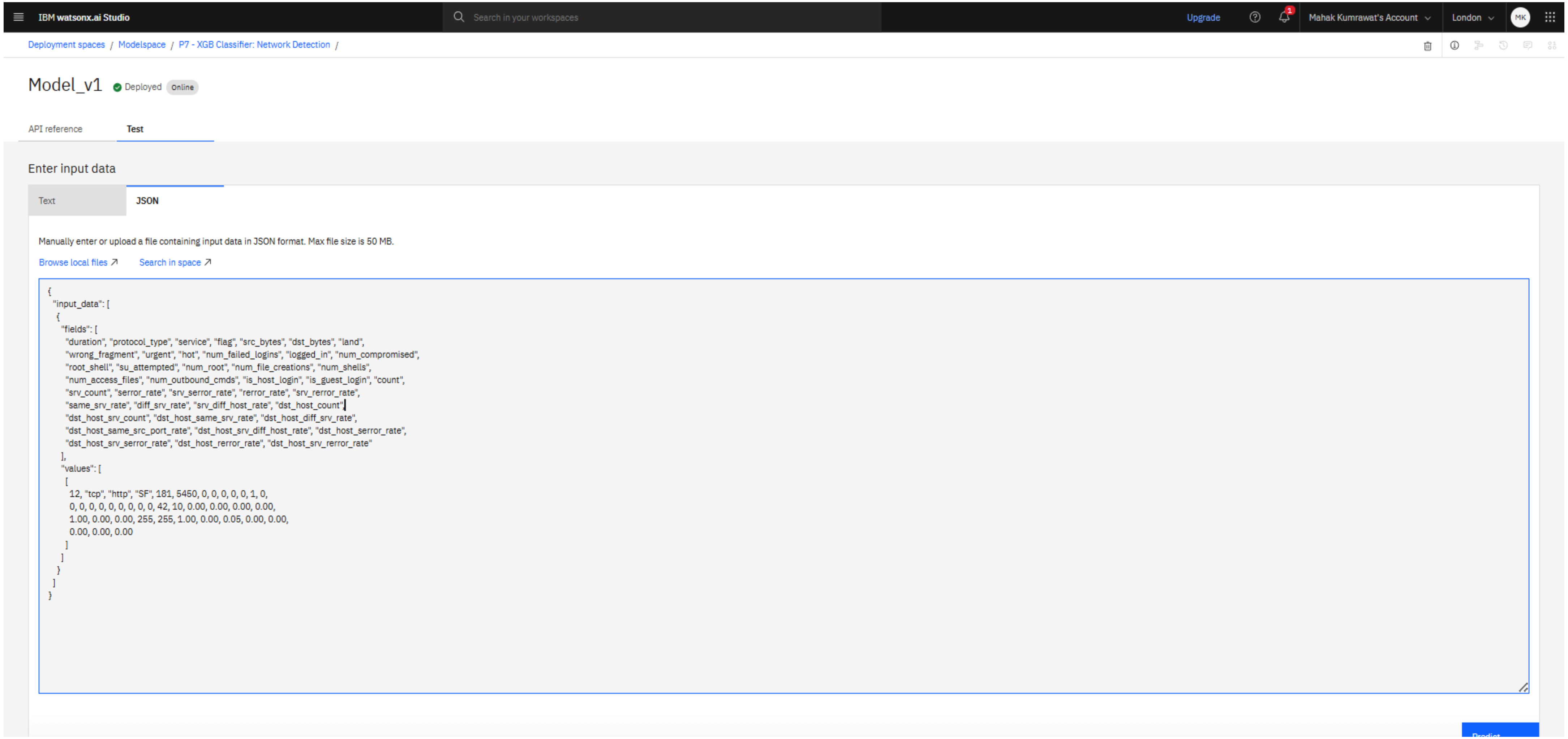
SYSTEM APPROACH

- Required Python Libraries
- pandas – Data manipulation and CSV handling
- numpy – Numerical computations
- scikit-learn – Data preprocessing, model building, evaluation
- xgboost – ML algorithm for intrusion detection (XGBoost Classifier)
- matplotlib – Data visualization (basic plots)
- seaborn – Advanced visualizations (heatmaps, distribution plots)
- joblib – Save and load trained models
- IBM Watson ai studio
- IBM Watson Auto AI

ALGORITHM & DEPLOYMENT

- Algorithm Selection: XGBoost Classifier was chosen for its speed, accuracy, and ability to handle tabular data with class imbalance—ideal for multi-class intrusion detection.
- Data Input: Features include network parameters like protocol type, service, source/destination bytes, failed logins, and connection counts. The target is the attack category (Normal, DoS, Probe, R2L, U2R).
- Training Process: Data was preprocessed, split into training/testing sets, and tuned using cross-validation and grid search. Evaluation metrics include accuracy, precision, recall, and F1-score.
- Prediction Process: The trained model classifies real-time network traffic to detect and label potential attacks.

RESULT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API reference
Test
Text
JSON

Model_v1 Deployed Online

Enter input data

Manually enter or upload a file containing input data in JSON format. Max file size is 50 MB.

Browse local files ↗ Search in space ↗

```
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    "duration", "protocol_type", "service", "flag", "src_bytes", "dst_bytes", "land",
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    "root_shell", "su_attempted", "num_root", "num_file_creations", "num_shells",
    "num_access_files", "num_outbound_cmds", "is_host_login", "is_guest_login", "count",
    "srv_count", "serror_rate", "srv_serror_rate", "rerror_rate", "srv_rerror_rate",
    "same_srv_rate", "diff_srv_rate", "srv_diff_host_rate", "dst_host_count",
    "dst_host_srv_count", "dst_host_same_srv_rate", "dst_host_diff_srv_rate",
    "dst_host_same_src_port_rate", "dst_host_srv_diff_host_rate", "dst_host_serror_rate",
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     1.00, 0.00, 0.00, 255, 255, 1.00, 0.00, 0.05, 0.00, 0.00,
     0.00, 0.00, 0.00
    ]
   ]
  }
 ]
}
```
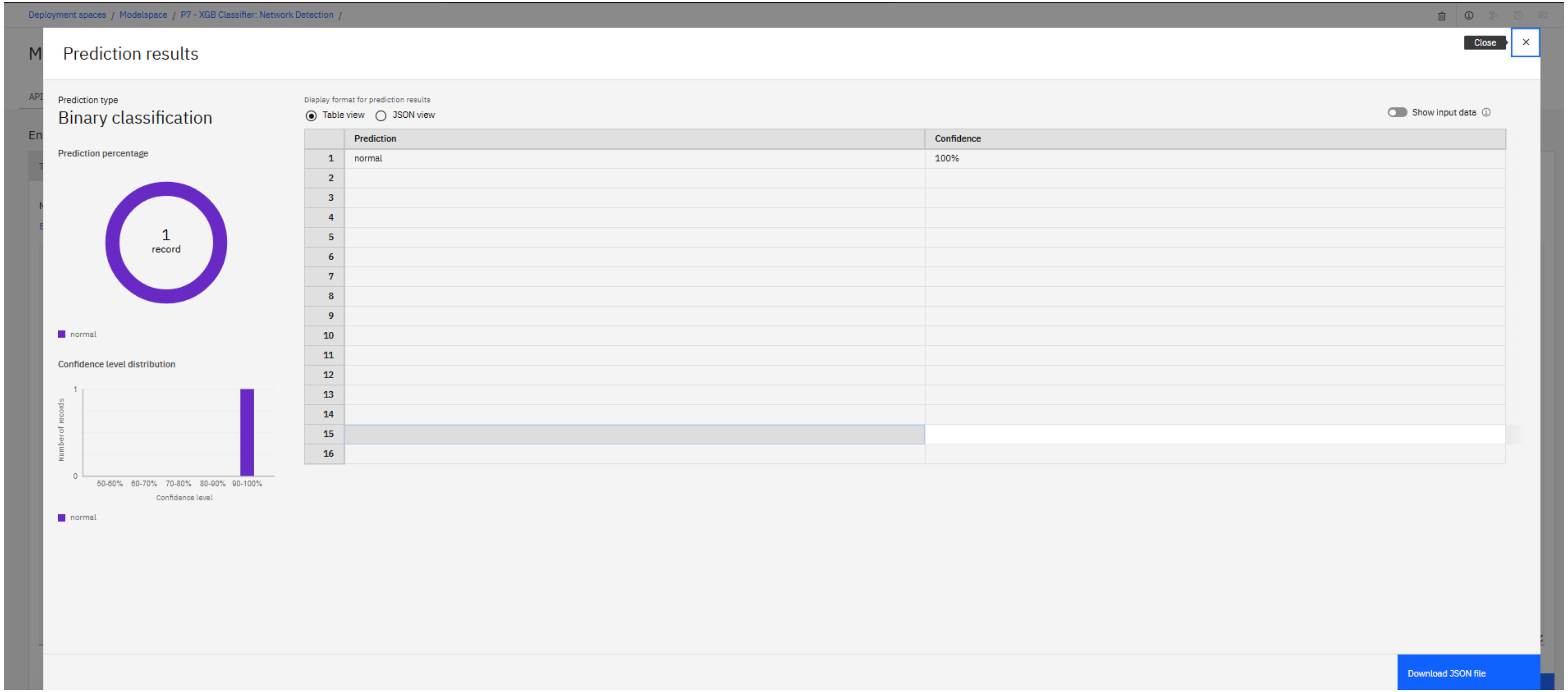

RESULT



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Prediction results

Close ×

Prediction type

Binary classification

Prediction percentage

1 record

■ normal

Confidence level distribution

Display format for prediction results

● Table view ○ JSON view

Show input data ⓘ

	Prediction	Confidence
1	normal	100%
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

Download JSON file

CONCLUSION

- Findings: XGBoost achieved high accuracy in detecting and classifying network intrusions. Effectively handled multiple attack types (DoS, Probe, R2L, U2R).
- Challenges: Imbalanced dataset for rare attacks. Complex preprocessing of features.
- Importance: Accurate intrusion detection is essential for securing networks—just like accurate bike demand prediction ensures availability in rental systems.

FUTURE SCOPE

- Improvements
- Use deep learning for better detection of rare attacks.
- Enable real-time deployment and model updates.

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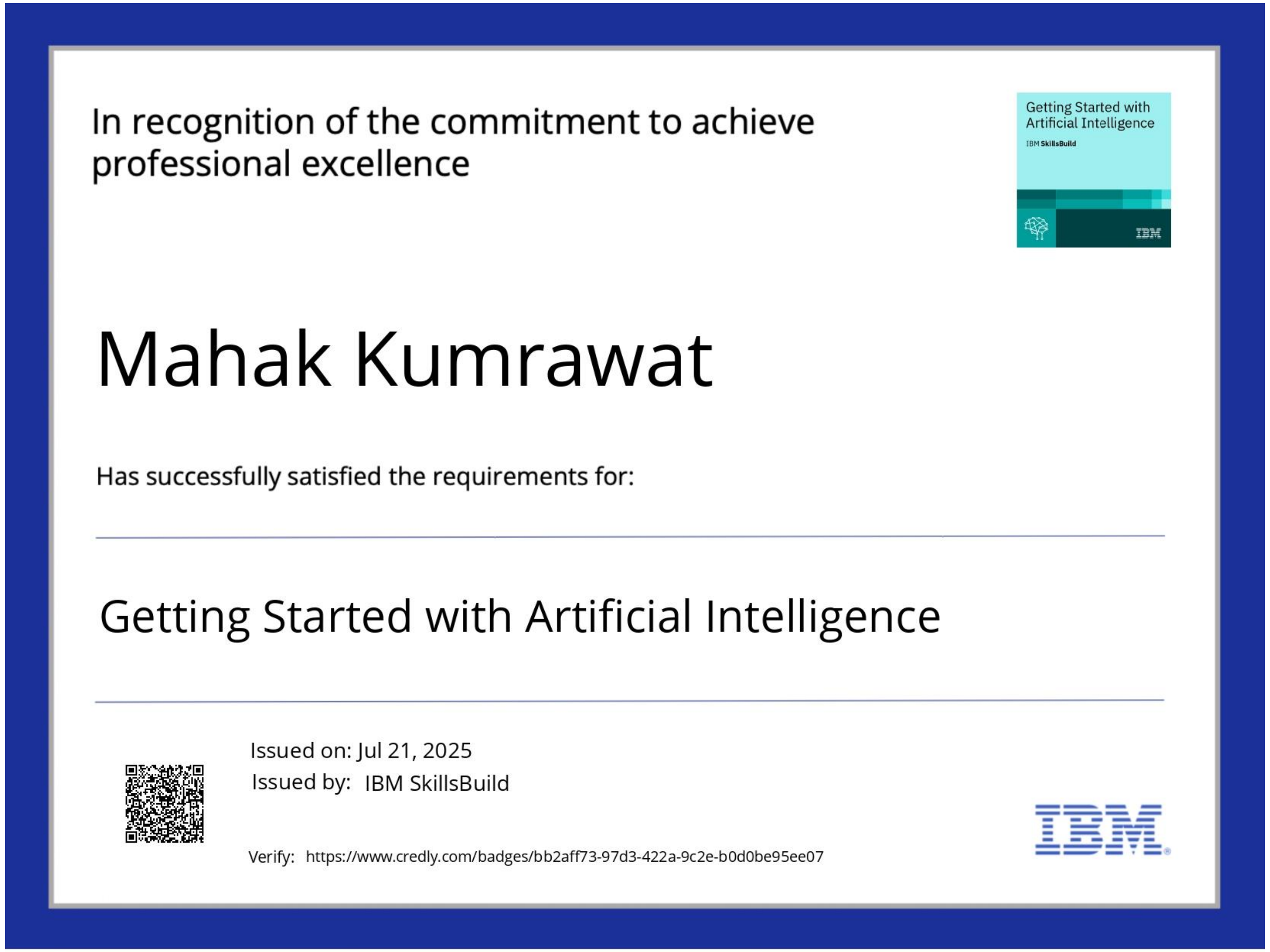
REFERENCES

- Scikit-learn documentation. (n.d.). *Machine Learning in Python*. https://scikit-learn.org/
→ For data preprocessing, model training, and evaluation best practices.

- IBM Watson Machine Learning. (n.d.). *Model deployment and management on IBM Cloud*. https://www.ibm.com/cloud/machine-learning
→ For potential deployment of the model on cloud infrastructure.

- Dua, D., & Graff, C. (2019). *UCI Machine Learning Repository: KDD Cup 1999 Data*. https://kdd.ics.uci.edu/databases/kddcup99/kddcup99.html
→ Source of benchmark dataset for network intrusion detection.

IBM CERTIFICATIONS



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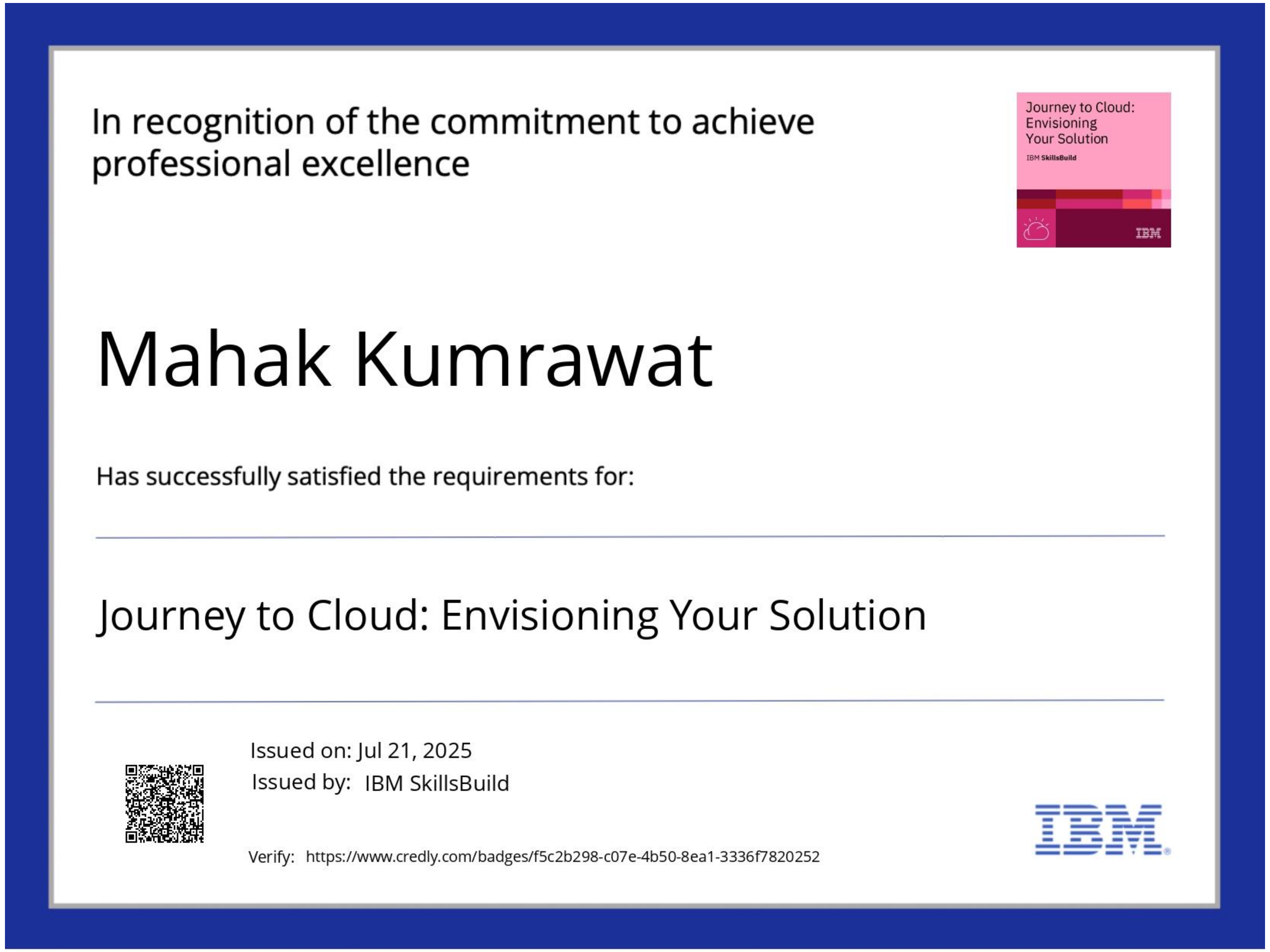

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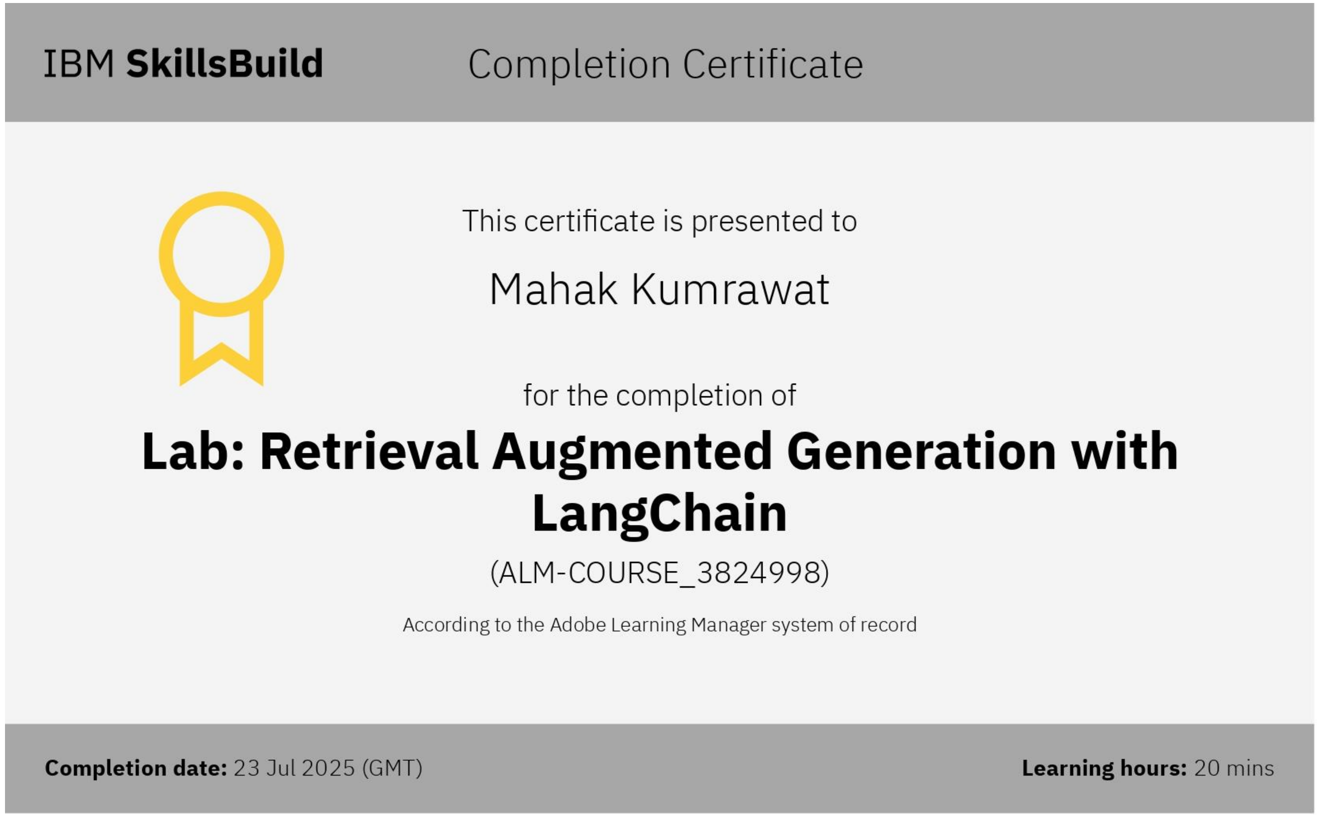

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