

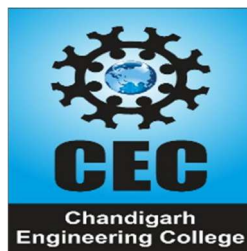


Chandigarh Engineering College Jhanjeri
Mohali-140307
Department of Artificial Intelligence and Machine Learning

PROJECT REPORT ON

AI-Driven Water Quality Prediction For Aquatic Ecosystem Using Deep Learning and Automated Hyperparameter Optimization

Project-I



Department of Artificial Intelligence & Machine Learning
CHANDIGARH ENGINEERING COLLEGE JHANJERI, MOHALI

**In partial fulfillment of the requirements for the award of the Degree of
Bachelor of Technology in Artificial Intelligence & Machine Learning**

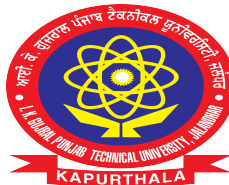
SUBMITTED BY:

Akshat Choudhary
2231060

Under the Guidance of

Ankur Srivastava
Assistant Professor

April 2025



Affiliated to I.K Gujral Punjab Technical University, Jalandhar
(Batch: 2022-2026)



Chandigarh Engineering College Jhanjeri

Mohali-140307

Department of Artificial Intelligence and Machine Learning

DECLARATION

I Akshat Choudhary hereby declare that the report of the project entitled AI-Driven Water Quality Prediction for Aquatic Ecosystem Using Deep Learning and Automated Hyperparameter Optimization has not presented as a part of any other academic work to get my degree or certificate except Chandigarh Engineering College Jhanjeri, Mohali, affiliated to I.K. Gujral Punjab Technical University, Jalandhar, for the fulfillment of the requirements for the degree of B.Tech in Artificial Intelligence & Machine Learning.

Student Signature

Akshat Choudhary

2231060

6TH SEM

Mentor Signature

Ankur Srivastava

Assistant Professor (CSE APEX)

Signature of the Head of Department



Chandigarh Engineering College Jhanjeri

Mohali-140307

Department of Artificial Intelligence and Machine Learning

ACKNOWLEDGEMENT

It gives me great pleasure to deliver this report on Project-I, which I worked on for my B.Tech in Artificial Intelligence & Machine Learning 3rd year, which was titled AI-Driven Water Quality Prediction for Aquatic Ecosystem Using Deep Learning and Automated Hyperparameter Optimization. I am grateful to my university for presenting me with such a wonderful and challenging opportunity. I also want to convey my sincere gratitude to all coordinators for their unfailing support and encouragement.

I am extremely thankful to the HOD and Project Coordinator of Artificial Intelligence & Machine Learning at Chandigarh Engineering College Jhanjeri, Mohali (Punjab) for valuable suggestions and the heartiest cooperation.

I am also grateful to the management of the institute and Dr. Avinash, Director Engineering, for giving me the chance to acquire the information. I also appreciate all of my faculty members, who have instructed me throughout my degree.

(Signature of Student)



ABSTRACT

Accurate water quality assessment is critical for environmental monitoring and public health. This research proposes a deep learning-based classification model for water quality prediction for aquatic ecosystems, leveraging automated hyperparameter optimization via Optuna to enhance accuracy and computational efficiency. The dataset undergoes rigorous preprocessing, including feature standardization with StandardScaler and stratified train-test splitting to maintain class distribution integrity. The neural network architecture consists of three fully connected hidden layers with ReLU activation, batch normalization for training stability, and dropout regularization to mitigate overfitting. Model training employs the Adam optimizer with a dynamic learning rate scheduler (ReduceLROnPlateau). The optimization process tunes key hyperparameters, including neuron allocation per layer, dropout rate, and learning rate, yielding an optimal configuration of 179-104-36 neurons, 0.2586 dropout, and a 0.00999 learning rate. Experimental evaluation using stratified k-fold cross-validation achieves a test accuracy of 98.02%, with high precision, recall, and F1-scores, ensuring robust predictive performance. The trained model is deployed with standardized input processing, enabling seamless adaptation to varying water quality datasets. Compared to conventional models, this AI-driven framework exhibits superior generalization, reduced computational overhead, and improved classification reliability, making it a scalable solution for real-time water quality assessment in IoT-integrated environmental monitoring systems.



Chandigarh Engineering College Jhanjeri
Mohali-140307

Department of Artificial Intelligence and Machine Learning

TABLE OF CONTENTS

PARTICULARS	PAGE NO
Title Page	I
Declaration by the Candidate	II
Acknowledgement	III
Abstract	IV
Table of Contents	V-VI
List of Tables	VII
List of Figures	VIII-IX



TABLE OF CONTENTS

SR. NO.	CONTENT	PAGE NO.
CHAPTER 1	INTRODUCTION	1-14
1.1	Introduction	1-3
1.2	Importance of water quality	3-5
1.3	Aquatic Ecosystem Impact	5-14
CHAPTER 2	REVIEW OF LITERATURE	15-25
2.1	Evolution of Water Quality Monitoring	15-16
2.2	Review of Existing Rsearch and Guidelines Quality Monitoring	16-20
2.3	Role of AI and Machine Learning in Water Quality	21-25
CHAPTER 3	PROBLEM DEFINITION AND OBJECTIVES	26-27
3.1	Problem Defination	26-27
3.2	Objective	27
CHAPTER 4	DESIGN AND IMPLEMENTATION	28-40
4.1	System Design Overview	28
4.2	Software and Hardware Requirement Specifications:	29
4.3	Methodology and Implementation	29-36
4.4	Coding Integration Screenshots	36-40
CHAPTER 5	RESULTS AND DISCUSSIONS	41-46
5.1	Results	41-45
5.2	Discussions	45-46
CHAPTER 6	CONCLUSION AND FUTURE SCOPE	47-49
6.1	Conclusion	47-48
6.2	Future Scope	48-49
REFERENCES		50-51



LIST OF TABLES

Table No.	Table Caption	Page Number
4.1	Software Requirements	8
4.2	Hardware Requirements	9
4.3	Dataset Sample	10



LIST OF FIGURES

Figure No.	Figure Caption	Page Number
4.1	The code importing essential Python libraries.	23
4.2	The code shows that fetch the dataset.	23
4.3	This code shows that how many null values in dataset.	23
4.4	This code shows displays dataset summary like data types and non-null counts.	24
4.5	Calculates the min and max value of each column in dataset.	24
4.6	Normalizes the value of each column scaling the result to a range between 0 and 100.	24
4.7	Calculates the Water Quality Index (WQI) by normalizing parameter values and applying weights.	25
4.8	Assigns water quality labels (Good, Moderate, Poor) based on the Water Quality Index.	25
4.9	The cleaned and processed dataset was exported to a CSV file named Finaldata.csv	25
4.10	Train the model	26
4.11	Test the model with enter the input features values	26
5.1	The figure shows the class distribution of water quality before scaling.	29
5.2	The figure shows the optimal hyperparameters including layer sizes, dropout, and learning rate.	29
5.3	The figure reports high model performance with a test accuracy of 98.02%, and matching precision, recall, and F1-score of 0.9802.	30
5.4	The figure shows a confusion matrix comparing actual vs. predicted classes	30



Chandigarh Engineering College Jhanjeri
Mohali-140307

Department of Artificial Intelligence and Machine Learning

5.5	Water quality prediction results showing excellent quality based on 14 input features	31
5.6	Water quality prediction results showing good quality based on 14 input features.	31
5.7	Water quality prediction results showing poor quality based on 14 input features.	32