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# Cape Institute Of Technology

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| LEARNING |

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| AND PREDICTION USING MACHINE |

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| EFFICIENT WATER QUALITY ANALYSIS |

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| PROJECT REPORT |

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| Sprint Delivery Schedule |

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| Sprint Planning & Estimation |

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| SCHEDULING |

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| PROJECT PLANNING & |

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| User Stories |

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| Solution & Technical Architecture |

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| Data Flow Diagrams |

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| PROJECT DESIGN |

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| Non-Functional requirements |

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| Functional requirement |

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| REQUIREMENT ANALYSIS |

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| 3.4 |

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| Problem Solution fit |

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| Proposed Solution |

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| Ideation & Brainstorming |

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| Empathy Map Canvas |

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| SOLUTION |

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| IDEATION & PROPOSED |

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| Problem statement and definition |

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| Reference |

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| Existing problems |

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| Literature survey |

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| 1.b |

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| Purpose |

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| 1.a |

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| Project overview |

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| Introduction |

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| FUTURE SCOPE |

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| CONCLUSION |

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| DISADVANTAGES |

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| ADVANTAGES & |

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| Performance Metrics |

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| RESULTS |

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| User Acceptance Testing |

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| Test Cases |

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| TESTING |

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| Database Schema (if Applicable) |

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| Feature 2 |

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| Feature 1 |

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| project along with code) |

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| (Explain the features added in the |

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| CODING & SOLUTIONING |

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| Reports from JIRA |

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| disturbing rate. Furthermore, infrastructures, with the absence of public awareness, |

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| Hence, rapid industrial development has prompted the decay of water quality at a |

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| 1.2. PURPOSE |

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| possible future applications of machine learning approaches to water environments. |

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| water, groundwater, drinking water, sewage, and seawater. Furthermore, we propose |

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| applied to evaluate the water quality in different water environments, such as surface |

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| review, we describe the cases in which machine learning algorithms have been |

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| water quality improvement, and watershed ecosystem security management. In this |

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| Additionally, machine learning can provide solutions for water pollution control, |

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| evaluation, and optimization of various water treatment and management systems. |

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| machine learning have been applied to the construction, monitoring, simulation, |

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| problems. In water environment research, models and conclusions derived from |

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| models based on machine learning can efficiently solve more complex nonlinear |

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| prediction. Unlike traditional models used in water-related research, data-driven |

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| learning has become an important tool for data analysis, classification, and |

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| With the rapid increase in the volume of data on the aquatic environment, machine |

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| 1.1 PROJECT OVERVIEW |

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| frequently for the development of human societies. |

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| various sources of water supply, due to easy access, rivers have been used more |

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| Water quality has a direct impact on public health and the environment among |

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| development of water sports and entertainment has greatly helped to attract tourists. |

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| used for various practices, such as drinking, agriculture, and industry. Recently, |

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| Water quality has a direct impact on public health and the environment. Water is |

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| 1.INTRODUCTION |

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| models, decision-tree-based models are more favorable to short-term prediction and |

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| sensitive to missing values and being highly efficient. Compared to other ML |

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| reasons for this are its ability to manage both regular attributes and data, not being |

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| Gradient Boosting (GB), always outperform the single decision tree |

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| However, decision-tree-based ensemble models, including Random Forest (RF) and |

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| frequently found in the literature and performed well on water quality data. |

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| Traditional Machine Learning models, such as the Decision Tree model, are |

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| models, such as Gradient Boosting and Random Forest |

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| in recent years, some researchers are moving towards more advanced ML ensemble |

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| Vector Machine , K-Nearest Neighbors |

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| and Naïve Bayes |

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| . However, |

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| such as Decision Tree |

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| , Artificial Neural Network |

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| , Support |

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| (ML) approaches. Some researchers used the traditional Machine Learning models, |

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| Many works had been conducted to predict water quality using Machine Learning |

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| 2. LITERATURE SURVERY |

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| probability, multivariate interpolation, and regression analysis . |

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| multivariate statistical techniques have been employed and used for transitional |

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| the correlation and relationship among different water quality parameters, |

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| analysing algorithms, and predictive algorithms. For the sake of the determination of |

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| of the WQ. These methodologies include statistical approaches, visual modelling, |

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| the WQ. There are several methodologies proposed for the prediction and modelling |

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| for forecasting the WQ patterns to ensure the monitoring of the seasonal change of |

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| to predict the water quality. It is recommended to consider the temporal dimension |

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| Therefore, it is very important to suggest new approaches to analyse and, if possible, |

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| accidents, crimes, and terrorist attacks. |

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| reported annually .Such a mortality rate is higher than deaths resulting from |

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| caused by contaminated water. Five million deaths and 2.5 billion illnesses are |

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| diseases. In developing countries, it is announced that 80% of health problems are |

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| about 1.5 million people die each year because of contaminated water-driven |

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| health, the environment, and infrastructures. As per the United Nations report , |

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| the consequences of polluted drinking water are so dangerous and can badly affect |

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| and less hygienic qualities, significantly affect the quality of drinking water. In fact, |

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| achieves a better forecasting accuracy compared to the ANN model. This is because |

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| and ANN model to predict phosphorus and nitrogen. They found that SVM model |

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| representation of domain knowledge. In China, Liu and Lu |

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| developed the SVM |

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| determine the water quality class if the data provided represent an accurate |

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| Naive Bayes and K-NN classifiers. It also revealed that ML models can quickly |

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| lowest error rate, which is 0%, in classifying water quality class compared to ANN, |

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| Vector Machine and Decision Tree are the best classifiers because they have the |

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| compared to other models. A study by Babbar and Babbar |

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| found that Support |

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| Some studies proved that SVM is the best model in predicting water quality |

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| Support Vector Machine has also been extensively used in water quality studies. |

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| dataset and the testing data are outside the range of the training data |

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| drawback as the prediction power becomes weak if they are used with a small |

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| (r) and bias values. Although ANN models are the most broadly used, they have a |

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| of the ANN model using root-mean-square error (RMSE), coefficient of correlation |

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| outperforms the MLR model. However, the research only assessed the performance |

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| multivariate linear regression models in his research and found that the ANN model |

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| Gradient Descent Adaptive (GDA) algorithm. Abyaneh |

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| used ANN and |

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| used ANN algorithms to predict water quality. They |

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| found that Lavenberg Marquardt (LM) algorithm has a better performance than the |

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| India, Aradhana and Singh |

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| imbalanced and when all initial weights of the parameter have the same value. In |

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| However, the performance of ANN can be obstructed if the training data are |

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| non-linearity of water quality data and the uncertainty of contaminant source. |

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| linear and non-linear associations among output and input data. It is used to treat the |

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| Neural Network (ANN). ANN is a remarkable data-driven model that can cater both |

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| Another popular Machine Learning model to predict water quality is Artificial |

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| continuous datasets. |

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| accuracy compared to the other algorithms and the methods are more suitable for |

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| high water quality zones. They found that ODT and Random Forest produce higher |

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| Automatic Interaction Detector and Iterative Dichotomiser 3 (ID3), to determine |

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| also compared five decision-tree-based models, |

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| which are Random Tree, Random Forest, Ordinary Decision Tree (ODT), Chi-square |

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| Another study by Jeihouni et al. |

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| the highest accuracy of 94%, while Decision Stump showed the lowest accuracy. |

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| Hoeffding tree, Random Forest and Decision Stump. They found that J48 showed |

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| different decision tree classifiers, which are Logistic Model Tree (LMT), J48, |

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| may have a quicker calculation speed |

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| . Gakii and Jepkoech |

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| compared five |

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| methods provide a higher stability to the classifiers and are good in reducing |

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| which are bagging and boosting. Both the bagging and boosting |

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| principle. There are two commonly used ensemble families in Machine Learning, |

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| The ensemble method ensures the two features in several ways based on its working |

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| learner are two important features to make the ensemble learners work properly |

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| . This method has also gained wide |

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| attention among researchers recently. The diversity and accuracy of each base |

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| with having each base learner’s decision |

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| learners’ decisions to produce a more precise prediction than what can be achieved |

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| The ensemble method is a Machine Learning technique that combines several base |

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| ensemble method. |

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| . One of the strategies considered by many previous works |

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| to reduce the effects of overfitting is to adopt more advanced methods, such as the |

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| classifier complexity |

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| overfitting occurs due to the presence of noise, a limited training set size, and |

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| observed on the training data, as well as unseen data on the testing set. Hence, |

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| . Overfitting is a fundamental issue in supervised Machine |

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| Learning that prevents the perfect generalization of the model to fit the data |

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| enough layers |

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| are too many layers, while the prediction error may be affected if there are not |

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| the training process takes a longer time and overfitting problems may occur if there |

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| prevent overfitting problems and bias from using only sample information. In ANN, |

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| Meanwhile, the Bayes model uses prior and posterior probabilities in order to |

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| reducing the model’s complexity and fitting the training data successfully |

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| . For example, SVM uses the structural risk |

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| minimization principle to address overfitting problem in Machine Learning by |

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| biased and a high variance |

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| do not perform well. They have some weaknesses, such as a high tendency to be |

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| traditional ML models, for example, Decision Tree, ANN, Naïve Bayes and SVM, |

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| found that Random Forest and Naïve Bayes produce better |

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| accuracy and low classification error compared to the C5.0 classifier. However, |

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| Vijay and Kamaraj |

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| . Naïve Bayes has also been widely used for predicting water quality. A study by |

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| showed smaller error and higher R |

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| than the results attained in Abbasi et al.’s report |

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| quality parameters, which are total dissolved solid and conductivity. The results |

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| . They found that SVM has a better |

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| performance compared to the K-Nearest Neighbor algorithm in estimating two water |

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| another study in Eastern Azerbaijan, Iran |

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| overtraining data to have a better generalization ability |

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| . This is supported by |

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| principle of structural risk minimization, hence avoiding the occurrence of |

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| the SVM model optimizes a smaller number of parameters acquired from the |

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| 2.2 REFERENCES |

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| further prediction |

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| parameter pass these readings to the Arduino microcontroller and ZigBee handset for |

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| parameters like, Temperature, Turbidity, and so on. And further after reading this |

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| framework. That IoT framework system uses some limits for the sensor to check the |

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| using that it can predict the water quality fast and more accurately than any other IoT |

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| based framework to study large datasets and to expand our study to a larger scale. By |

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| is calculated using AI techniques. So in future work, we can integrate this with IoT |

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| includes 3277 examples of the distinct wellspring. In this paper, Water Quality Index |

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| Organisation. The data taken in this paper is taken from the PCPB India which |

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| significant and easily available water quality index which is set by the World Health |

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| approach using artificial intelligence to predict water quality. This method uses a |

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| costly and time-consuming as well. So, in this paper, we propose an alternative |

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| For testing the water quality we have to conduct lab tests on the water which is |

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| 2.1 EXISITNG PROBLEM |

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| generalizes them by optimizing a suitable cost. |

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| assembles the model in a stage-wise way similar to other boosting techniques and it |

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| trees, to create a robust classifier for regression and classification problems. It |

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| . Another popular ensemble model is Gradient Boosting. Gradient Boosting is a |

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| Machine Learning technique that trains multiple weak classifiers, typically decision |

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| advantages of a decision tree with the added effectiveness of using several models |

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| . It uses feature randomness and bagging when building each individual |

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| decision tree to produce an independent forest of trees. Random Forest carries all the |

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| models |

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| trees, on a given subset of data independently and makes decisions based on all |

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| . A famous ensemble model that uses the bagging algorithm is Random |

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| Forest. It is a classification model that uses multiple base models, typically decision |

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| problem |

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| variance. Boosting can reduce the bias, while bagging can solve the overfitting |

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| costs outweigh the costs of undertaking the interventions. |

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| a net economic benefit, since the reductions in adverse health effects and health care |

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| regions, it has been shown that investments in water supply and sanitation can yield |

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| important as a health and development issue at a national, regional level. In some |

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| health, a basic human right and a component of effective policy for health .This is |

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| To predict the water safe or not for Access to safe drinking-water is essential to |

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| 2.3 PROBLEM STATEMENT DEFINITION |

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| 3.1 EMPATHY MAP CANVAS |

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| 3. IDEATION AND PROPOSED SOLUTION |

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| 3.2 IDEATION AND BRAINSTORMING |

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| 3.3 PROPOSED SOLUTION |

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| 3.3 PROBLEM SOLUTION FIT |

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| 4.1 FUNCTIONAL REQUIREMENT |

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| 4. REQUIREMENT ANALYSIS |

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| 4.2 NON-FUNCTIONAL REQUIREMENT |

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| what changes the information, and where data is stored. |

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| system requirement graphically. It shows how data enters and leaves the system, |

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| flows within a system. A neat and clear DFD can depict the right amount of the |

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| A Data Flow Diagram (DFD) is a traditional visual representation of the information |

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| 5.1 DATA FLOW DIAGRAM |

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| 5.PROJECT DESIGN |

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| replace them with mean and remove noise from the data.. |

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| In this step, we clean that data like if there are some missing values in it so we |

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| D. Data Cleaning |

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| with the WHO standards of water. It gives a slight overview of the data. |

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| In this step, we analyse the data visually by comparing some parameters of water |

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| C. Data Exploration:- |

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| collected between 2014 to 2020. |

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| dataset which contains 3277 instances of 13 different wellsprings which are |

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| quality. So for that, we take the CPCB(Central Pollution Control Board India) |

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| In this, we extract the data from the internet to train our data and predict the water |

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| B. Data Extraction:- |

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| to be solved by our model is water quality prediction using a dataset. |

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| In this step, we identify the problem which is solved by our model. So the problem |

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| A. Problem Identification |

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| water samples. Those steps are:- |

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| There are basically 10 steps for making our model predict the water quality of the |

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| 5.2 SOLUTION AND TECHNINCAL ARCHITECTURE |

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| structure of conceptual models and to set connections between data. |

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| better understanding. A Data Model is this theoretical model that permits the further |

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| In this step, we create a graph of the dataset for visual representation of data for |

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| H. Data Modelling |

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| information and the other to prepare the model. |

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| Normally, with a two-section split, one section is utilized to assess or test the |

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| In this step, we divide the dataset into smaller subsets for easing the complexity. |

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| G. Data Splitting |

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| respond to explore questions sufficiently |

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| selection is deciding fitting data type, source, and instrument that permit agents to |

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| In this step, we select the data types and source of the data. The essential goal of data |

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| F. Data Selection |

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| step, we evaluate our model and check how well our model do in the future |

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| Model Evaluation is a fundamental piece of the model improvement process. In this |

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| I. Model Evaluation |

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| 5.3 USER STORIES |

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| used: a carefully created huge synthetic data set and an available real data set |

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| or historical data collections. For the forecasting task, two types of data sets were |

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| parameters influence water quality. This information can come from a domain expert |

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| For water quality applications, it is vital to understand how various water quality |

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| Data mining techniques require domain knowledge in order to generate predictions. |

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| Data collection and creation |

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| 7.1 FEATURE 1 |

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| 7. CODING AND SOLUTIONS |

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| 6.3 REPORTS FROM JIRA |

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| recommended standard value of parameter (as shown in Table 1) |

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| value of parameter in pure water (0 for all parameters except and ), and is the |

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| where: is the measured value of parameter in the tested water samples is the ideal |

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| unit weight for each parameter calculated by equation (3). |

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| quality rating scale for each parameter calculated by equation (2) below, and is the |

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| where: is the total number of parameters included in the WQI calculations is the |

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| The WQI has been calculated using the following formula: |

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| test the proposed model, and seven significant water quality parameters are included. |

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| significantly affect WQ [40–42]. In this study, a published dataset is considered to |

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| To measure water quality, WQI is used to be calculated using various parameters that |

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| Water Quality Index Calculation |

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| normalization technique |

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| values. For obtaining superior accuracy, the -score method has been used as a data |

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| the dataset. Then, water samples have been classified on the basis of the WQI |

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| In this phase, the WQI has been calculated from the most significant parameters of |

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| The processing phase is very important in data analysis to improve the data quality. |

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| Data Preprocessing |

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| Accuracy = TP+TN/(TP+FP+FN+TN) |

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| of successfully predicted observations to total observations. |

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| Accuracy is the most basic and intuitive performance metric, consisting of the ratio |

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| False Negatives (FN) are negative outcomes that the model predicts negative class. |

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| outcomes that the model predicted incorrectly are known as False Positives (FP). |

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| matrix designed to demonstrate how classification algorithms work. Positive |

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| positive class properly. True Negatives (TN) is one of the components of a confusion |

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| Performance Measures Results True Positives (TP) are when the model predicts the |

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| 7.2 FEATURE 2 |

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| 8.1 TEST CASES |

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| 8.TESTING |

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| User Acceptance Testing (UAT). |

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| open issuesof the [ProductName] project at the time of the release to |

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| The purpose of this document is to briefly explain the test coverage and |

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| Purpose of Document |

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| 8.2 USER ACCEPTANCE TESTING |

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| untested |

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| This report shows the numberof test cases that have passed, failed,and |

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| Test Case Analysis |

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| severity level, and how they were resolved |

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| This report showsthe number of resolved or closed bugs at each |

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| Defect Analysis |

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| classification prediction |

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| WQI, the SVM, KNN, and Naive Bayes were utilized for the water quality |

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| and 30% testing subsets. While the ANN and LSTM models were used to predict the |

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| For validating the developed model, the dataset has been divided into 70% training |

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| 9.1 PERFORMANCE METRICS |

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| 9.RESULT |

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| XGBOOST |

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| 61.7 |

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| 0.43 |

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| 0.12 |

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| 0.18 |

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| FOREST |

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| 58.5 |

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| 0.42 |

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| 0.38 |

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| 0.40 |

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| RANDOM |

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| Score |

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| SN. |

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| Algorithm |

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| Type |

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| ACCURACY |

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| Precision |

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| Recall f1- |

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| Table 1. Comparison of algorithms SN. |

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| Accuracy = TP+TN/(TP+FP+FN+TN) |

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| of successfully predicted observations to total observations. |

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| Accuracy is the most basic and intuitive performance metric, consisting of the ratio |

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| False Negatives (FN) are negative outcomes that the model predicts negative class. |

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| outcomes that the model predicted incorrectly are known as False Positives (FP). |

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| matrix designed to demonstrate how classification algorithms work. Positive |

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| positive class properly. True Negatives (TN) is one of the components of a confusion |

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| Performance Measures Results True Positives (TP) are when the model predicts the |

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| procedures. |

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| for them to get an overview of the water quality assessment standards and |

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| place for the convenience of the researchers and analysts. Thus, it may be helpful |

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| been standardized. In this article such guidelines are discussed concisely in one |

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| used. After prolonged research, the procedures for the assessment of the water have |

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| compared with their standard values to determine the acceptability of the water to be |

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| source for the designated use. Several water quality parameters are assessed and |

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| Assessment of water quality is essential to check the suitability of a water |

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| 11. CONCLUSION |

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| water may cause hazards and severe economic loss. |

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| degradation, it is also a threat to the ecosystem. In industries, improper quality of |

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| Poor condition of water bodies are not only the indictor of environmental |

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| DISADVANTAGES |

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| unique properties that can only be discovered through testing. |

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| products based on a hunch or a general trend is ill-advised, as each body of water has |

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| you may need to improve the condition of your water. Simply guessing and buying |

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| information that you can obtain will assist you with your decision on what product |

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| your monitoring will enable you to save money in the long term. The more |

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| some help. Ultimately, finding a source of pollution, or remaining proactive with |

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| Identifying the health of your water will help you to discover where it may need |

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| be in compliance with Australian laws. |

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| of action. This testing will also allow you to adhere to strict permit regulations and |

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| management plan, then investing in water quality testing should be your first point |

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| you’re wanting to create a solid foundation on which to build a broader water |

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| reasons why it is important for you to undertake regular water quality testing. If |

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| Whether it be for groundwater, surface water or open water, there are a number of |

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| 10. ADVANTAGES |

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| learning techniques and apply them in engineering practices. |

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| knowledge in different fields should be trained to develop more advanced machine |

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| water treatment and management requirements. (3) Interdisciplinary talent with |

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| and more universal algorithms and models should be developed according to the |

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| approaches. (2) The feasibility and reliability of the algorithms should be improved , |

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| to collect sufficiently accurate data to facilitate the application of machine learning |

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| including soft sensors, should be developed and applied in water quality monitoring |

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| considered in future research and engineering practices: (1) More advanced sensors, |

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| To overcome the above-mentioned challenges, the following aspects should be |

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| requires researchers to have certain professional background knowledge. |

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| The implementation of machine learning algorithms in practical applications |

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| systems, which hinders the wide application of machine learning approaches. (3) |

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| can be extremely complex, the current algorithms may only be applied to specific |

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| limitations. (2) As the conditions in real water treatment and management systems |

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| and management systems is often difficult owing to the cost or technology |

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| of high-quality data. Obtaining sufficient data with high accuracy in water treatment |

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| evaluate water quality: (1) Machine learning is usually dependent on large amounts |

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| challenges remain in fully applying machine learning approaches in this field to |

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| resource allocation, manage water resource shortages, etc. Despite this, several |

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| water environment because it can be applied to predict water quality, optimize water |

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| Machine learning has been widely used as a powerful tool to solve problems in the |

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| 12.SOURCE CODE |

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| APP.PY |

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| 13. APPENDIX |

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| INDEX.HTML |

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| WATER QUALITY.IPYNB |

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| VIDEO LINK -<https://drive.google.com/file/d/1tc4bhQlKvUI0lh5K88hKZSGkBW8CMlvA/view?usp=drivesdk> |

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| GITHUB -<https://github.com/IBM-EPBL/IBM-Project-23961-1659934463> |

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