PROJECT REPORT

ON

Predicting And Analyzing Urban Water Quality Using Ibm Watson Machine Learning Service

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INTRODUCTION

Water (chemical formula **H_2O**) is an inorganic, transparent, tasteless, odorless, and nearly colourless chemical substance, which is the main constituent of Earth's hydrosphere and the fluids of all known living organisms (in which it acts as a solvent). It is vital for all known forms of life, even though it provides neither food, energy, nor organic micronutrients. Its chemical formula, H_2O, indicates that each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds. The hydrogen atoms are attached to the oxygen atom at an angle of 104.45°."Water" is also the name of the liquid state of H_2O at standard temperature and pressure.

A number of natural states of water exist. It forms precipitation in the form of rain and aerosols in the form of fog. Clouds consist of suspended droplets of water and ice, its solid state. When finely divided, crystalline ice may precipitate in the form of snow. The gaseous state of water is steam or water vapor.

Water covers about 71% of the Earth's surface, mostly in seas and oceans (about 96.5%).Small portions of water occur as groundwater (1.7%), in the glaciers and the ice caps of Antarctica and Greenland (1.7%), and in the air as vapor, clouds (consisting of ice and liquid water suspended in air), and precipitation (0.001%). Water moves continually through the water cycle of evaporation, transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea.

The aim of this study is the prediction of water quality components using artificial intelligence (AI) techniques including MLP, SVM, and group method of data handling (GMDH). Therefore, in the first part of this section, the studied area is introduced and then ranges of measured water quality components are presented. Overviews on applied AI models are then presented.

PURPOSE

Water is considered as a vital resource that affects various aspects of human health and lives. The quality of water is a major concern for people living in urban areas. Quality of water serves as a powerful environmental determinant and a foundation for the prevention and control of waterborne diseases. However predicting the urban water quality is a challenging task since the water quality varies in urban spaces non-linearly and depends on multiple factors, such as meteorology, water usage patterns, and land uses, so this project aims at building a Machine Learning (ML) model to Predict Water Quality by considering all water quality standard indicators.

The main purpose of the project is to analyse and predict the urban water quality in which it consists of different florides and chlorides.These florides and chlorides should be in smaller portion. In order to find these quantities we use methods like

Temperature testing

Testing the temperature helps determine the rate of biochemical reaction in an aquatic environment and indeed whether they are able to occur at all. If the water temperature is too elevated, this can limit the water's ability to hold oxygen and decrease organisms' capacity to resist particular pollutants.

pH testing

Measures the acidity of water. Most aquatic organisms are only able to survive within a pH range of 6 to 8.

Chloride test

Chloride is usually present in fresh and salt water. However, its levels can be exacerbated as a result of minerals dissolving and industrial pollution.

Turbidity test

Measures the amount of particulate matter that is suspended in the water, or more simply, how clear the water is. If high levels of turbidity are present, photosynthesis is affected as light is unable to penetrate, increasing water temperature.

Dissolved oxygen test

Measures the amount of oxygen dissolved in water. Without this, aquatic life is unable to conduct cellular respiration and is thus a key indicator of water health.

Nitrate and Phosphate test

The presence of these essential nutrients is a good indicator of strong plant life. However, the addition of artificial nitrates and phosphates through detergents, fertilisers or sewage can be harmful and result in eutrophication, generally in the form of unwanted algal blooms.

Electrical conductivity test

Estimates the total amount of solids dissolved in the water. This can be a good indicator of the level of salinity.

Salinity testing

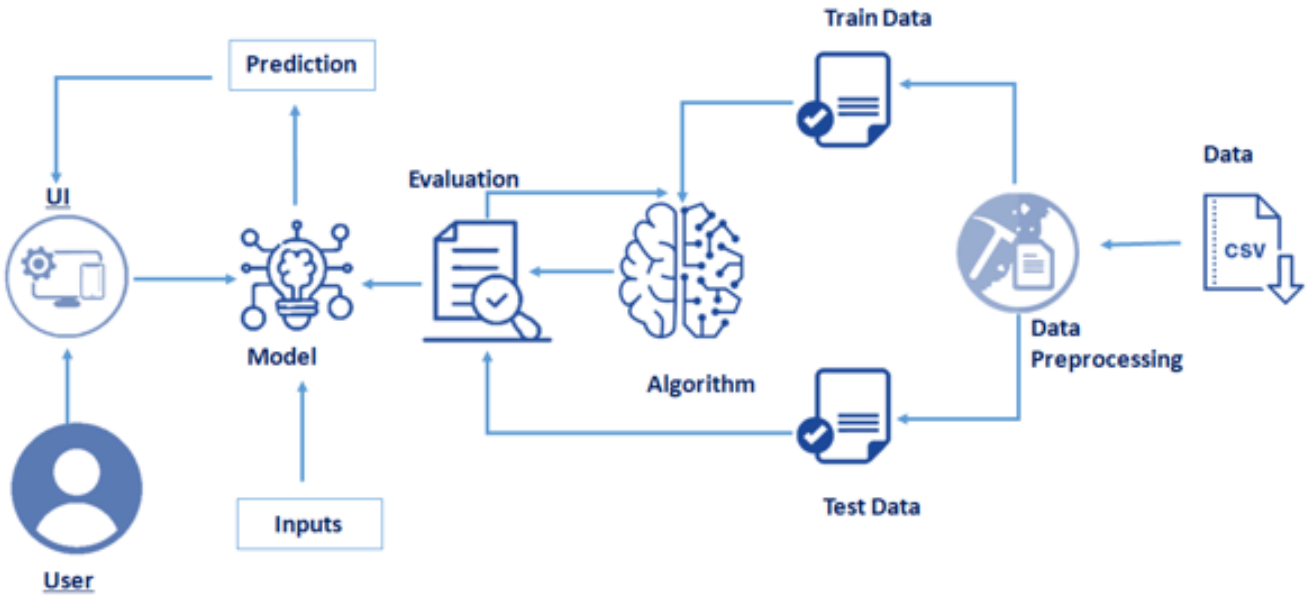
Measures the total of all non-carbonate salts dissolved in water. Measuring groundwater salinity indicates how salty your topsoil may become if the watertable rises.

So to know the quality of water we use the above traditional methods. But in this we will predict the quality of water by machining learning model.

LITERATURE SURVEY

Groundwater quality parameters in selected points of rural, sub urban and urban areas. But none have exclusively studied the confluence zone. In this backdrop the investigator of this project has proposed to undertake this study with UGC support which is locally relevant and has lab to land orientation as well. Since the levels of certain physico - chemical parameters like pH, alkalinity, BOD, COD, total hardness (Ca,Mg,Chlorides,HCO_3^- ,CO_3^{2-}), NO_3^- , PO_4^{3-} , Na, K and total dissolved solids found in ground water determine its behaviour as well as quality, it has been proposed to analyse ground water in the five slum areas separately so as to find reasons for the ground water problems in the said area.

Methodology used



Data collection

ML depends heavily on data, without data, it is impossible for an "AI" to learn. It is the most crucial aspect that makes algorithm training possible. In Machine Learning projects, we need a training data set. It is the actual data set used to train the model for performing various actions.

ANALYSIS

Water Quality Index Calculation

To measure water quality, WQI is used to be calculated using various parameters that significantly affect WQ [40–42]. In this study, a published dataset is considered to test the proposed model, and seven significant water quality parameters are included. The WQI has been calculated using the following formula:

$$WQI = (\sum_{i=1}^{N} q_i \times w_i) / \sum_{i=1}^{N} w_i$$

Where N is the total number of parameters included in the WQI calculations qi is the quality rating scale for each parameter i calculated by equation (2) below, and w_i is the unit weight for each parameter calculated by equation

$$q_i = 100 \times \frac{(V_i - V_{Ideal})}{(S_i - V_{Ideal})}$$

Where V_i is the measured value of parameter i in the tested water samples V_{Ideal} is the ideal value of parameter i in pure water (0 for all parameters except DO = 14:6 mg/l and pH = 7:0), and Si is the recommended standard value of parameter i

$$W_i = \frac{K}{S_i}$$

Z-Score Normalization Method

Normalization is a way to simplify calculations. It is a dimensional expression transformed into a nondimensional expression and becomes a scalar. Z-score normalization (or normalization score) is a normalization method used to normalize parameters by using the mean (μ) and standard deviation (σ) values of the tested data. It can be calculated as follows:

$$\text{Z-score} = \frac{(x-\mu)}{\sigma}$$

Permissible limits of the parameters used in calculating WQI

Parameters	Permissible limits
Dissolved oxygen, mg/l	10
pH	8.5
Conductivity, μS/cm	1000
Biological oxygen demand, mg/l	5
Nitrate, mg/l	45
Fecal coliform, Cfu/100 ml	100
Total coliform, Cfu/100 ml	1000

Prerequisites

To complete this project you should need the following Packages and libraries

- Anaconda Navigator
- Jupyter Notebook'
- All necessary Python packages

Importing The Libraries

It is important to import all the necessary libraries such as pandas, numpy, matplotlib.

- **Numpy**- It is an open-source numerical Python library. It contains a multi-dimensional array and matrix data structures. It can be used to perform mathematical operations on arrays such as trigonometric, statistical, and algebraic routines.
- **Pandas**- It is a fast, powerful, flexible, and easy to use open-source data analysis and manipulation tool, built on top of the Python programming language.
- **Seaborn**- Seaborn is a Python data visualization library based on matplotlib. It provides a high-level interface for drawing attractive and informative statistical graphics.
- **Matplotlib**- Visualisation with python. It is a comprehensive library for creating static, animated, and interactive visualizations in Python

PROJECT FLOW

- Data Collection.
  - Collect the dataset or Create the dataset
- Data Preprocessing.
  - Import the Libraries.
  - Importing the dataset.
  - Checking for Null Values.
  - Data Visualization.
  - Taking care of Missing Data.
  - Label encoding.
  - One Hot Encoding.
  - Feature Scaling.
  - Splitting Data into Train and Test.
- Model Building
  - Training and testing the model
  - Evaluation of Model
- Application Building
  - Create an HTML file
  - Build a Python Code

Dataset

The dataset used in this study is collected from certain historical locations in India. It contained different samples from different Indian states during the period . The dataset has 7 significant parameters, namely, dissolved oxygen (DO), pH, conductivity, biological oxygen demand (BOD), nitrate, fecal coliform, and total coliform. Data was collected by the Indian government to ensure the quality of the supplied drinking water. This dataset was obtained from Kaggle https://www.kaggle.com/anbarivan/indian-water-quality-data.

Data preprocessing

The processing phase is very important in data analysis to improve the data quality. In this phase, the WQI has been calculated from the most significant parameters of the dataset. Then, water samples have been classified on the basis of the WQI values. For obtaining superior accuracy, the -score method has been used as a data normalization technique.

Reading The Dataset

You might have your data in .csv files, .excel files

Let’s load a .csv data file into pandas using read csv() function. We will need to locate the directory of the CSV file at first (it’s more efficient to keep the dataset in the same directory as your program).

If your dataset is in some other location, Then see below command
Data=pd.read_csv(r”File_location/filename.csv”)

Data visualization

Data visualization is where a given dataset is presented in a graphical format. It helps the detection of patterns, trends and correlations that might go undetected in text-based data. Understanding your data and the relationship present within it is just as important as any algorithm used to train your machine learning model. Machine learning models will perform poorly on data that wasn’t visualized and understood properly.

To visualize the dataset we need libraries called Matplotlib and Seaborn. The Matplotlib library is a Python 2D plotting library that allows you to generate plots, scatter plots, histograms, bar charts etc.

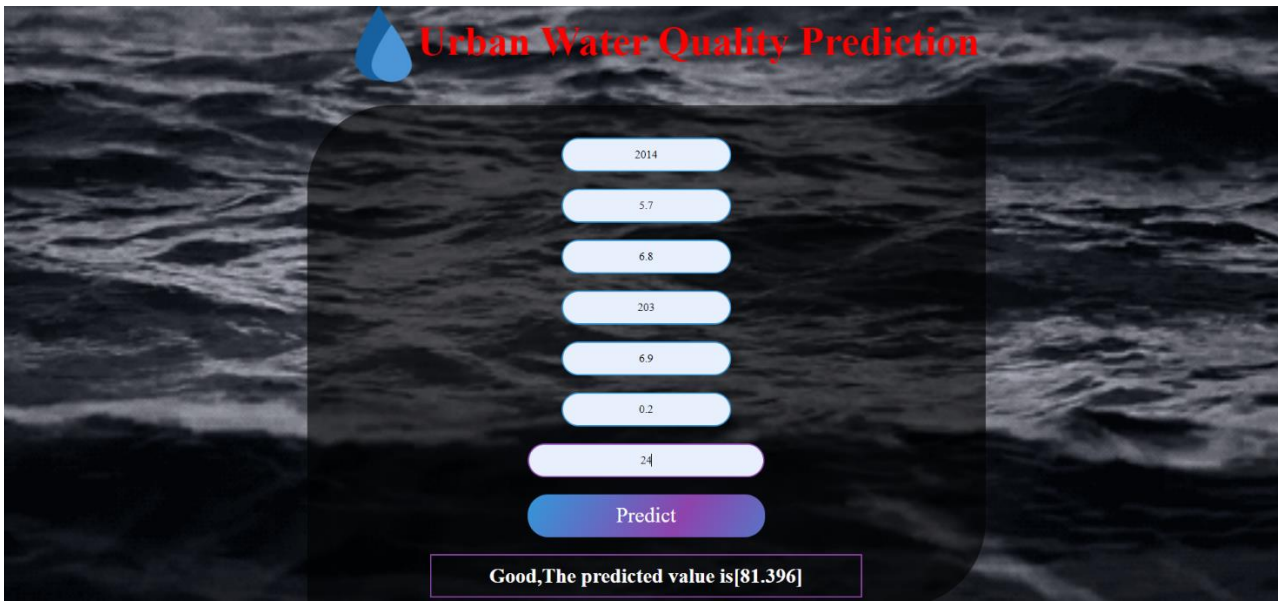
EXPERIMENTAL INVESTIGATION

Modeling and prediction of water quality are very important for the protection of the environment. Developing a model by using advanced artificial intelligence algorithms can be used to measure the future water quality. In this proposed methodology, the advanced artificial intelligence algorithms, namely, NARNET and LSTM models were used to predict the WQI. Moreover, machine learning algorithms such as SVM, KNN, and Naive Bayes were used to classify the WQI data. The proposed models were evaluated and examined by some statistical parameters. For the WQI prediction, the result has revealed that the performance of the NARNET model is slightly better than the LSTM model based on the obtained value. However, the SVM algorithm has achieved the highest accuracy of the prediction of the WQC as compared with KNN and Naive Bayes algorithms. After examining the robustness and efficiency of the proposed model for predicting the WQI, in future work, the developed models will be implemented to predict the water quality in Saudi Arabia for different types of water.

RESULT

For validating the developed model, the dataset has been divided into 70% training and 30% testing subsets. While the ANN and LSTM models were used to predict the WQI, the SVM, KNN, and Naive Bayes were utilized for the water quality classification prediction.

A NARNET model, with 12 hidden layers, showed a good performance to predict the WQI values. As presented earlier, it has the following characteristics: 1 : 8 number of delays and 12 number of epochs. However, the developed LSTM model has a total number of 200 hidden layers,150 maximum number of epochs, and delay. The proposed models were evaluated and examined by some statistical parameters. For the WQI prediction, the result has revealed that the performance of the NARNET model is slightly better than the LSTM model based on the obtained R value. However, the SVM algorithm has achieved the highest accuracy of the prediction of the WQC as compared with KNN and Naive Bayes algorithms. After examining the robustness and efficiency of the proposed model for predicting the WQI, in future work, the developed models will be implemented to predict the water quality in Saudi Arabia for different types of water.



Here we can see the final output of the project in which it will analyse and gives the predicted value of the water.

Advantages

The predicted values are accurate.

It will analyse the given water sample.

It is the advanced technology used for prediction.

We can also get the graphical representation by using the data visualization.

Disadvantages

Accuracy should be maintained to get exact values.

Difficult to built the model.

Applications

Urban water prediction for drinking, household purposes etc..

Industry and commerce.

For power generation.

CONCLUSION

The performance of artificial intelligence techniques including GMDH, SVM and ANN were evaluated to predict the water quality components of Tireh River (Iran). To this end most dataset related well-known components, such as pH, SO_4, Na, Ca, Cl, Mg, HCO_3 etc., were collected. Results indicated that the applied models have suitable performance for predicting water quality components, however, the best performance was related to the SVM. Reviewing the structure of SVM showed that the best accuracy was related to the RBD as kernel function. Results of ANN indicated that its accuracy is acceptable for practical purposes. The best performance of tested transfer function was related to tansig. The lowest accuracy of models was related to GMDH. The DDR index of results of applied models shows that all three models slightly over-estimate. Comparison of the performance of GMDH, SVM and ANN according to DDR shows that the data dispersion of SVM was less than the others. Although the accuracy of model GMDH is less than that of model SVM, their DDR indices are close together. Furthermore, comparison of the performance of applied models indicated that the outcomes of GMDH and SVM models were more reliable in comparison with ANN.

FUTURE SCOPE

The paper presents the economical solution to avoid contamination of water in residential overhead tanks. The quality of water is monitored using IoT devices and

the future prediction of water contamination is achieved using machine learning algorithms. The proposed system consists of multi sensors connected to NodeMcU to collect the water parameters. And the alert message is sent to the user before the water gets contaminated. The system helps to save the water from contamination and is also cost effective. The future scope for this project is to detect the diseases caused by different parameters and finding the appropriate solution for to clean the tank. Also biosensors can be used to detect the microbacterias for better quality of water.

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