e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:04/April-2022 Impact Factor- 6.752 www.irjmets.com

UNDERWATER MINE & ROCK PREDICTION BY EVALUATION OF MACHINE LEARNING ALGORITHMS

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ABSTRACT

Underwater Mine usage by the naval defense system provides great security but also possesses a threat to the marine life and submarine vessels as the mines can be easily mistaken for rocks. We need a much more accurate system to predict the object as it is very dangerous if a mistake is made. To have a great accuracy we need accurate data to generate accurate results. We worked on the data set which is provided by Gorman, R. P., and Sejnowski, T. J. (1988). The data is used to train the machine.

This paper presents a method for the prediction of underwater mines and rocks using Sonar signals. Sonar signals are used to record the various frequencies of underwater objects at 60 different angles. We constructed three binary classifier models according to their accuracy. Then, prediction models are used to predict the mine and rock categories. Python and Supervised Machine Learning Classification algorithms are used to construct these prediction models.

Keywords: Underwater Mines, SONAR, Supervised Machine Learning, Classification Algorithms, Prediction Model.

I. INTRODUCTION

UNDERWATER MINES:

Underwater mines or naval mines are self-contained explosive devices placed in water to destroy enemies' surface ships or submarines. Underwater mines are used since the mid-19th century. Sea mines were introduced by David Bushner in 1977 during the American civil war. There is an estimate of 5000 naval mines remaining from the two world wars in the Adriatic Sea.

Previously mines were only activated by physical contact but the newly created mines can be activated by various methods. Modern mines can be activated by acoustic, pressure, and, magnetic changes in the water which provoke them to explode. These are called influence mines. Generally, underwater mines are classified as offensive or defensive warfare. Mines are strewn across hostile shipping lanes in order to damage merchant ships and military boats. Defensive mines are placed along coastlines to divert enemy submarines and ships away from critical locations and into more heavily guarded places.

Usually, mines are mistaken as rocks during their identification, as mines can have the same shape, length, and width as rocks. To avoid this confusion it is better to use a more accurate input to receive an accurate output. One of the methods in detecting the mines is SONAR.

SONAR:

Sound Navigation and Ranging system works on sound waves to steer and detect objects. In general, SONAR is used for acoustic mine detection that comes under Military purposes. It is also used for Finding Fish, Mapping the Sea bottom, and also for locating sea divers which are Non Military purposes. The sound wave attenuation, which increases rapidly with frequency and limits the reachable distance, restricts the frequency used for a specific underwater sonar application (or range).In mine hunting, the frequencies of underwater SONARs vary between 0.1 and 1 MHz (and their range between 1 and 0.1 km, respectively). Sonar prefers ultrasonic waves instead of infrasonic, as they cannot move under the water, and even though they have long wavelengths they cannot capture much energy. We have active and passive SONAR. Passive SONAR is only used to detect noises so they are named Listening SONAR.

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We have a sound transmitter and receiver in active sonar. When a sound wave from the transmitter reaches the target, it propagates and reflects an echo. The receiver decodes the echo and records the target object's frequencies. The frequency of active sonar is normally in the 20KHz range. We utilize the frequencies obtained by active sonar at 60 various angles as our input to determine if the target is a mine or a rock in this case.

II. EXISTING SYSTEMS

In the existing system, the detection of mines is done by explosive ordnance disposal divers, marine mammals, video cameras on mine neutralization vehicles, laser systems, etc but not by using a definite data set or equipment which can cause risk and loss to the marine life if it goes wrong. As technology improved SONAR is being used as a primary tool to detect the mines.

III. PROPOSED SYSTEM

We have proposed a predictive system to give accurate results and outcomes. We utilized the dataset from "Analysis of Hidden Units in a Layered Network Trained to Classify Sonar Targets" by R. Paul Gorman and Terrence J. Sejnowski. They employed SONAR to perform trials in a simulated region with metal cylinders in place of mines. The object was struck with sonar signals from 60 various angles, and the results were recorded. The dataset is then trained to the evaluated models. The Sonar output frequencies are sent into the predictive system as input. We use classification machine learning techniques to predict if the object is a Rock or a Mine.

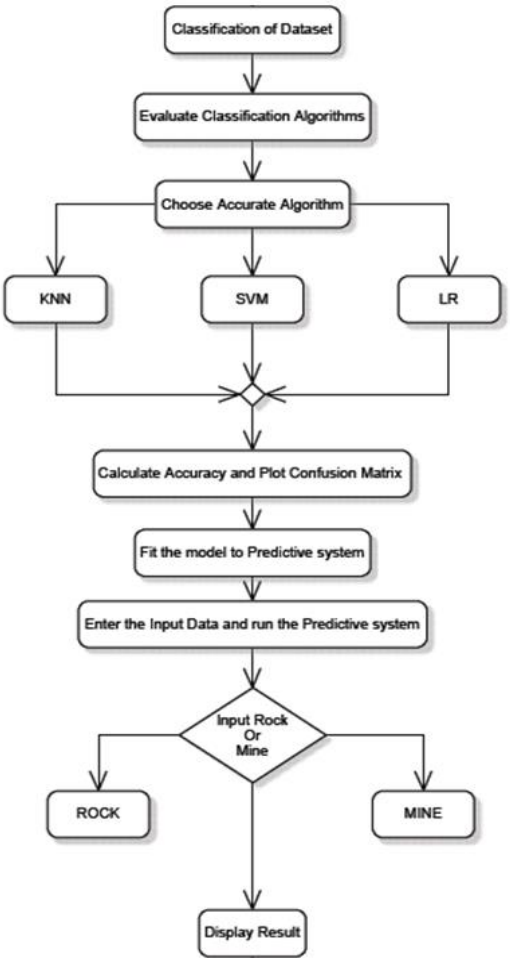
IV. WORKING PROCEDURE

4.1 ALGORITHM:

Step 1: We gather the dataset and perform data preparation and Exploratory Data Analysis to clean the dataset.

Step 2: We split the data into train and test datasets. Using them we evaluate the classification models.

Step 3: Following the evaluation, the top three performing models are determined to be KNN, SVM, and Logistic regression.



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Step 4: The accuracy of these models is evaluated, and a classification report is generated.

Step 5: We now fit the models to create a prediction system that's both accurate and efficient.

Step 6: Using the predictive systems, we can finally determine if the object is a Mine or a Rock.

4.2 EVALUATION OF CLASSIFICATION MODELS:

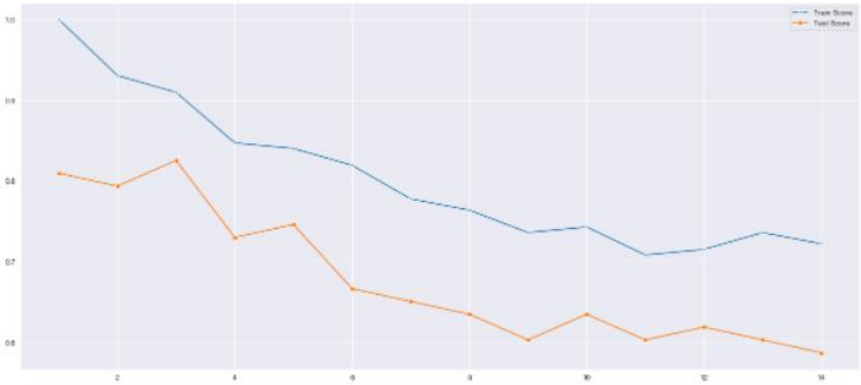
Performance, understandability, complexity, dataset size and dimensionality, and interface time should all be considered while choosing an ML model. To increase the model's performance, it's critical to analyze it before choosing and fitting it. Model assessment techniques as well as a model evaluation measure are required. Here, classification metrics are taken into account. These are the most commonly used in machine learning and data science. We assess the potential of various techniques using the same set of criteria, which are the assessment metrics. The easiest approach for assessing a Model's performance is to look at its accuracy.

$$\text{Accuracy} = (\text{TP} + \text{TN})/(\text{TP} + \text{TN} + \text{FP} + \text{FN}).$$

4.3 KNN ALGORITHM:

The KNN Technique is the most basic supervised machine learning algorithm for classification. It comes in handy while doing a pattern recognition task for data categorization based on features. When the K-nearest neighbors are determined and the distance between them is calculated, it determines which class the input belongs to.

First, the dataset must have categorical values, and then it is divided into dependent and independent variables. The target variable is the dependent variable in this case. Using the train test split() method, we split the data into training and testing data. We go for the most appropriate distance measure. The k value, on the other hand, must be calculated. We fit the knn model to the train and test data, using the optimal k value (in this case, k=3).



4.4 SVM ALGORITHM:

The Support Vector Machine (SVM) method is a supervised learning technique that may be used for classification and regression, however, it is most commonly employed for classification tasks. The goal of this approach is to find a hyperplane in an N-dimensional space that categorizes data points clearly. The support vector classification (SVC) algorithm is a variation of the support vector machine (SVM).

The dataset must first have categorical values, after which we partition it into dependent and independent variables. The target variable is the dependent variable in this case. Using the train test split() method, we split the data into training and testing data. We choose the optimal hyperparameters, such as the kernel function and the c parameter, using the grid selection approach. We now utilize correct hyperparameters to fit the svc model to the train and test data. We used rbf and c=1.5 in our model.

4.5 LOGISTIC REGRESSION:

Logistic Regression is a statistical method used to determine the binary outcome of the dependent variable in a dataset with one or more independent variables. This model predicts the dependent variable by the analysis of the relation between one or more independent variables.

The dataset must first have categorical values, after which we partition it into dependent and independent variables. The target variable is the dependent variable in this case. Using the train test split() method, we split the data into training and testing data. 3. For the perfect fit of input data to the regression model, we utilize a

binary encoder. We now apply an accurate solver to fit the logistic regression model to the train and test data, in our case a liblinear solver.

We created a confusion matrix using the values of TP, TN, FP, and FN in the three classifiers we evaluated. To have a better understanding of the model's accuracy, the classification error and precision numbers must be determined. Finally, we utilize this model to create a prediction system that predicts the output based on the input values we supply.

V. CONCLUSION

Our project "Underwater mine and rock prediction by the evaluation of machine learning algorithms" are used to detect rocks and mines in the ocean bed. Naval mines are an effective method for blocking ships and restricting naval operations which result in significant negative economic and environmental impacts. There are two existing ways to detect a mine, one by using sonar signals and the other by using manpower. Using Sonar signals has been a better option as the risk for the latter is more. The data is collected and stored in a CSV file. By using different machine learning techniques we can observe and understand the nature of the predictive system. By the evaluation of algorithms, we get to check and compare the accuracies to build a better-performing prediction model. A python is open-source software and the machine computation is also faster than many others and the cost might decrease dependently. Through this project, we want to make the process a bit easy and simple to achieve and use.

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