A descriptive approach to solve Fetal diseases classification problem

Abstract

Various techniques are developed traditionally in order to understand the patient's health and diagnose fatal diseases quickly but the problem is that the human body is complex, which needs an efficient approach compared to existing techniques. Even having the advanced techniques, it is not easy to check the body sample efficiently and suggest the health of patients so, in order to improve the diagnosis process, machine learning is considered to help in efficiently identifying the disease accurately. The problem considered for this analysis is found as significant as it would help in getting appropriate approach with the help of which diagnosis process could be improved to some extent. In order to resolve problem, experimental analysis is done using image encoding, CNN architecture and others. Using these methods, an analysis is conducted in order to study the process that is required to diagnose the health problem. The results of this analysis demonstrate that the proposed model is performing well in identifying the health problem as it obtained an accuracy of around 95%. In the end, it is concluded that CNN model be an efficient approach, which can help in resolving problem associated with fetal disease classification in an improved manner.

Introduction

Healthcare is evolving with the new discoveries and development of various technologies. As in this industry, various problems are still not encountered which are actually studied by various researchers to find solutions for various healthcare issues such as identifying the diseases accurately, designing machines to diagnose the patients etc. Traditionally various approaches are used, which fails as it has limitations, so to improve the approaches and techniques it is required to develop new solutions or methods to handle the critical health problems. In this concern, (Piri, and Mohapatra, 2019) focused on exploring the fetal health status with the use of an association based classification approach. The author demonstrated that the chosen approach is appropriate for cartographic analysis, which can provide efficient outcomes for fetal health status. To efficiently analyze health problems and diseases, machine learning approaches are introduced in

health care sectors to develop systems that can handle various health care problems. These approaches mainly include naïve bayes, deep learning, decision tree and others (Cömert and Kocamaz, 2017).

In this concern, the main purpose of this study is to understand the healthcare problems and the use of machine learning in healthcare. After studying the research papers, it is found that various researches are conducted to provide solutions to solve the problems in healthcare industries mainly for fetal disease classification, which needs to be improved using advanced techniques such as machine learning. In this concern, this study is conducted with an aim to implement a model using machine learning that can help in solving the problem of disease classification. The study will contribute in health sector by providing them an efficient approach to improve current diagnosis process mainly for fetal diseases.

Research question

In order to perform the research, research questions are formulated that are:

RQ1: How can machine learning models help in improving diagnosing process for fetal movements?

The given research focuses on evaluating the accuracy of machine learning models to improve diagnosing process for fetal movements by reducing problems with current approaches.

Literature review/Background

(Li and Liu, 2021) conducted a research study to perform fetal health classification on the basis of machine learning algorithms. The researcher stated that cardiotocogram (CTG) is the widely used approach for detecting fetal state whereas two main physiological signals are monitored in CTG which include uterine contractions and fetal heart rate. In this research study, twelve ML models are used and experimented on selected CTG data and four best models are selected for creating the Blender model. Gradient boosting, CatBoost, light gradient boosting machine, extreme gradient boosting, random forest, decision tree, cascade forest, extra trees, K-neighbor, ada boost, linear discriminant analysis and logistic regression are the ML models evaluated on the basis of accuracy, recall, precision, F1 and AUC. Herein, blender model is developed using Gradient boosting, CatBoost, light gradient boosting machine and extreme gradient boosting because of their efficient

performance in comparison to other models for detecting fetal health. The research results further demonstrated that the created blender model in this research study provides excellent results in getal health classification than all the other identified ML models.

In a similar context, (Rahmayanti, Pradani, Pahlawan and Vinarti, 2022) also conducted research to provide a comparison between different ML models used for the classification of fetal health with the help of CTG data. For this, the researcher considered seven algorithms for predicting fetus health which include, LSTM, XGBoost, SVM, K-nearest neighbor, random forest, Light GBM, ANN. Three scenarios are considered by the researcher including different data pre-processing stages. On the basis of conducted experiment analysis, it has been analyzed that five out of seven models provided efficient performance with an accuracy ranging between 89 to 99%. Those five models are SVM, LGBM, RF, KNN and XGB. Only one out of five algorithms performed efficiently through all the three scenarios that is LGBM.

Methodology

In order to conduct this research, an experimental analysis is performed in python with the use of secondary data. The chosen dataset in this research is about fetal diseases, which is used for classifying the health of a fetus based on the target values such as Normal, Suspect or Pathological. The data is basically the CTG test data in which various attributes are available which can be used for performing the classification (Li and Liu, 2021). This dataset comprises 2126 records of features extracted from Cardiotocogram exams, and all the features values are classified by three expert obstetricians into 3 classes.

In this research, the main focus is on evaluating machine learning models and their appropriateness to improve diagnosis process mainly for fetal movements. The feature values are required in order to train the model as these attributes are having high correlation and distribution are around the mean values meaning the attributes having relationships that can be used for solving the health classification problems. In addition, machine learning models are efficient in handling the diagnosis problem as it automatically extracts the features that could help in performing classification to suggest the correct classes.

In this study, machine learning model is designed and evaluated by performing various tasks such as data splitting, preprocessing, classification and others. For this, Xgboost classifier is used in

order to resolve classification problem. Along with this, exploratory analysis is performed to evaluate overall findings of this research and address research questions.

Results

In order to evaluate results for this research, data is splitted using the train test split function in which the data is divided into training and testing with a ratio of around 0.25. This is significant for performing the training and testing. In addition, data processing is performed by using methods such as data cleaning in which the null values are explored and dropped/replaced if found. From the analysis, it is found that there are no null values available in the dataset.

Xgboost classifier is used as it is the best ensemble method for solving classification problems and moreover, it also reduces the overall overfitting while training the feature values in the target values. In the below process, initially the classifier is fitted with the training and testing and then predicted based on the testing data to suggest the target values.

XgBoost classifier

```
import xgboost as xgb
boost_classifier= xgb.XGBClassifier()
```

```
[ ] boost_classifier.fit(x_train, y_train)

    XGBClassifier(objective='multi:softprob')
```

```
[ ] prediction= boost_classifier.predict(x_test)
```

```
[ ] from sklearn.metrics import classification_report
    from sklearn.metrics import accuracy_score,confusion_matrix
```

```
[ ] print("Accuracy score:-", accuracy_score(prediction, y_test))

    Accuracy score:- 0.9511278195488722
```

From the analysis it can be suggested that the model performed well as the model obtained an accuracy of around 95%.

Evaluation methods and metrics used

For evaluating the model, accuracy, precision, f1-score and recall is used for identifying the performance of the model. The below figure shows that accuracy observed is around 95% with 90% precision, 93% recall and 92% f1 score.

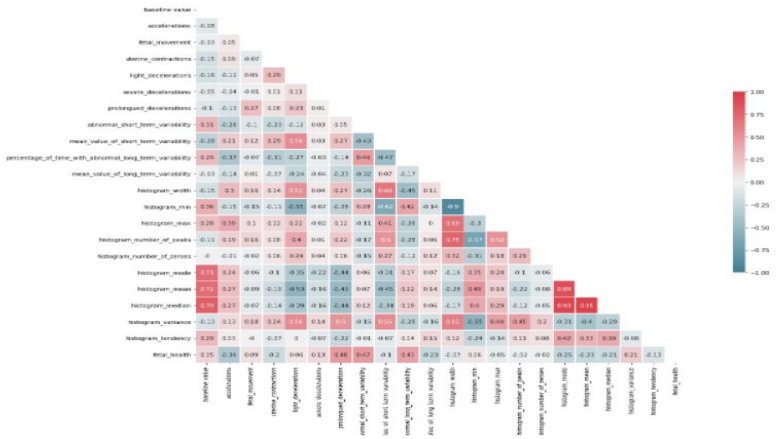
```
] print("Classification_report:-\n", classification_report(prediction, y_test))

  Classification_report:-
                precision    recall  f1-score   support

           1.0       0.98      0.96      0.97       419
           2.0       0.78      0.88      0.82        64
           3.0       0.94      0.96      0.95        49

      accuracy                           0.95       532
     macro avg       0.90      0.93      0.92       532
  weighted avg       0.95      0.95      0.95       532
```

Exploratory data analysis

In the exploratory data analysis, data is described and correlation between the attributes are found which is high relationship the attributes. From the below figure, it can be suggested that there are few attributes whose mean value is greater than the standard deviation values meaning that there is high deviation in the attribute values.

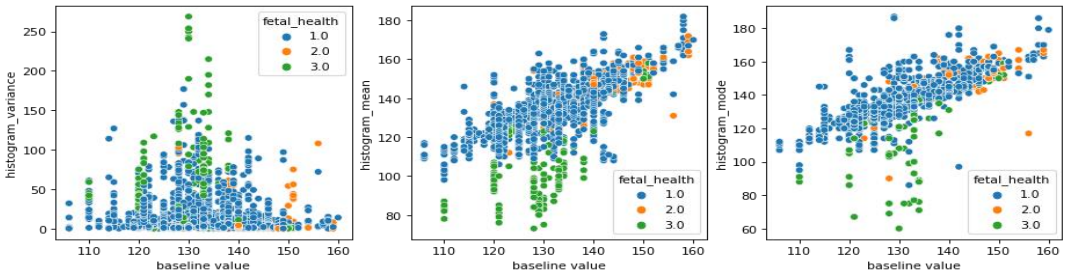
	count	mean	std	min	25%	50%	75%	max
baseline value	2126.0	133.303857	9.840844	106.0	126.000	133.000	140.000	160.000
accelerations	2126.0	0.003178	0.003866	0.0	0.000	0.002	0.006	0.019
fetal_movement	2126.0	0.009481	0.046666	0.0	0.000	0.000	0.003	0.481
uterine_contractions	2126.0	0.004366	0.002946	0.0	0.002	0.004	0.007	0.015
light_decelerations	2126.0	0.001889	0.002960	0.0	0.000	0.000	0.003	0.015
severe_decelerations	2126.0	0.000003	0.000057	0.0	0.000	0.000	0.000	0.001
prolongued_decelerations	2126.0	0.000159	0.000590	0.0	0.000	0.000	0.000	0.005
abnormal_short_term_variability	2126.0	46.990122	17.192814	12.0	32.000	49.000	61.000	87.000

From the correlation, it is observed that there are various attributes which have high correlation. It can be assumed from the below analysis that all the attributes could be chosen as attributes as all are showing relation to one another.

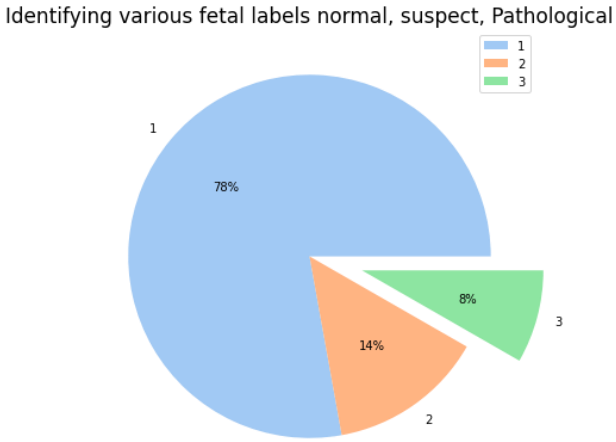


Discussion

From the analysis, various insights are found in which it is observed that there is huge change in distribution values among the attributes. From the below, it can be observed that there are various classes having huge deviations on the distribution of values based on the baseline values.



Further analysis is performed in which target values are observed and found that the level target influences around 78%, second and third level influences around 8% and 14%.



Conclusions

In this study, a model is designed to solve classification problems in order to detect fetal diseases. In order to perform the analysis, various steps are considered including data loading, data preparation, exploratory analysis, visualization, designing machine learning algorithms. From the analysis it is observed that the model outperforms in classifying the target values as the accuracy obtained is around 95%. Furthermore, in this analysis, limitations is that the dataset is not well defined which limits the user to understand what attribute suggested and what results could be obtained in order to provide the solution to the framed problems (Rahmayanti, Pradani, Pahlawan and Vinarti, 2022). So, other research will be conducted in which information about each of the attributes are explored to be conducted that could be helpful in suggesting various facts from the dataset.

References

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