Prediction for Patient Maternal Health Risk Level

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# **Abstract**

Prediction for Maternal Health risk for patients or the maternal outpatients provides illustration of various statistical and machine learning methods to predict the risk level for the patients. The primary concern addressed in this paper about improving maternal health, reducing maternal and child mortality. This paper demonstrates effective monitoring of pregnant women mostly in rural areas of Bangladesh, which indicates the pregnant women and their family about the health conditions. Many health factors can influence maternity and some among them like age of the patient, blood pressure, blood sugar levels, body temperature, heart rate are considered in this study for analysis and prediction. The dataset collected from different hospitals and community clinics of many rural areas of Bangladesh have these features and the pregnancy risk factors are predicted. The dataset obtained from the UCI machine learning library contains 1013 enrollments of the maternal patients with these features: Ahmed,Marzia. (2023). Maternal Health Risk. UCI Machine Learning Repository. <https://doi.org/10.24432/C5DP5D> . This dataset is fit into machine learning model by splitting into training and test datasets. Different machine learning classifiers are considered for evaluation and the GridSearchCV decision tree classifier has provided the maximum accuracy score for the dataset yielding a mean success prediction rate of 83% and some of the predictions are more than 90% accurate.

# **Introduction**

Infant mortality has been a major concern in many underdeveloped or developing countries even to this era. Many pregnant women lose their lives with severe health conditions, and this is due to lack of proper medical monitoring systems and information about maternal health care. Pregnant women must have regular health monitoring and care to assist with healthy living of the women and child. Some of the external factors those can influence health of pregnant women are: mental health conditions influencing factors including work environment, nutrition, air quality, water quality, living conditions, excessive exposure to sun’s heat in the Asian or middle-eastern countries causing dehydration and other blood pressure related conditions. These conditions are to be monitored for optimal living environment and healthy mental and physical state of both the pregnant women and fetus. Unfortunately, some of the rural regions of developing countries do not have facilities to improve the knowledge and providing timely health related recommendations to these pregnant women therefore causing abnormal deliveries impacting the child and pregnant women mortality.

Smaller Internet of Things (IoT) devices can be of greater help in this scenario those are highly capable of collecting the health features and transmitting to other local servers and computers, and the data from these features can be analyzed to know the current health conditions and predict the maternal risk status. A prototype of the data collection, analysis process and decision-making algorithms predicting the health risk can be represented as in the Figure 1.

A diagram of a data source

Description automatically generated

Figure 1. Prototype of the IoT and ML algorithms interaction to predict health.

This research is to solve the problem of infant mortality and death risk of the pregnant women in the under-developed and developing countries. The first problem is the collection of data. This can be achieved through wearable IoT devices or devices at the medical facilities connected over internet and those can transmit data into larger data collecting systems like cloud or local servers. The second problem is the accurate analysis and prediction of the health risk. Various Machine learning classification algorithms like SVM (Support Vector Machines), Decision tree, GSV (Grid Search Classification Vector), Randomized Search CV are considered and implemented for data analysis and building a model that has the highest accuracy. Decision trees are the most advanced and helpful algorithms for accuracy and prediction rather than the regression models. The third task is sharing the information to the hospital staff and patient to make them aware of the status and further take necessary actions.

# **Exploratory Data Analysis**

The dataset obtained at the UCI Machine Learning library consists of the following features: Age of the patient, Systolic blood pressure, Diastolic blood pressure, Blood sugar levels, body temperature, heart rate. The risk level of the patient health is classified into low, mid and high considering the values of the features. A sample of the data in this dataset is shown in Figure 2.

A table with numbers and text

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Figure 2. Sample of the data in the initial dataset

Several cross tabulations were performed to determine what variables could be used for classifying the health risk of the patient.

A screenshot of a graph

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Figure 3. Statistical data showing risk levels of patients for the body temperature

A table of numbers with numbers on it

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Figure 4. Statistical data showing risk levels of patients per Heart rate

A table of numbers with numbers

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Figure 5. Statistical data showing risk levels of patients for the Systolic and Diastolic blood pressure.

A table with numbers on it

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### Figure 6. Statistical data showing risk levels of patients per Heart rate

The statistical data shown above has no significance in indicating any contributing features for high risk of the patients. Hence, the data is further considered for input to various machine learning classifying algorithms to find the accuracy and obtaining a decision tree.

### **Data Cleaning/Preparation**

# The data is categorized as two equal halves of test and training data. Groups of data is fit into SVM, Decision tree, GridSearchCV, RandomizedSearchCV through python code. The GridSearch CV algorithms have a hyperparameter tuning capability to get the best parameters. Algorithms have shown below Decision-tree classification can vary for different tree depth. GridSearchCV algorithm has predicted the results with 83% accuracy.

# **Model Analysis**

The proposed model algorithm implements the following strategy:

Inputs: Age, BodyTemp, HeartRate, SystolicBP, DiastolicBP, BS(Blood Sugar)

Output: low / mid / high risk level for a patient.

The pseudocode for these machine learning algorithms can be as follows:

***BEGIN***

***Read the input file and loop through each patient record***

***LOOP***

***Choose features from the patient record***

***Calculate significance for each feature, calculate accuracy and error rate***

***Implement statistical data approach and calculate the best value for a combination***

***For other combination of features repeat the loop***

***END LOOP***

***COMPARE with trained data and test data***

***Predict the output risk level and display the values***

***END***

The max depth of search for this model is limited to 21 due to the considerations for cost pruning. The GridSearchCV algorithm has predicted with upto 90% accuracy on the training dataset. The accuracy of the predictions has increased exponentially as the depth of the tree increased. The GridSearchVC algorithm has also predicted with consistent accuracy for test data and has shown constant 80% accuracy rate as the depth of the tree increased.

A graph with blue and orange lines

Description automatically generatedFigure 7. GridSearchCV prediction accuracy scores against training and test datasets.

Comparison between different Machine learning algorithms

A graph of different colored shapes

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Figure 8. Plot showing prediction accuracy scores between SVM and Decision tree classifiers

A graph of different colored bars

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Figure 9. Plot showing prediction accuracy scores between GridSearchCV and Randomized Search CV classifiers.

A diagram of a company

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Figure 10. Decision tree diagram for GridSearchCV at maximum depth = 4.

# **Conclusion and Recommendations**

This research opens the possibility for the use of decision tree model in predicting maternal health risks of the patients in underdeveloped or developing countries. The GridSearch CV Machine learning algorithm yielded highest accuracy rate amongst other models used for this research. The decision tree provided with a max depth =4 can be considered for manual prediction in the situations that there are not online or computing devices available. This gives the doctors the ability to serve and predict more patients’ health risk and thus saving more lives and controlling infant mortality rate.

In the future, this research can be conducted with more contributing risk factors those are excluded in this research. This research can also be conducted on big data or larger volumes of datasets from other densely populated or developed nations to improve training the model and predict with best results.

# **References**

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# **Keywords**

Pregnancy, Machine learning algorithms, Predictive maternal risk, Decision trees, decision classifiers

**Index Terms**

Maternal Health Risk Level, Internet of Things, Blood Sugar, Blood Pressure, Fetal Health, Decision Tree algorithm, Search Vector algorithms, Highest accuracy, Cloud computing, Machine Learning, Artificial Intelligence.