

EVALUATION OF MACHINE LEARNING MODELS FOR PREDICTING PREGNANCY RISK AND FETUS RISK USING INFORMATION OF DIFFERENT PROVINCE OF INDIAN

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1. ABSTRACT

Pregnancy complications or disorders can threaten the life of both the mother and the fetus, and emotional factors like anxiety, stress, or depression can be significant risk factors. This paper presents a comprehensive evaluation of machine learning algorithms to predict pregnancy risk and fetal risk, based on an Indian pregnant women database from different provinces.

Our project seeks to improve the accuracy of these predictions by including genetic data. We performed a scoping review of the scientific literature published in the last 12 years (2008-2020) to list methodologies, techniques, algorithms, and frameworks employed in AI and Affective Computing for pregnancy well-being and health. By evaluating and understanding the impact of AI implementation in clinical practice, we focus on healthcare technology and delivery improvement potential for pregnant patients. We also emphasize fetal well-being, with a perspective to develop predictive models that can support clinical decision-making and enhance maternal and fetal health outcomes.

2. INTRODUCTION

Predicting pregnancy and fetal risk is a crucial aspect of maternal and fetal healthcare. Accurate predictions can help in timely interventions, potentially reducing the risk of complications that could endanger the lives of both the mother and the fetus. Various factors, including medical history, lifestyle, and clinical measurements, play a significant role in determining these risks. In recent years, Artificial Intelligence (AI) and machine learning have emerged as powerful tools in healthcare, providing new avenues for enhancing predictive accuracy and clinical decision-making.

3. PROBLEM STATEMENT

Despite advancements in medical technology, predicting pregnancy and fetal risk remains challenging, especially in diverse populations like India's. Traditional methods such as clinical expertise, rule-based approaches and statical models often struggle to account for the complex interplay of multiple risk factors. Machine learning models offer a promising solution by identifying patterns in large datasets, potentially improving prediction accuracy. However, evaluating the effectiveness of different machine learning models in this specific context is essential for ensuring reliable and clinically relevant predictions.

4. OBJECTIVES

The study aims to evaluate and compare the performance of different machine learning models in predicting pregnancy risk, with a reliable model for fetal risk prediction, and assessing the impact of incorporating the current medical dataset of Indian pregnant women from different provinces on model accuracy. By leveraging current medical information, we seek to enhance the predictive accuracy of these models.

5. METHODOLOGY OVERVIEW

The dataset used in this study includes information from pregnant women across various provinces of India. We performed extensive data preprocessing, including handling missing values and normalization. Several machine learning models, including . Several machine learning models, including **Logistic Regression, Random Forest, K-Nearest Neighbors (KNN), and Gradient Boosting Classifier (GBC)**, were evaluated for

their predictive performance in pregnancy and fetal risk classification.

6. DATASET

6.1 MATERNAL RISK DATASET

The dataset used in this research is derived from a variety of healthcare facilities, including hospitals, community clinics, and maternal healthcare centers, leveraging an IoT-based risk monitoring system. It contains critical health indicators such as **age, systolic and diastolic blood pressure (BP), blood glucose levels (BS), and heart rate**, which are essential in predicting pregnancy and fetal risks.

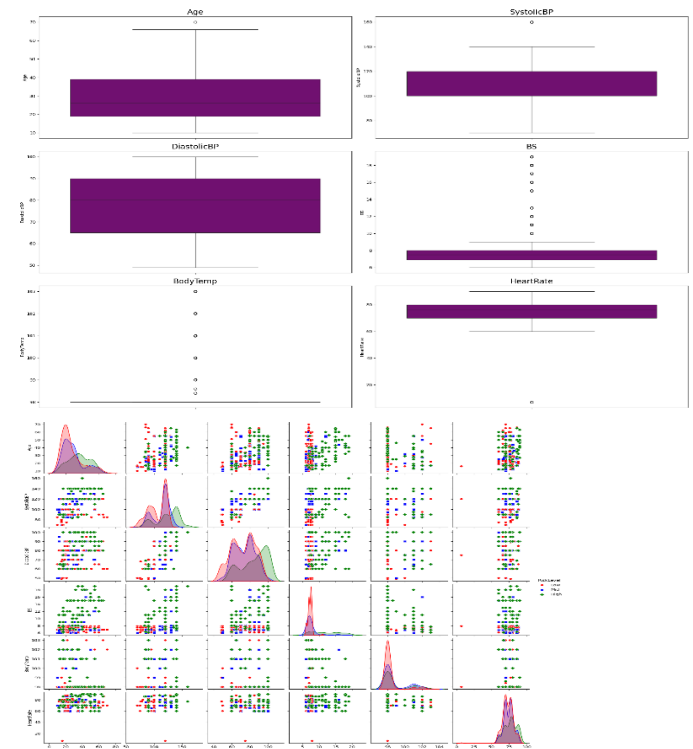
A significant challenge encountered during pregnancy risk prediction was the presence of **outliers in the heart rate data and collinearity issues between systolic and diastolic blood pressures, as indicated by high Variance Inflation Factor (VIF) values**. Initially, these factors hindered the model's performance.

However, by removing the systolic BP variable, which was less informative, and focusing on diastolic BP, the prediction accuracy improved substantially, reaching 81% from random forest. For fetal risk prediction, the challenge arose from the multitude of potential factors influencing fetal health, necessitating careful feature selection. By selecting the most relevant features and fine-tuning the model, predictive performance was enhanced. This is crucial, as fetal risk prediction plays a key role in reducing child mortality, a critical goal of the United Nations' Sustainable Development Goals (SDGs). The UN aims to reduce preventable deaths of newborns and children under five years of age by 2030, with a target mortality rate of under 25 per 1,000 live births.

Maternal mortality also remains a significant concern, with a substantial number of deaths occurring in low-resource settings, many of which are preventable. In addressing these issues, Cardiotocograms (CTGs), which assess fetal heart rate, movements, and uterine contractions, offer a cost-effective solution for monitoring fetal health. By utilizing the data

from 2,126 records of CTG exams, the research focuses on three classes—Normal, Suspect, and Pathological—classified by expert obstetricians. The study also includes an in-depth analysis of the data using various techniques, including correlation metrics, confusion matrices, feature importance graphs, pairwise graphs, and outlier detection. These analyses help in understanding the relationship between features and their impact on pregnancy and fetal risk prediction, offering valuable insights for improving healthcare outcomes. By incorporating these advanced analytical methods, the research aims to contribute to the ongoing efforts to reduce maternal and child mortality through more accurate and accessible healthcare tools.

6.1.2 EVALUATION/PREDICTION

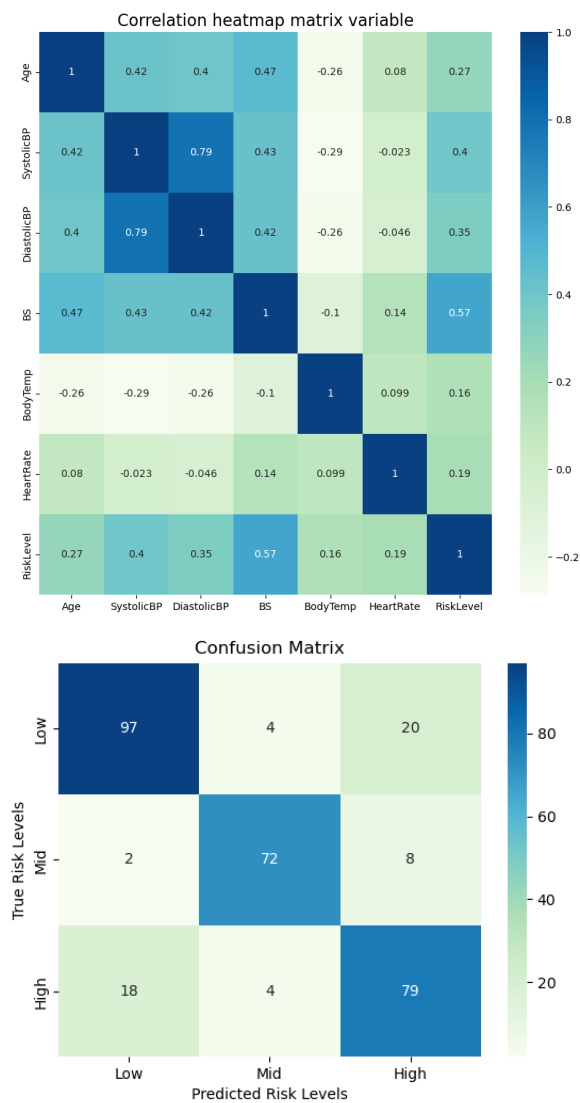


Forest model effectively balances both precision and recall, ensuring that it accurately identifies high-risk cases while minimizing false positives and false negatives. Consequently, the Random Forest model is highly reliable for predicting

maternal risk, making it an ideal choice for clinical applications where accurate and timely identification of at-risk patients is crucial for providing appropriate care and interventions.

6.1.4 MATERNAL RISK CLASSIFICATION REPORT

	precision	Recall	F1-score	Support
0	0.79	0.82	0.80	121
1	0.70	0.75	0.73	101
2	0.92	0.79	0.85	82
Accuracy			0.79	304
Macro avg	0.80	0.79	0.79	304
Weighted avg	0.80	0.79	0.79	304



6.2 FETUS RISK DATASET

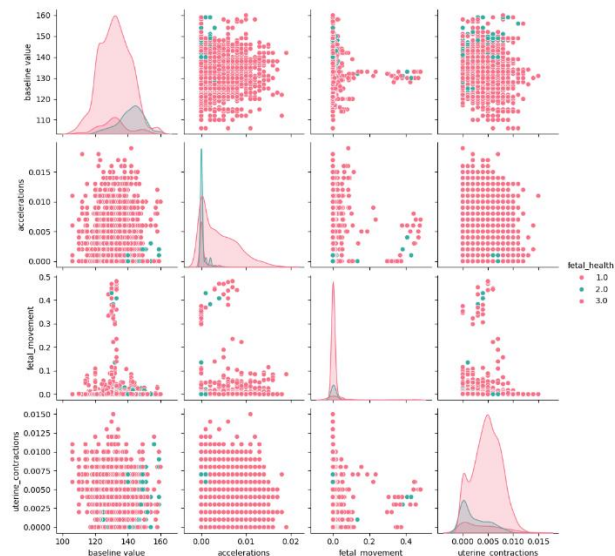
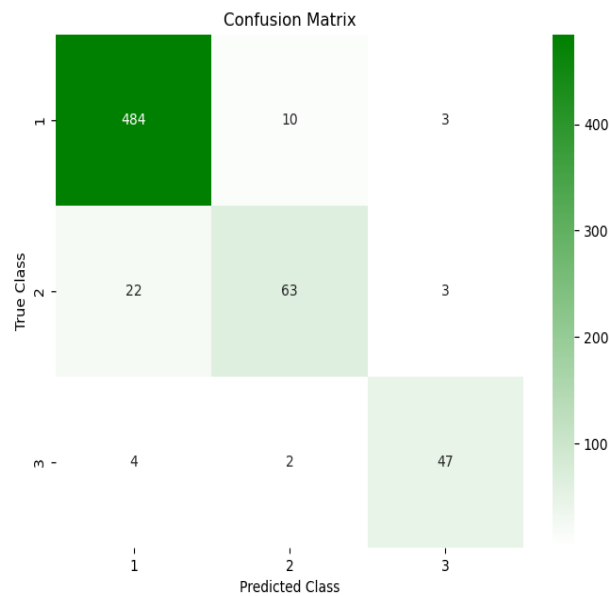
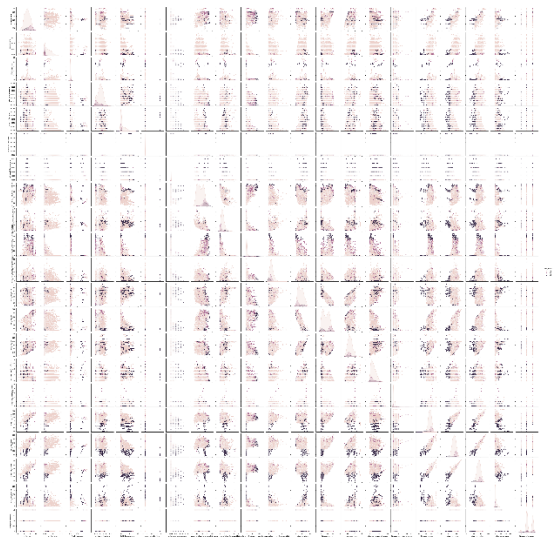
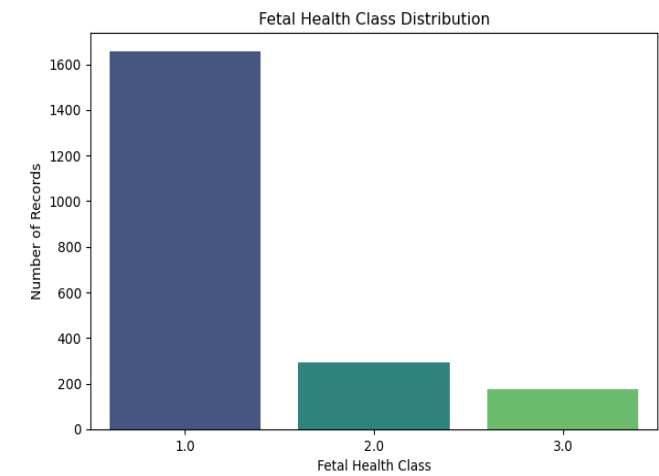
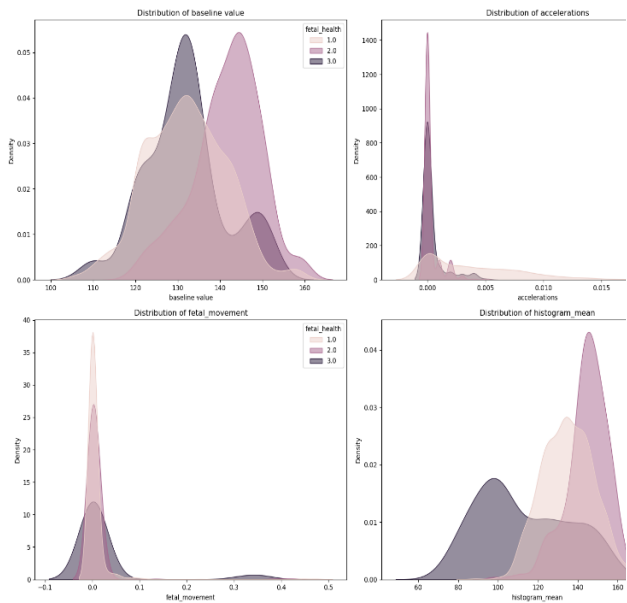
Child and maternal mortality remain pressing global challenges, with profound implications for human development. The United Nations' Sustainable Development Goals (SDGs) emphasize the reduction of child mortality as a critical indicator of progress, with a target to end preventable deaths of newborns and children under five by 2030. Specifically, the goal is to reduce under-5 mortality to below 25 per 1,000 live births. However, maternal mortality continues to be a significant concern, claiming 295,000 lives annually during and after pregnancy, with 94% of these deaths occurring in low-resource settings. Many of these deaths are preventable with timely intervention and improved healthcare.

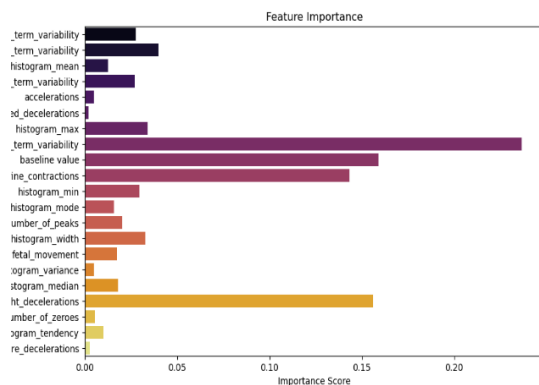
In addressing these challenges, Cardiotocograms (CTGs) offer a promising, cost-effective solution for monitoring fetal health. CTGs work by emitting ultrasound pulses to measure vital indicators such as fetal heart rate (FHR), fetal movements, and uterine contractions, which can help healthcare professionals make informed decisions to prevent maternal and child mortality.

This study utilizes a dataset containing 2,126 records extracted from CTG exams. The data, classified by three expert obstetricians, categorizes the fetal health status into three classes: **Normal**, **Suspect**, and **Pathological**. The goal of the model is to accurately predict

fetal health outcomes, providing valuable insights for medical professionals to take proactive measures in reducing mortality risks.

6.2.1 VISUAL REPRESENTATION





6.2.2 FETUL CLASSIFICATION REPORT:

	precision	recall	f1-score	support
1.0	0.95	0.97	0.96	497
2.0	0.84	0.72	0.77	88
3.0	0.89	0.89	0.89	53
Accuracy			0.93	638
Macro avg	0.89	0.86	0.87	638
Weighted avg	0.93	0.93	0.93	638

The classification report evaluates the model's performance across three classes, with key metrics like precision, recall, and F1-score.

Precision measures how accurate the positive predictions are. For Class 1.0, the precision is high at 0.95, indicating a strong ability to correctly predict this class, while Class 2.0 has a lower precision of 0.84, and Class 3.0 stands at 0.89.

Recall reflects the model's ability to identify all actual positive instances. Class 1.0 has a recall of 0.97, showing excellent identification, while Class 2.0 has a lower recall of 0.72, meaning the model misses some instances of this class. Class 3.0 performs well with a recall of 0.89.

The **F1-score**, which balances precision and recall, is highest for Class 1.0 at 0.96, indicating strong performance. Class 2.0's F1-score is 0.77, suggesting room for improvement, and Class 3.0's F1-score is 0.89, showing good balance.

Accuracy is 93%, meaning the model makes correct predictions for 93% of all instances. The **Macro average** (averaging metrics across all classes) shows a balanced performance with precision at 0.89, recall at 0.86, and F1-score at 0.87. The **Weighted average**, taking class size into account, is 0.93 for all metrics, reflecting the model's overall strong performance despite some challenges with Class 2.0.

7. CONCLUSION

This study aimed to evaluate the performance of various machine learning models in predicting pregnancy and fetal risk using a dataset of Indian pregnant women. The results indicate that different models perform optimally for different prediction tasks. The **Gradient Boosting Classifier (GBC)** demonstrated the highest accuracy in predicting fetal risk, while **Random Forest** emerged as the most reliable model for pregnancy risk assessment. These findings highlight the importance of selecting the appropriate machine learning model for specific healthcare predictions.

Comprehensive analysis using correlation metrics, confusion matrices, feature importance graphs, pairwise plots, and outlier detection provided deeper insights into the factors influencing both pregnancy and fetal risks. The incorporation of current medical data significantly improved prediction accuracy, reaffirming the value of data-driven approaches in maternal and fetal healthcare.

While the models performed well, future research could focus on integrating genetic data and real-time health monitoring to enhance prediction capabilities further. Expanding the dataset and applying advanced techniques such as deep learning could lead to even more accurate and personalized risk assessments, ultimately contributing to improved maternal and fetal health outcomes.

Observation

By performing effective data cleaning, removing unnecessary or irrelevant features, and selecting

the appropriate machine learning models, accurate predictions regarding fetal health and pregnancy risk can be achieved. This process highlights the importance of preprocessing in improving model performance. It is crucial to note that fetal health and pregnancy risk, while closely related, remain distinct topics. A healthy pregnancy does not always guarantee a healthy fetus, as various other factors influence fetal outcomes.

8. LIMITATION

The findings may not apply to community settings, to women who are asymptomatic or have only minor symptoms, or in the setting of an HEV epidemic.

9. FUTURE EXPECTS

In the future, the inclusion of genetic information, along with current health and situational data, may offer more comprehensive insights into fetal and maternal health. This evolution would help create even more accurate prediction models, leading to better-informed decisions and interventions. Incorporating genetic data, in addition to the existing medical factors, could potentially enhance the ability to predict risks more effectively and contribute to more personalized and proactive healthcare strategies.

10. ETHICS

Patient trust and the preservation of the human physician-patient relationship are critical in moving forward with AI implementation in healthcare. Pregnant individuals are cautiously optimistic about AI use in their care.

11. Reference

[1] Authors: [Sharda Patra, MS](#), [Ashish Kumar, M D, DM](#), [Shubha Sagar Trivedi, MS](#), [Manju Puri, MS](#), and [Shiv Kumar Sarin, MD, DM](#)

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