PROJECT REPORT

1. INTRODUCTION

1.1 Project Overview:

This pioneering initiative stands as a beacon in response to the global call embedded in the United Nations' Sustainable Development Goals, specifically addressing the imperative of reducing child and maternal mortality. With an unwavering commitment to the UN's 2030 goal of preventing deaths in newborns and children under 5 years, the project strategically deploys Cardiotocograms (CTGs) as a transformative, cost-effective instrument for fetal health assessment. Unveiling the intricacies of fetal heart rate, movements, and uterine contractions through ultrasound pulses, CTGs serve as a revolutionary means for healthcare professionals to gain comprehensive insights. In recognizing the profound impact of fetal health on the prevention of child and maternal mortality, the project endeavours to arm healthcare professionals with an avant-garde solution, enabling proactive and targeted interventions.

1.2 Purpose:

At its core, this multifaceted project serves a dual purpose that reverberates across global healthcare landscapes. Firstly, it endeavours to make substantial contributions to the overarching goal of reducing child and maternal mortality rates worldwide. Secondly, the project seeks to redefine the standards of prenatal care by introducing an intricate Fetal Health classification system. This innovative system, driven by state-of-the-art machine learning and artificial intelligence algorithms, meticulously dissects a spectrum of physiological parameters. In doing so, it empowers healthcare professionals not just to identify potential risks early on but to do so with a precision that allows for the formulation of highly personalized care plans and the execution of timely interventions. The ultimate aspiration of the project is to transcend conventional healthcare outcomes for both mothers and infants, establishing an unassailable foundation for informed, proactive decision-making within the realm of maternal and child health.

2. LITERATURE SURVEY

2.1 Existing Problem:

The literature survey reveals a complex landscape in maternal and child health, highlighting the persistent challenges that impede global efforts to reduce child and maternal mortality rates. Numerous studies emphasize the urgent need to address preventable deaths, particularly in newborns and children under 5 years, with a keen focus on vulnerable populations in resource-limited settings. Maternal mortality, responsible for a staggering 94% of deaths during and following pregnancy and childbirth in low-resource areas, remains a poignant concern. Despite advancements in healthcare, the literature underscores existing gaps in implementing comprehensive solutions to reduce mortality rates and elevate the standards of

prenatal care. This synthesis of existing knowledge emphasizes the crucial role of technology, such as Cardiotocograms (CTGs), in assessing fetal health as a means to address these challenges.

2.2 References:

The literature survey is enriched by insights from a variety of authoritative sources, presented in a succinct bullet-point format:

- World Health Organization (WHO):
  - Global reports on maternal and child health, provide a comprehensive overview of the current challenges and trends.

- Lancet Series:
  - In-depth analyses of maternal and child mortality trends, offering nuanced perspectives on global healthcare issues.

- Peer-Reviewed Journals:
  - Journal of Obstetrics and Gynaecology Research:
    - Scientific contributions to the understanding of maternal and child health, featuring rigorous peer-reviewed research.
  - American Journal of Perinatology:
    - Scholarly articles offering insights into perinatal healthcare and related advancements.

- UNICEF Publications:
  - Reports and publications by UNICEF, contribute valuable perspectives on the state of global child health.

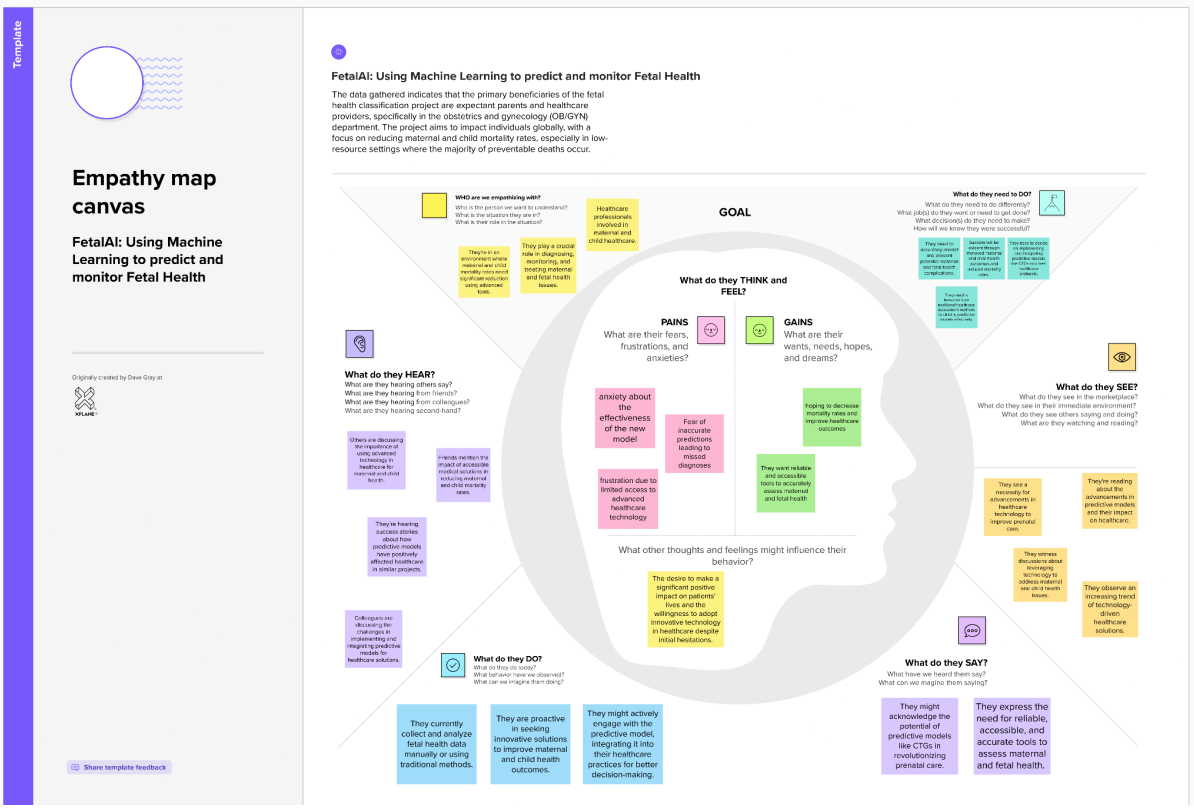
- Scientific Articles on CTG Application:
  - Exploration of the application of Cardiotocograms in fetal health assessment, providing a technological lens to the literature survey.

2.3 Problem Statement Definition:

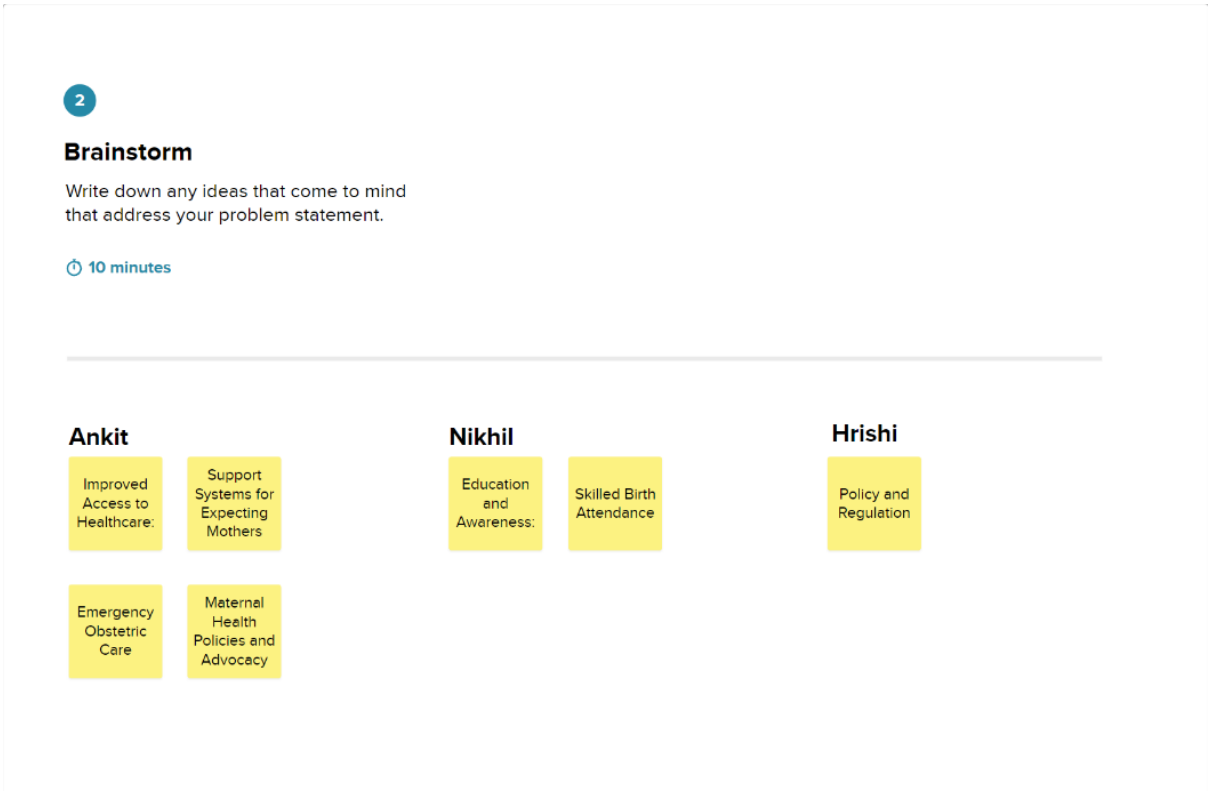
The culmination of the literature survey distils into a refined problem statement, crystallizing the essence of challenges illuminated by existing research. The dual-fold problem encompasses the persistently high rates of child and maternal mortality, particularly in resource-constrained environments, and the existing voids in comprehensive fetal health assessment. The imperative for an advanced and accessible solution becomes evident, calling for the integration of cutting-edge technologies like Cardiotocograms and the strategic use of machine learning algorithms. The project's problem statement is meticulously crafted to serve as a bridge across these gaps, contributing to the global endeavour to reduce child and maternal mortality by enhancing early detection and intervention measures through innovative healthcare technologies.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming



4. REQUIREMENT ANALYSIS

4.1 Functional Requirements:

- Fetal Health Classification System:
    - Develop a robust algorithm for accurate classification of fetal health into categories, including 'Normal,' 'Pathological,' and 'Suspect.'

    - Ensure the algorithm considers key parameters such as fetal heart rate, movements, and uterine contractions for precise classifications.

- Integration with Healthcare Systems:
    - Enable seamless integration with existing Electronic Health Records (EHRs) and Hospital Information Systems (HIS) to ensure a cohesive healthcare environment.
    - Ensure compatibility with standard healthcare data exchange protocols for efficient interoperability.

- Real-time Monitoring:
    - Implement a real-time monitoring feature that allows healthcare professionals to receive immediate alerts and notifications based on critical fetal health parameters.
    - Ensure the system provides continuous and instantaneous updates for timely decision-making.

- User-Friendly Interface:
    - Design an intuitive and user-friendly interface for healthcare providers, facilitating easy navigation and interpretation of the system's outputs.
    - Incorporate user feedback mechanisms to enhance the interface based on practical usability.

- Interdisciplinary Collaboration:
    - Implement secure communication channels within the system to encourage seamless interdisciplinary collaboration among healthcare professionals.
    - Provide features that facilitate information sharing and collaborative decision-making.

4.2 Non-Functional Requirements:

- Security and Privacy:
    - Implement robust security measures to safeguard the confidentiality and integrity of patient data.
    - Ensure compliance with healthcare privacy regulations and standards, including encryption and access control.

- Scalability:
    - Design the system to be scalable, accommodating an increasing volume of patient data and meeting the evolving demands of healthcare facilities.
    - Consider future expansions and technological advancements in scalability planning.

- Reliability and Availability:

- Ensure high reliability with minimal downtime to guarantee continuous availability of the system for healthcare professionals.
- Implement redundancy measures to minimize the impact of potential system failures.

- Performance:
  - Optimize system performance for efficient processing and analysis of fetal health data.
  - Set benchmarks for response times to meet the requirements of timely decision-making in healthcare settings.

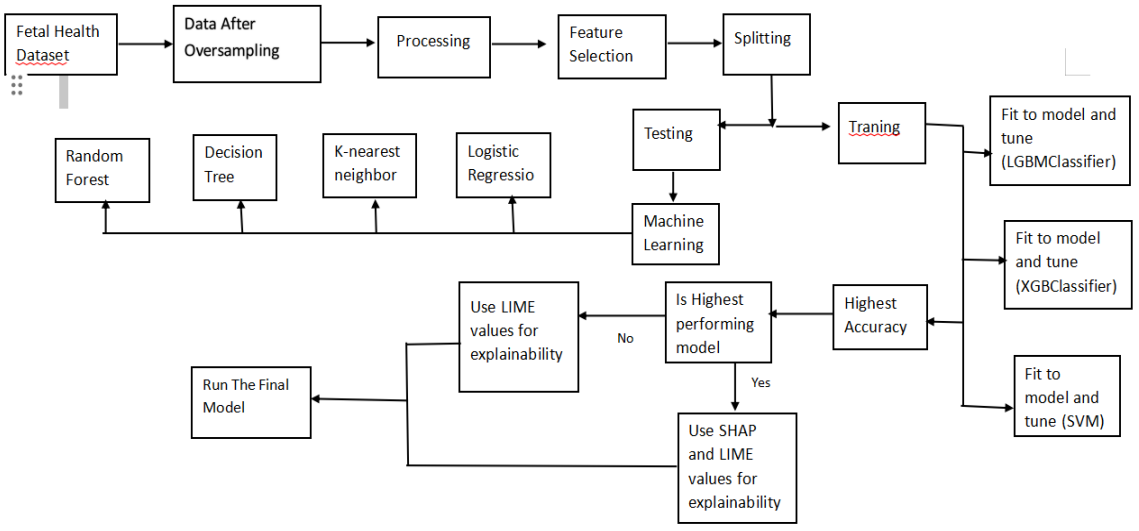
- Usability:
  - Prioritize usability in the system design, considering the diverse technical expertise of healthcare professionals.
  - Conduct usability testing and incorporate user feedback to enhance the overall user experience.

- Accuracy of Classification:
  - Define and meet accuracy benchmarks for the fetal health classification algorithm, ensuring reliable and precise categorization.
  - Regularly update and refine the algorithm based on emerging medical knowledge and research.

- Compliance with Standards:
  - Adhere to relevant healthcare standards and regulations governing data management, ensuring ethical and legal compliance.
  - Conduct regular audits to verify continued compliance with evolving standards.

5. PROJECT DESIGN

5.1 Data Flow Diagrams & User Stories:



5.2 Solution Architecture:

Project Flow:

- The user interacts with the UI to enter the input.
- Entered input is analyzed by the model which is integrated.
- Once the model analyzes the input the prediction is showcased on the UI

Architecture:

1.)Define Problem / Problem Understanding
    - Specify the business problem
    - Business requirements
    - Literature Survey
    - Social or Business Impact.

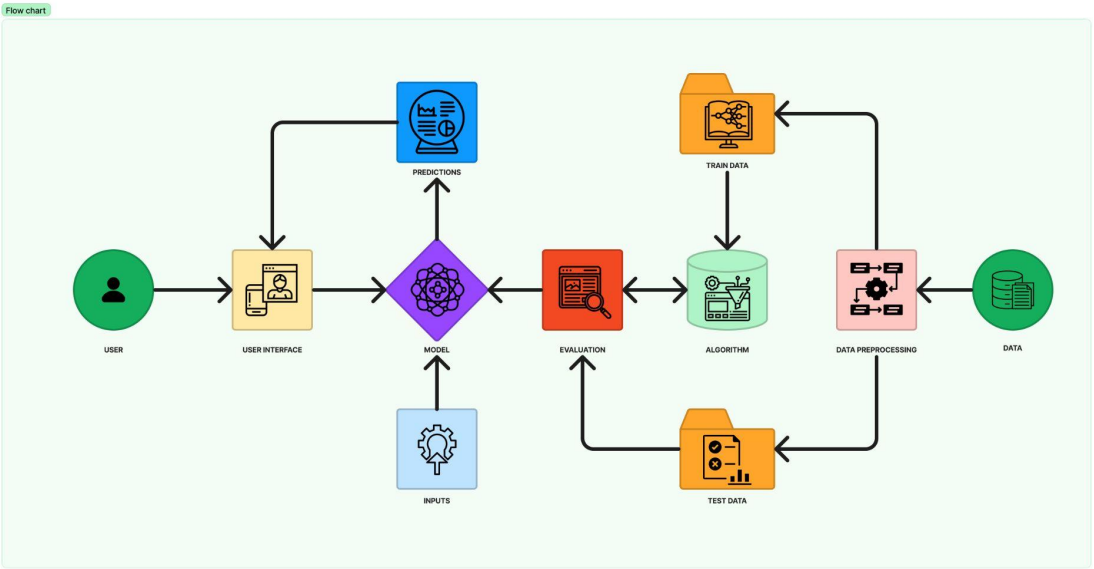
2.)Data Collection & Preparation
    - Collect the dataset

3.)Exploratory Data Analysis
    - Descriptive statistical
    - Visual Analysis
    - Feature Selection
    - Scaling the data
    - Checking if the dataset is balanced or not

4.)Model Building
    - Splitting data into train and test
    - Applying SMOTE to balance the data
    - Training the model after applying SMOTE
    - Training the model in multiple algorithms
    - Testing the model

5.)Performance Testing
    - Create a data frame of model performance
    - Bar plot for model performance

6.)Model Deployment
    - Save the best model
    - Integrate with Web Framework



6. PROJECT PLANNING & SCHEDULING

6.1 Technical Architecture

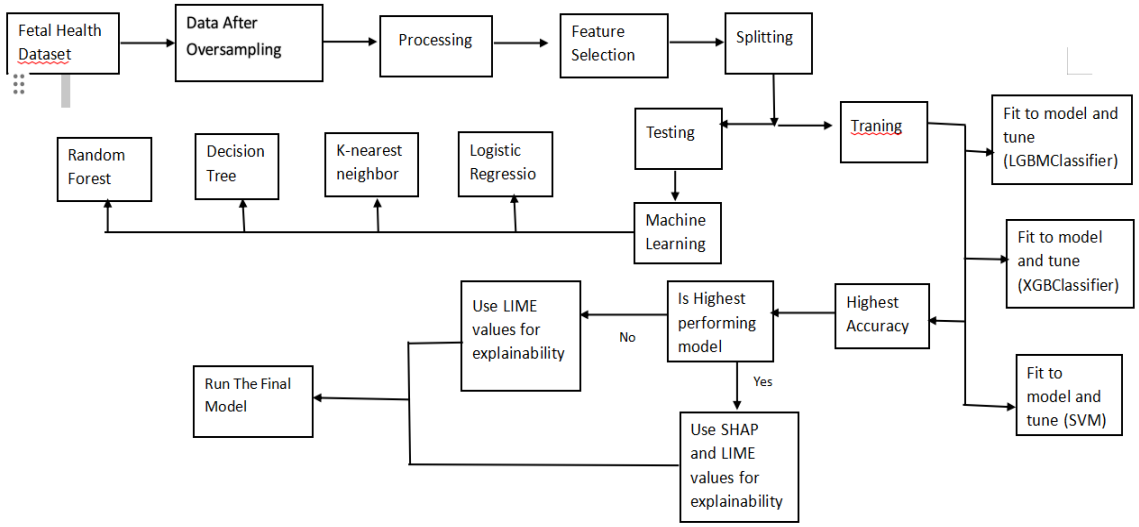


Table -1: Components &Technologies:

S.No	Component	Description	Technology
1.	User Interface	User interacts to the model using Streamlit	Streamlit
2.	Application Logic-1	Use libraries such as numpy, pandas, Seaborn in model building	Jupyter Notebook

3.	**Application Logic-2**	**User libraries such as pickle and streamlit to pick the best accuracy and connect to the server**	**Python**
4.	**Database**	**Used the dataset from the Kaggle to train and process the data**	**Fetal_health.csv**
5.	**External API**	**Used external server to run the model**	**Streamlit**
6.	**Machine Learning Model**	**Used model such as Random Forest Classifier, Decision Tree Classifier, K Neighbors Classifier to test in highest probability**	**Jupyter notebook**

Table-2: Application Characteristics:

S.No	Characteristic	Description	Technology
1.	**Availability**	**Ensuring consistent access to the model**	**Redundant storage, local servers**
2.	**Performance**	**Efficient data processing and predictions**	**Optimized algorithms, efficient code**
3.	**Scalability**	**Handling larger datasets and user demands**	**Scalable code, optimized algorithms**
4.	**Interpretability**	**Explaining model predictions for understanding**	**Feature importance, model explainers**
5.	**User Interface**	**Intuitive platform for easy user interaction**	**Streamlit, interactive visualization**
6.	**Data Handling**	**Effective data management and processing**	**Pandas, NumPy, data preprocessing**
7.	**Model Accuracy**	**Ensuring reliable predictions for fetal health**	**Fine-tuning, ensemble methods**

6.2 Sprint Planning & Estimation

Product Backlog, Sprint Schedule, and Estimation

Sprit	Functional Requirements(Epic)	User Story Number	User Story/Task	Story Points	Priority	Team Members
1	Dashboard	1	As a user, I want a personalized view. Design and implement customizable dashboards	8	High	Ankit
1	Profile Settings	2	As a user, I want to edit my profile. Allow users to modify profile information	5	High	Ankit
2	Search Feature	3	As a user, I want to search for items . Develop item search functionality	5	Medium	Hrishikesh
2	Notifications	4	As a user, I want to receive alerts. Implement notification system	3	Medium	Nikhil
3	Analytics	5	As an admin, I want data analytics. Develop data visualization for admin	8	High	Nikhil

6.3 Sprint Delivery Schedule

Project Tracker, Velocity & Burndown Chart:

Sprint	Total Story points	Duration	Sprint Start Data	Sprint End Date(Planed)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint -1	13	7 Days	1 Nov 2023	8 Nov 2023	13	8 Nov 2023
Sprint -2	8	8 Days	12 Nov 2023	20 Nov 2023	8	20 Nov 2023
Sprint -3	8	8 Days	22 Nov 2023	30 Nov 2023	8	30 Nov 2023

7. CODING & SOLUTIONS

7.1 Feature 1

Fetal Health Classification Algorithm:

- Develop a sophisticated algorithm capable of accurately classifying fetal health based on input parameters, including fetal heart rate, movements, and uterine contractions.
- Implement machine learning techniques to continuously improve the algorithm's accuracy over time.
- Conduct extensive testing to validate the algorithm's effectiveness across diverse datasets.

7.2 Feature 2

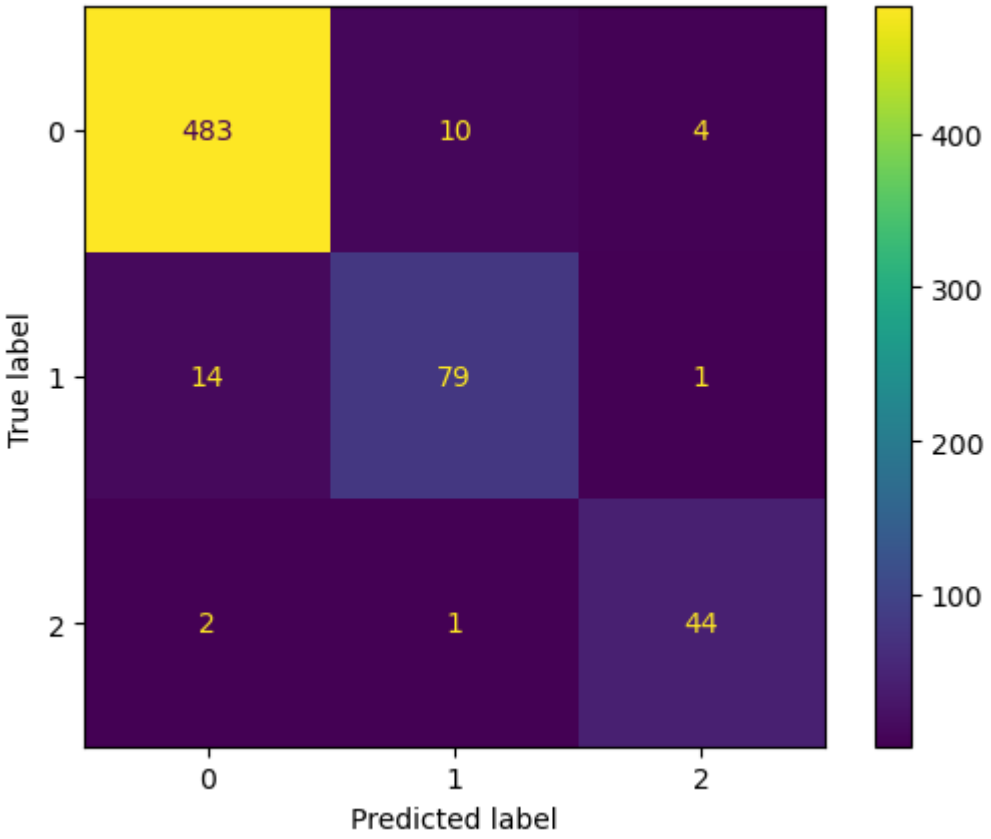
Easy-to-use User Interface

- We have used Streamlit to host the app
- It provides a very easy-to-use interface, with just 8 input boxes
- It keeps it to the point and no unnecessary webpages to confuse the user

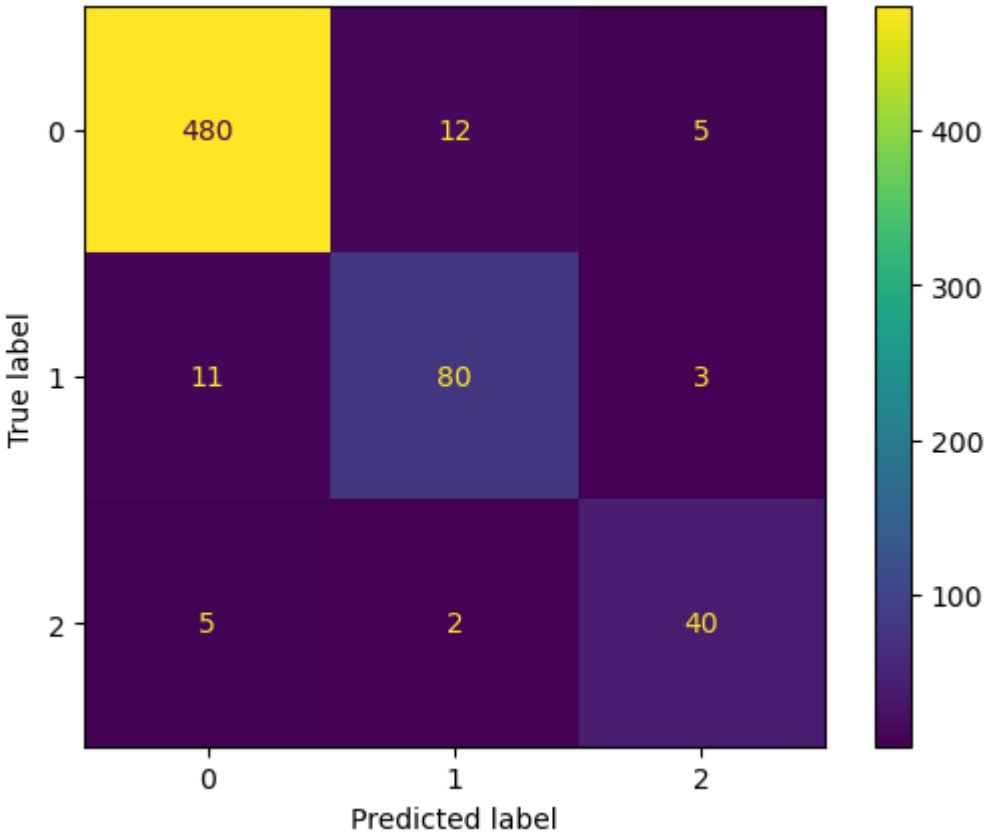
8. PERFORMANCE TESTING

8.1 Performace Metrics

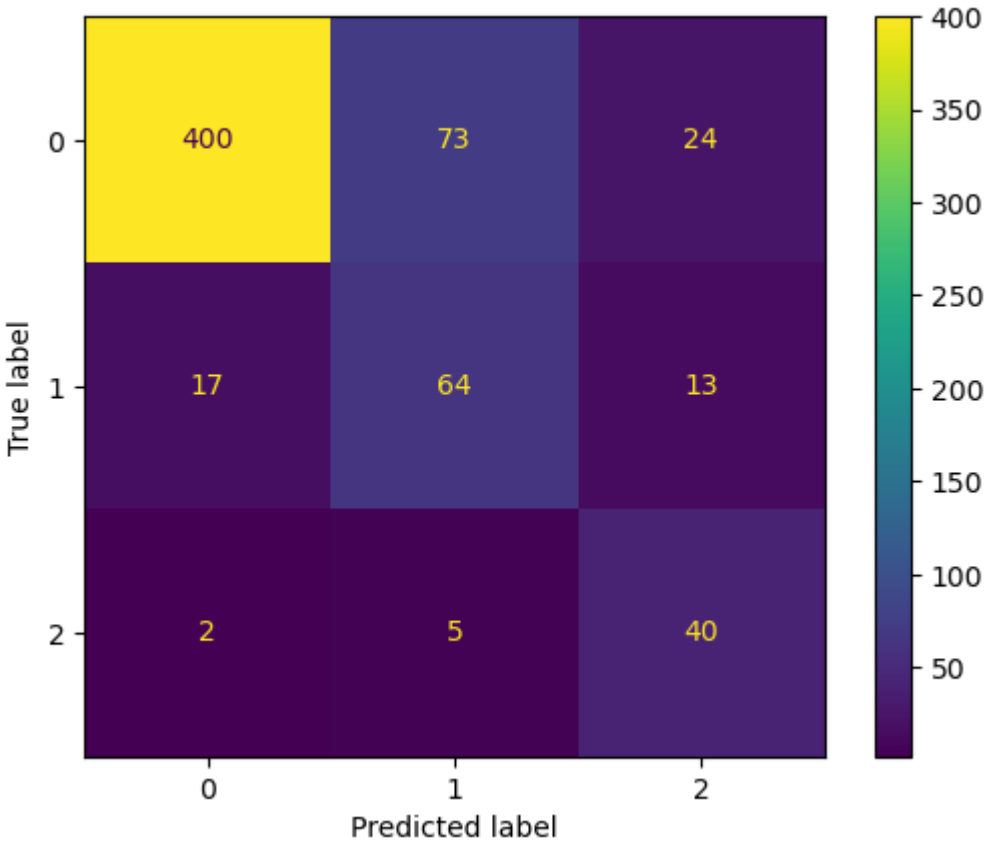
- **Accuracy of Random Forest Classifier:**
  - 0.9498432601880877



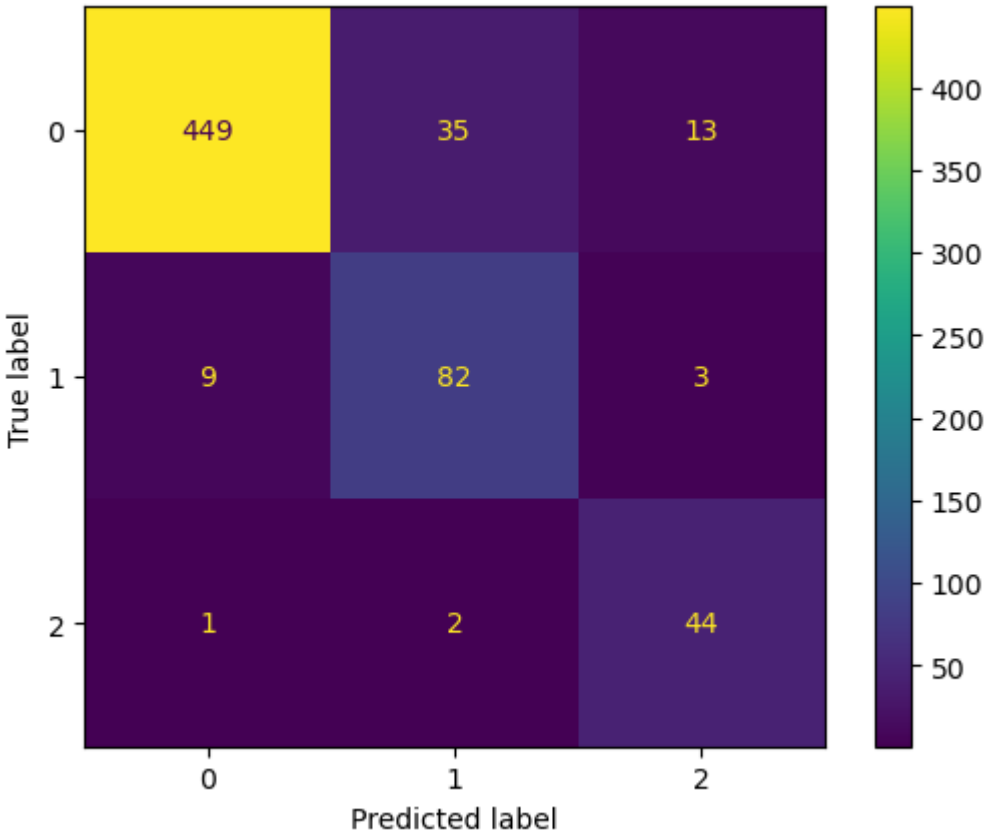
- **Accuracy of Decision Tree Classifier:**
  - 0.9404388714733543



- **Accuracy of Logistic Regression:**
  - 0.7899686520376176



  -
- **Accuracy of K Neighbours Classification:**
  - 0.9012539184952978

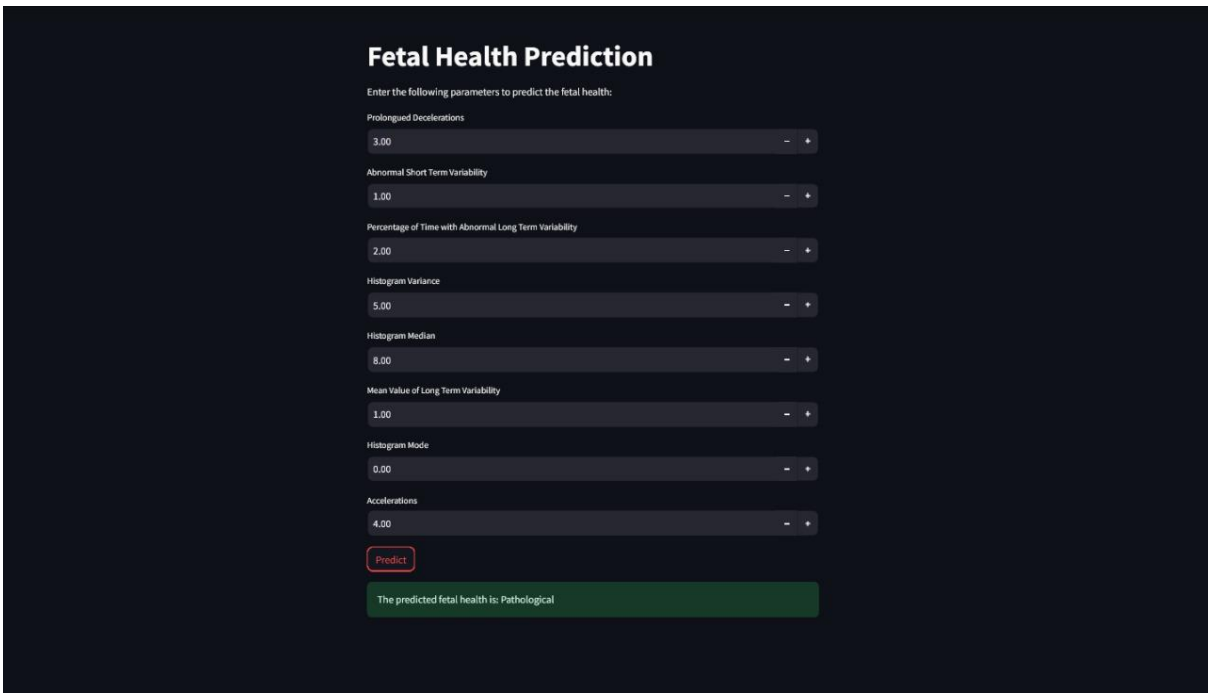


Comparative Accuracy

	name	score
0	Random Forest Classifier	0.948275
1	Decision Tree Classifier	0.926332
2	Logistic Regression	0.782131
3	K Neighbors Classifier	0.884012

9. RESULTS

9.1 Output Screenshots



10. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

1. Early Detection and Intervention:
   - Enables early detection of potential fetal health issues, allowing healthcare professionals to intervene and initiate timely treatments.

2. Improved Patient Outcomes:
   - Contributes to improved outcomes for both mothers and infants by providing accurate and timely information for healthcare decision-making.

3. Enhanced Prenatal Care:
   - Facilitates the development of personalized prenatal care plans, addressing specific health issues detected during fetal health assessments.

4. Global Impact on Child and Maternal Mortality:
   - Aligns with global efforts to reduce child and maternal mortality rates by providing a proactive approach to healthcare during pregnancy.

5. Interdisciplinary Collaboration:
   - Promotes collaboration among healthcare professionals from various disciplines, fostering a holistic approach to maternal and child health.

6. Revenue Generation for Healthcare Providers:
   - Offers additional revenue streams for healthcare providers through fetal health testing and monitoring services.

7. Research and Development Opportunities:
    - Drives research and development in the healthcare industry, fostering innovation in diagnostic tests and treatments based on fetal health monitoring data.

DISADVANTAGES

1. Technological Dependency:
    - Dependency on technology may pose challenges in healthcare settings with limited access to advanced equipment or in resource-constrained environments.

2. Data Privacy Concerns:
    - Raises concerns about the privacy and security of sensitive patient data, necessitating robust measures to safeguard against unauthorized access or breaches.

3. Initial Implementation Costs:
    - Involves initial implementation costs for healthcare facilities, including training staff, acquiring technology, and ensuring seamless integration with existing systems.

4. Limited Accessibility in Some Settings:
    - May face challenges in accessibility in remote or underdeveloped areas, limiting the reach and benefits of fetal health classification technology.

5. Accuracy Challenges:
    - The accuracy of fetal health classification algorithms may be subject to limitations, requiring continuous refinement and updates to maintain high precision.

6. User Training Requirements:
    - Healthcare professionals may require training to effectively use and interpret the outputs of the fetal health classification system, potentially posing a learning curve.

7. Ethical Considerations:
    - Raises ethical considerations regarding the implications of detecting serious health issues in the fetus and the decisions that may follow, necessitating careful counselling and support for expectant parents.

11. CONCLUSION

In conclusion, the Fetal Health Classification project stands as a pivotal initiative with profound implications for maternal and child health. Aligned with the United Nations' Sustainable Development Goals, the project addresses the imperative of reducing child and

maternal mortality by harnessing the power of advanced technologies, specifically Cardiotocograms (CTGs) and machine learning algorithms.

The robust Fetal Health Classification Module, featuring a sophisticated algorithm and user-friendly interface, offers healthcare professionals an innovative tool for early detection and intervention. This has the potential to significantly improve patient outcomes, redefine prenatal care, and contribute to global efforts to reduce child and maternal mortality rates.

12. FUTURE SCOPE

The Fetal Health Classification project opens up a realm of possibilities for future advancements and contributions to the field of maternal and child health. Several avenues for future development and expansion include:

1. Enhanced Algorithmic Capabilities:
    - Continuous refinement and enhancement of the fetal health classification algorithm to improve accuracy and broaden the scope of detectable conditions.

2. Integration with Wearable Technologies:
    - Exploring integration with wearable technologies to enable continuous fetal health monitoring, providing real-time data and further empowering expectant parents to actively participate in monitoring their pregnancy.

3. Telehealth Integration:
    - Expanding the project's reach by integrating with telehealth platforms, enabling remote monitoring and consultations for expectant parents in geographically remote or underserved areas.

4. Predictive Analytics:
    - Implementing predictive analytics to forecast potential health issues based on historical data, allowing for proactive measures and personalized interventions.

5. Global Collaboration and Data Sharing:
    - Establishing frameworks for global collaboration and data sharing to create a comprehensive database that can drive large-scale research and improve the understanding of fetal health on a global scale.

6. Artificial Intelligence Advancements:
    - Leveraging advancements in artificial intelligence to develop more sophisticated models capable of recognizing subtle patterns and variations in fetal health parameters.

7. Ethical and Societal Considerations:
    - Further research and development in addressing ethical considerations and societal impacts, including the psychological and emotional aspects of providing detailed fetal health information to expectant parents.

8. Accessible and Cost-Effective Solutions:
    - Exploring innovations to make the technology more accessible and cost-effective, ensuring that even resource-constrained healthcare settings can benefit from fetal health classification advancements.

9. Longitudinal Studies and Outcomes Research:
    - Conducting longitudinal studies and outcomes research to assess the long-term impact of early interventions based on the information provided by the fetal health classification system.

10. Cross-disciplinary Research Collaborations:
    - Fostering cross-disciplinary research collaborations between healthcare professionals, technologists, and researchers to explore novel approaches and technologies that can complement and enhance the existing project.

In essence, the future scope of the Fetal Health Classification project extends beyond its current implementation, presenting opportunities to revolutionize prenatal care, improve global maternal and child health outcomes, and contribute valuable insights to the broader healthcare landscape. Through continuous innovation, collaboration, and a commitment to addressing emerging challenges, the project sets the stage for a dynamic and impactful future in the realm of fetal health monitoring and classification.

APPENDIX

Source Code

app.py

C: > Users > Ankit Rane > Downloads > Fetal Health (2) > Fetal Health > app.py > ...

```python
from flask import Flask, request, render_template
import numpy as np
import pandas as pa
import pickle

model = pickle.load(open(r'fetal_health1.pkl','rb'))
app=Flask(__name__)

@app.route('/')
def index():
    return render_template('index.html')


@app. route ("/home", methods=["GET", "POST"])
def home():
    prolongued_decelerations = float(request.form['prolongued_decelerations'])
    abnormal_short_term_variability = float(request.form['abnormal_short_term_variability'])
    percentage_of_time_with_abnormal_long_term_variability = float (request.form['percentage_of_time_with_abnormal_long_term_variability'])
    histogram_variance = float(request.form['histogram_variance'])
    histogram_median = float(request.form['histogram_median'])
    mean_value_of_long_term_variability = float(request.form['mean_value_of_long_term_variability'])
    histogram_mode = float(request.form['histogram_mode'])
    accelerations = float(request.form['accelerations'])

    x=[[prolongued_decelerations,abnormal_short_term_variability,percentage_of_time_with_abnormal_long_term_variability,histogram_variance,histogram_median,mean_value_of_long_term_variability,histogram_mode,a

    output = model.predict (x)
    out=[ 'Normal','Pathological','Suspect']
    if int(output[0])==0:
        output= 'Normal'
    elif int(output[0])== 1:
        output= 'Pathological'
    else:
        output='Suspect'

    return render_template('output.html',output=output)

    if __name__ == "__main__":
        app.run(debug=True)
```

GitHub & Project Demo Link

https://github.com/smartinternz02/SI-GuidedProject-610171-1701658790