Project Report Format

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1. INTRODUCTION

1.1 Project Overview

An ML model that takes as input various health vitals of the fetus and its mother’s and then predicts the health status of the fetus and also gives any required advice on the immediate action to be taken if any.

1.2 Purpose

Fetal deaths in India remain a significant public health concern, reflecting complex challenges in maternal and child healthcare. High rates of malnutrition, inadequate prenatal care, and limited access to quality healthcare contribute to the prevalence of fetal deaths. Socioeconomic disparities exacerbate the issue, with rural areas facing greater hurdles than urban counterparts. Despite progress in maternal and child health initiatives, there's a pressing need for targeted interventions, improved infrastructure, and enhanced awareness. Addressing these multifaceted issues requires a comprehensive approach, and this way of ML integration into this aspect is one way to ensure better outcomes for maternal and fetal health across the diverse landscape of the world.

2. LITERATURE SURVEY

2.1 Existing problem

Current fetal health challenges persist globally, encompassing issues like inadequate prenatal care, and rising maternal age. Prevalent complications include congenital anomalies, intrauterine growth restrictions, and prematurity. In regions with limited healthcare access, maternal malnutrition and infectious diseases contribute to adverse fetal outcomes. Socioeconomic disparities exacerbate these problems, leading to unequal access to essential services. Additionally, environmental factors and exposure to pollutants pose emerging threats. Tackling contemporary fetal health issues demands targeted interventions, increased healthcare accessibility, and a holistic approach to address the multifaceted factors affecting fetal development and well-being.

2.2 References

Leddy, Meaghan A., Michael L. Power, and Jay Schulkin. "The impact of maternal obesity on maternal and fetal health." *Reviews in obstetrics and gynecology* 1.4 (2008): 170.

Vahter, Marie. "Effects of arsenic on maternal and fetal health." *Annual review of nutrition* 29 (2009): 381-399.

Liston, Robert, et al. "Fetal health surveillance: antepartum and intrapartum consensus guideline." *Journal of obstetrics and gynaecology Canada* 29.9 (2007): S3-S4.

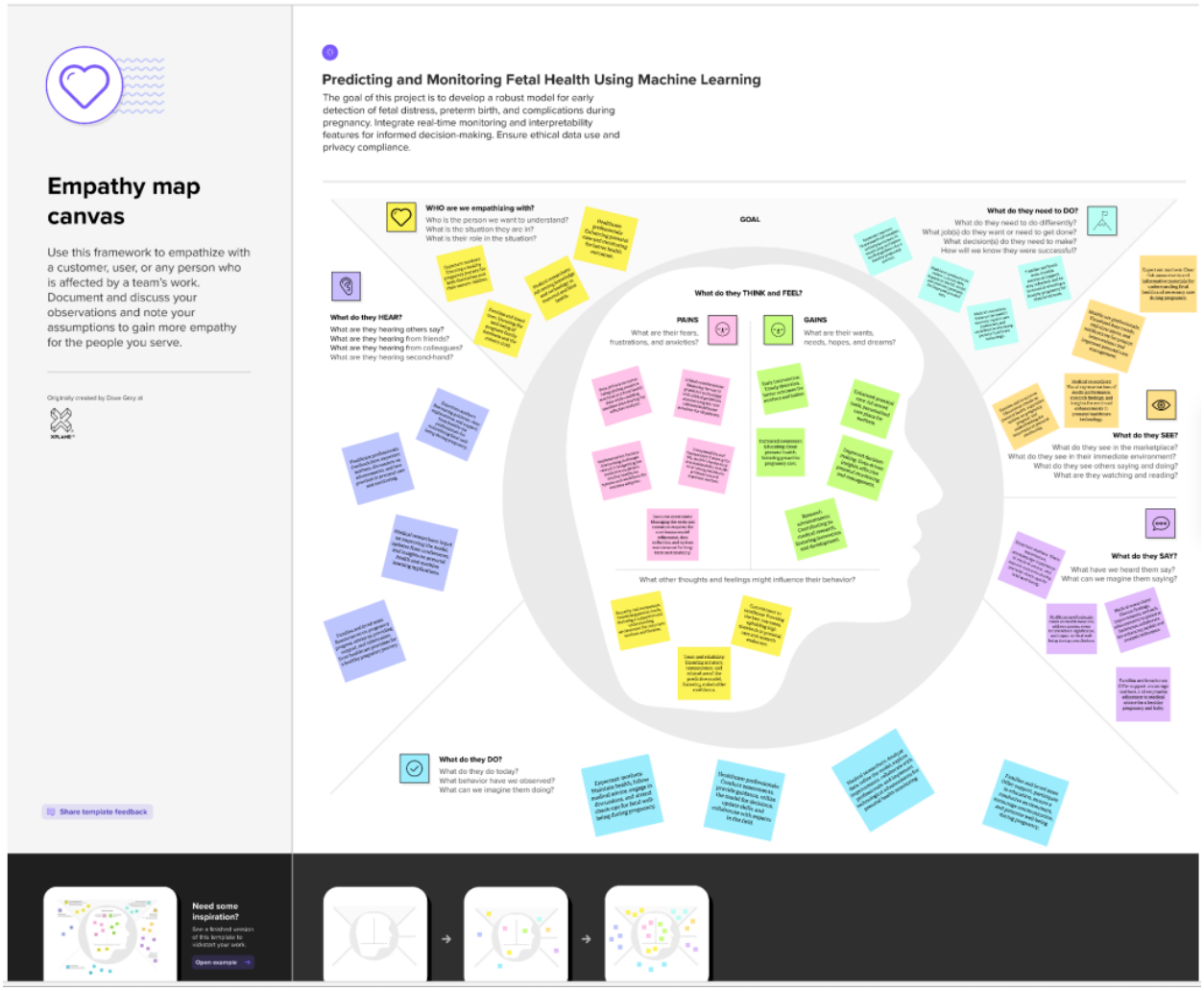
Tenenbaum-Gavish, Kinneret, and Moshe Hod. "Impact of maternal obesity on fetal health." *Fetal diagnosis and therapy* 34.1 (2013): 1-7.

2.3 Problem Statement Definition

To create an publicly accessible and simple interface that can predict the health of an unborn fetus just from taking minimal inputs of health vitals and shall also provide any immediate actions to be taken as suggestions if any, also giving necessary advice to the expecting parents based on the health of the fetus.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

C **Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

There are multiple ways to determine our Problem Statement.

Few are stated below:

PROBLEM

How might we predict and monitor Fetal Health using Machine Learning

PROBLEM

Automate fetal health monitoring for early distress detection in vital parameters, improving prenatal care accuracy and efficiency.

PROBLEM

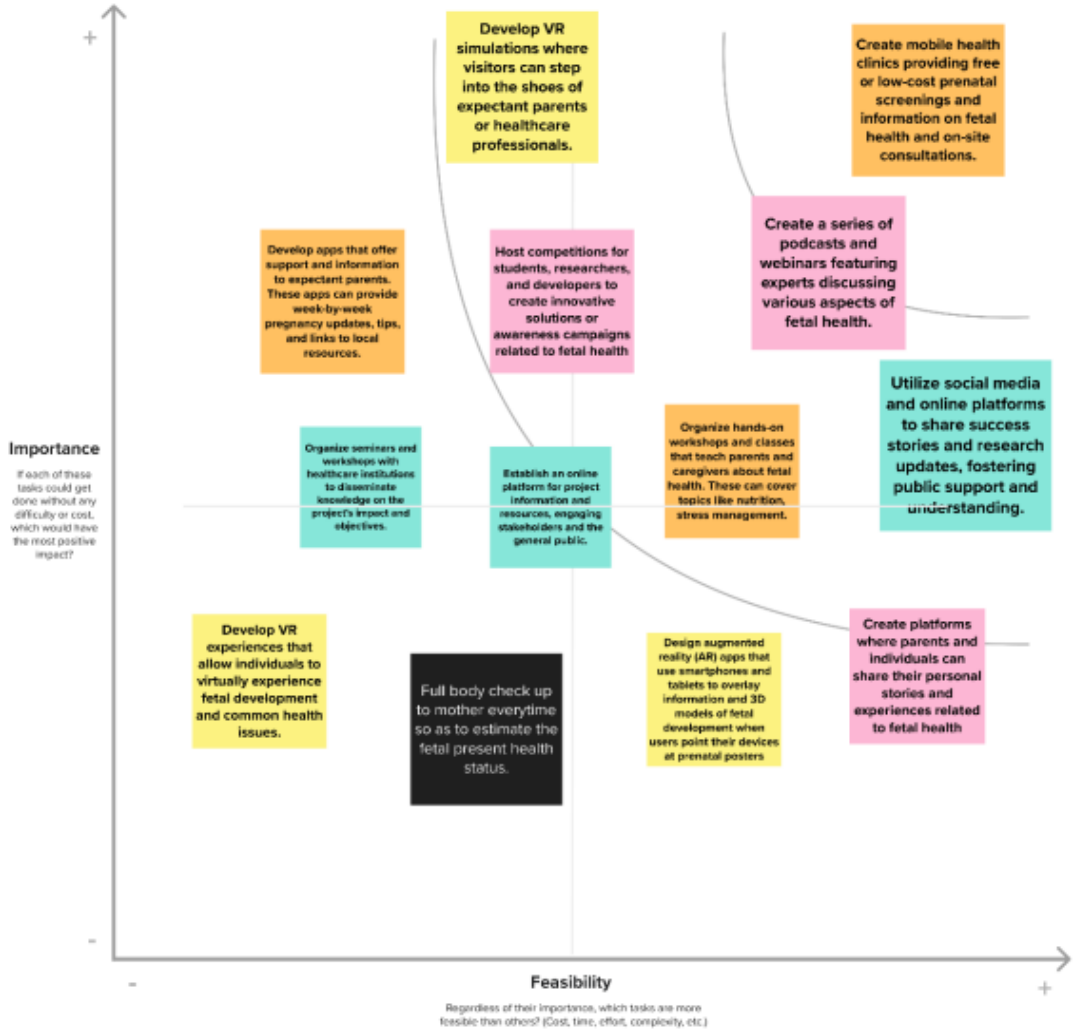
Enhance fetal anomaly detection in ultrasound using deep learning, enabling precise identification of structural abnormalities, developmental disorders.


10 minutes
S Surya
Try to find suspectability of diseases with genetic analysis
Detect NIPT blood test abnormalities
Try to find anomalies with ultra sound scanning
S Madhuri
Use wearable devices to get data of mother's health status for using in ML model
Detection of fetal issues with MRI
Create apps and websites for processing the data and ML models
Ch Amarnath
Use AI to analyze lifestyle and detect harmful foods
Incase of surgery requirements, use 3D models to prepare in advance.
Use fluid Analysis with amniotic fluid which detects fetal distress.
Ankit K
Environmental Study can help to pre-detect chances of fetal health issues.
Analyze the sleep quality of parents to check for restlessness.
Implement a system that tracks the expectant parent's physical activity levels and provides exercise routines
bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.
20 minutes
Mobile Clinics and workshops
Create mobile health clinics providing free or low-cost prenatal screenings and information on fetal health and on-site consultations.
Organize hands-on workshops and classes that teach parents and caregivers about fetal health. These can cover topics like nutrition, stress management.
Develop apps that offer support and information to expectant parents. These apps can provide week-by-week pregnancy updates, tips, and links to local resources.
VR and AR
Develop VR experiences that allow individuals to virtually experience fetal development and common health issues.
Design augmented reality (AR) apps that use smartphones and tablets to overlay information and 3D models of fetal development when users point their devices at prenatal posters
Develop VR simulations where visitors can step into the shoes of expectant parents or healthcare professionals.
Social Media and Outreach
Establish an online platform for project information and resources, engaging stakeholders and the general public.
Organize seminars and workshops with healthcare institutions to disseminate knowledge on the project's impact and objectives.
Utilize social media and online platforms to share success stories and research updates, fostering public support and understanding.
Fetal Health Competitions
Host competitions for students, researchers, and developers to create innovative solutions or awareness campaigns related to fetal health
Create platforms where parents and individuals can share their personal stories and experiences related to fetal health
Create a series of podcasts and webinars featuring experts discussing various aspects of fetal health.
WILD CARD
Full body check up to mother everytime so as to estimate the fetal present health status.

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the **H key** on the keyboard.



4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	User interacts with application through Web UI.	HTML, CSS, JavaScript
2.	Data Collection	Collection of the input data from the web interface. The user needs to provide information regarding various parameters of the present condition of the foetus.	Python
3.	Model prediction	The input values are hit to the pre trained pickle model and output is collected.	Python-Pickle,Flask
4.	Result	Displaying the collected output on the web interface about the heath of the fetus and displaying any precautions required.	HTML, CSS, JavaScript
5.	Machine Learning Model	Predict and monitor fetal health based on the present condition of the fetus.	Gradient Boosting Classifier Model

4.2 Non-Functional requirements

Table-2: Application Characteristics:

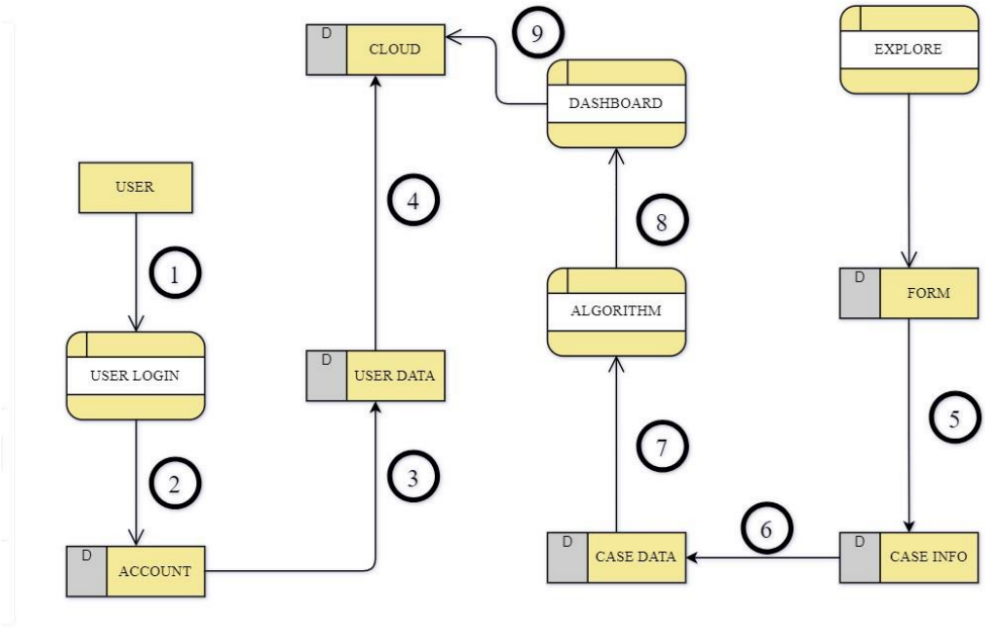
S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	Flask	Python

5. PROJECT DESIGN

5.1 Data Flow Diagrams & User Stories

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

Here is the Data Flow Diagram for Envisioning Success project



1. Users successfully complete the registration process.
2. Within the Web App's Explore section, users are prompted to input specific characteristics.
3. The provided Case Info undergoes a seamless transformation into formatted Case Data.
4. The transformed Case Data serves as input for the FetalAI algorithm.
5. The algorithm processes the data, predicts the score, and presents the results on a dynamic dashboard.

User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release

Customer (Mobile user)	Registration	USN-1	As a mobile user, I can register for the application by entering my email, password, and confirming my password.	• Successfully entering email, password, and confirming password leads to account creation. • Access to the FetalAI dashboard is granted upon successful registration.	High	Sprint-1
		USN-2	As a mobile user, I will receive a confirmation email once I have registered for the FetalAI application.	• Receive a confirmation email after successful registration. • The confirmation email should contain a clickable link to confirm the registration.	High	Sprint-1
		USN-3	As a mobile user, I can register for the FetalAI application through smartbridge internz platform.	Successful registration and access to the FetalAI dashboard using smartbridge internz credentials.	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	Successful registration and access to the FetalAI dashboard through Gmail.	Medium	Sprint-1

	Login	USN-5	As a mobile user, I can log into the FetalAI application by entering my email and password.	Successfully entering a valid email and password leads to login.	High	Sprint-1
	Dashboard	USN-6	As a user of the FetalAI application, I want to view all the details related to the health predictions of the selected pregnancies.	Access to a dashboard displaying comprehensive details about the health predictions of selected pregnancies.	High	Sprint-1
	Best Algorithm Finding	USN-7	Trying out all the available algorithms in order to find which one gives the best accuracy rate	Ability to filter and sort predictions based on parameters such as gestational age, health risk levels, and other relevant factors.	High	Sprint-1

	Finding correlations	USN-8	We have a huge number of 21 parameters which can be hectic to handle, hence we shall find correlated columns and eliminate them.	• Access a user-friendly dashboard offering comprehensive insights into health predictions for selected pregnancies. Explore predicted health parameters, receive recommendations, and view relevant data visualizations. Utilize convenient filters and sorting options based on parameters like gestationalage, health risk levels, and other relevant factors.	High	Sprint-1
Customer (Web user)	WebUI development	USN-9	Access to the homepage after validating the FetalAI profile to ensure accurate and personalized predictions.	Access a user-friendly dashboard that provides in-depth insights into health predictions for selected pregnancies. Explore various predicted health parameters, receive tailored recommendations.	High	Sprint-2

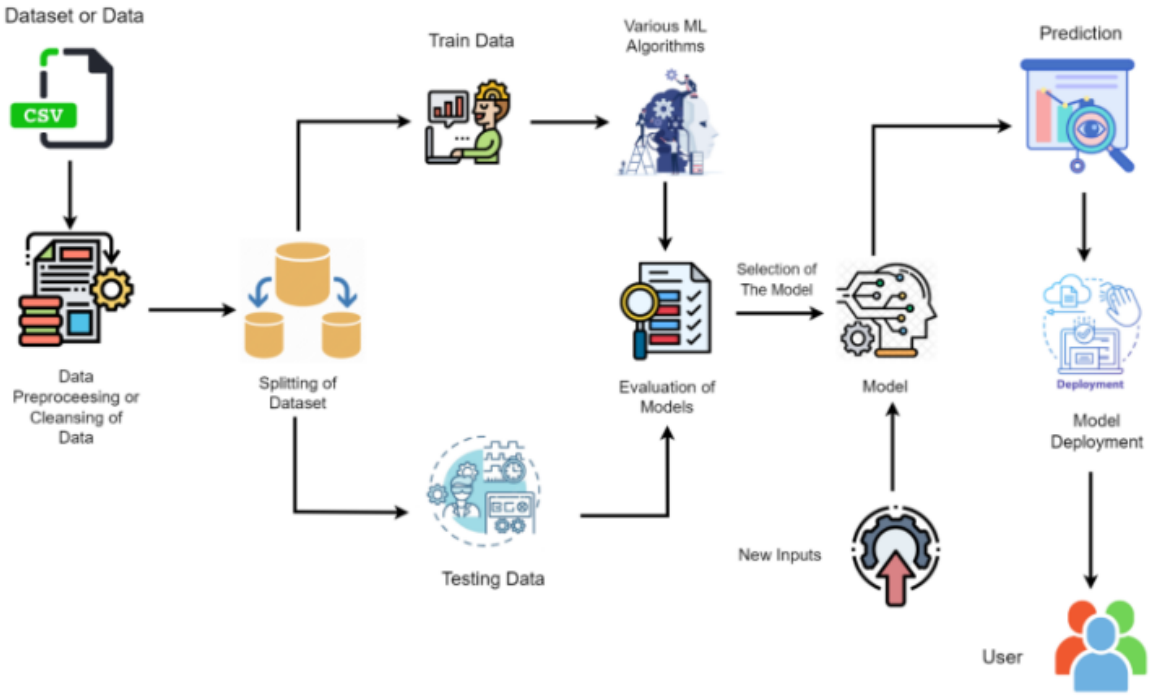
	Logo requirement	USN-10	Find or design an apt logo for the WebUI	The logo should reflect the essence of FetalAI, conveying a sense of health, pregnancy, and advanced technology. The colors used in the logo should be harmonious with the color scheme of the WebUI, promoting visual consistency.	Medium	Sprint-1
	Defining Description	USN-11	A detailed information about the application, its uses, and its application should be available for the users in order to understand better about the model.	The information should be easily accessible within the application, preferably through a dedicated section or help center.	Medium	Sprint-2
Customer Care Executive	Contact us page	USN-12	In order to allow the users to post further queries, a contact us part of the page must be made available with the details of our team in it and how to contact us.	Include a mechanism for users to provide feedback on the "Contact Us" process, ensuring continuous improvement and addressing any issues promptly.	Medium	Sprint-3

Administrator	Further contraction of parameters	USN-13	Though we have 16 parameters now, it is still a big number of inputs for the users to deal with, hence, we must further decrease them.	The reduction in the number of parameters aims to enhance the overall usability of the application, making it more user-friendly.	High	Sprint-3
	Back Navigator	USN-14	A button must be provided for the users to return to the predictor_inputs page to start predicting from the model again	Use an intuitive icon or label for the button to clearly convey its purpose, ensuring users understand that clicking it will take them back to the predictor_inputs page.	Low	Sprint-4
	Reset button	USN-15	A reset button may help the user to reset all the	Ensure that the reset button is integrated with all relevant form elements on the predictor_inputs page.	Low	Sprint-4
	Suggestions division	USN-16	Create a division in the result page that displays the suggestion of steps to be followed based on the predicted output of the fetal condition.	Perform thorough testing to validate that the displayed suggestions are dynamically linked to the predicted output. Check for different scenarios and ensure the correctness of the displayed information.	Medium	Sprint-4

Use the below template to list all the user stories for the product.

5.2 Solution Architecture

Solution Architecture Diagram:



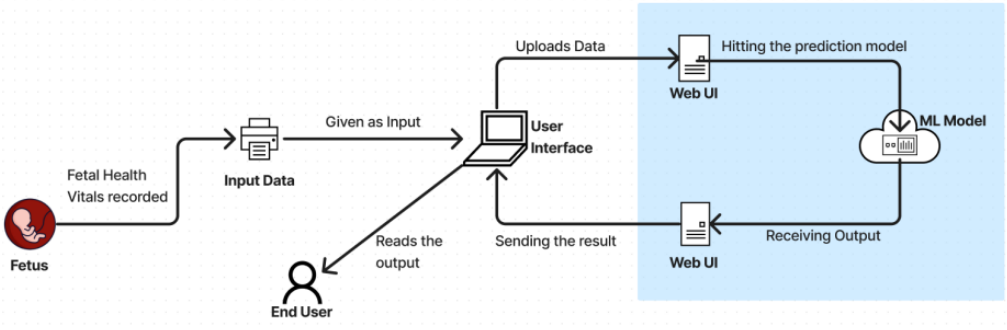
6. PROJECT PLANNING & SCHEDULING

6.1 Technical Architecture

Technical Architecture:

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table

Title: FetalAI: USING MACHINE LEARNING TO PREDICT AND MONITOR FETAL HEALTH



6.2 Sprint Planning & Estimation

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Best Algorithm Finding	USN-7	Trying out all the available algorithms in order to find which one gives the best accuracy rate.	4	High	Ankit Amarnath Surya Madhuri
Sprint-1	Finding correlations	USN-8	We have a huge number of 21 parameters which can be hectic to handle, hence we shall find correlated columns and eliminate them.	3	High	Ankit Surya Amarnath
Sprint-2	WebUI development	USN-9	We need a webUI so that the users can give their inputs and find predictions accordingly.	4	High	Madhuri Surya
Sprint-1	Logo requirement	USN-10	Find or design an apt logo for the WebUI	2	Medium	Madhuri Ankit

Sprint-2	Defining Description	USN-11	A detailed information about the application, its uses, and its application should be available for the users in order to understand better about the model.	2	Medium	Ankit
Sprint-3	Contact us page	USN-12	In order to allow the users to post further queries, a contact us part of the page must be made available with the details of our team in it and how to contact us.	4	Medium	Ankit Surya
Sprint-3	Further contraction of parameters	USN-13	Though we have 16 parameters now, it is still a big number of inputs for the users to deal with, hence, we must further decrease them.	5	High	Amaranth Ankit Madhuri Surya
Sprint-4	Back Navigator	USN-14	A button must be provided for the users to return to the predictor_inputs page to start predicting from the model again	2	Low	Madhuri Amarnath
Sprint-4	Reset button	USN-16	A reset button may help the user to reset all the values entered,	1	Low	Madhuri

			thus may find use in needy times.			
Sprint-4	Suggestions division	USN-10	Create a division in the result page that displays the suggestion of steps to be followed based on the predicted output of the fetal condition.	3	Medium	Surya

6.3 Sprint Delivery Schedule

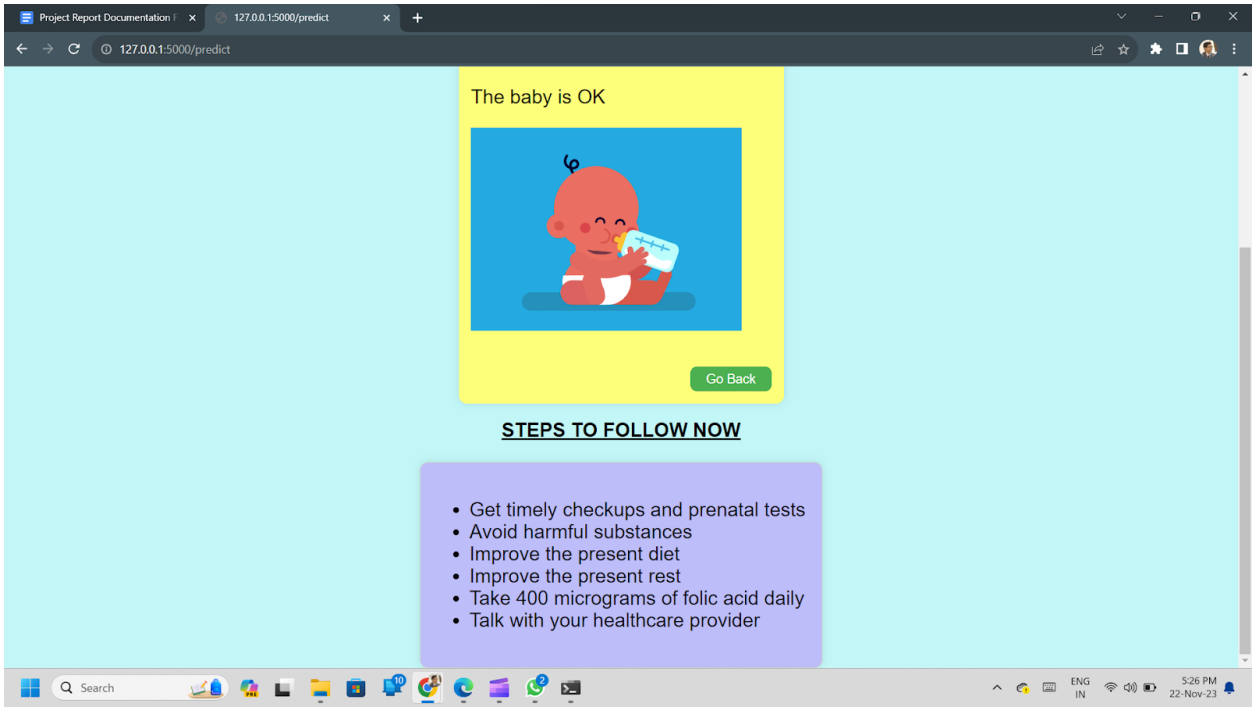
Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	9	6 Days	16 October 2023	21 October 2023	9	21 October 2023
Sprint-2	6	6 Days	23 October 2023	28 October 2023	6	28 October 2023
Sprint-3	9	6 Days	30 October 2023	4 November 2023	9	4 November 2023
Sprint-4	7	6 Days	7 November 2023	11 November 2023	7	11 November 2023

7. CODING & SOLUTIONING (Explain the features added in the project along with code)

7.1 Feature 1

Gives suggestions based on fetal health

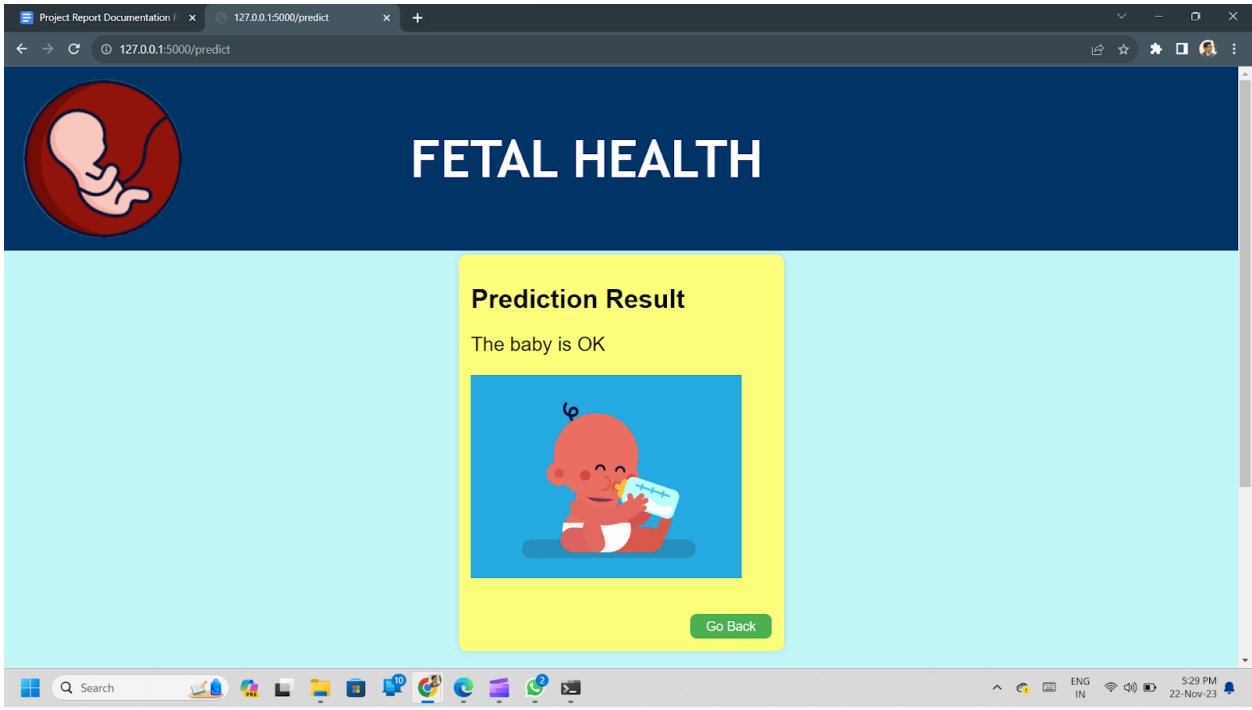

Project Report Documentation F
127.0.0.1:5000/predict
127.0.0.1:5000/predict
The baby is OK
Go Back
STEPS TO FOLLOW NOW
Get timely checkups and prenatal tests
Avoid harmful substances
Improve the present diet
Improve the present rest
Take 400 micrograms of folic acid daily
Talk with your healthcare provider
Search
ENG
IN
5:26 PM
22-Nov-23

7.2 Feature 2

A dedicated reset button for ease of users to reset the given values

7.3 Feature 3

Dedicated go back button for ease of navigation for user.



8. PERFORMANCE TESTING

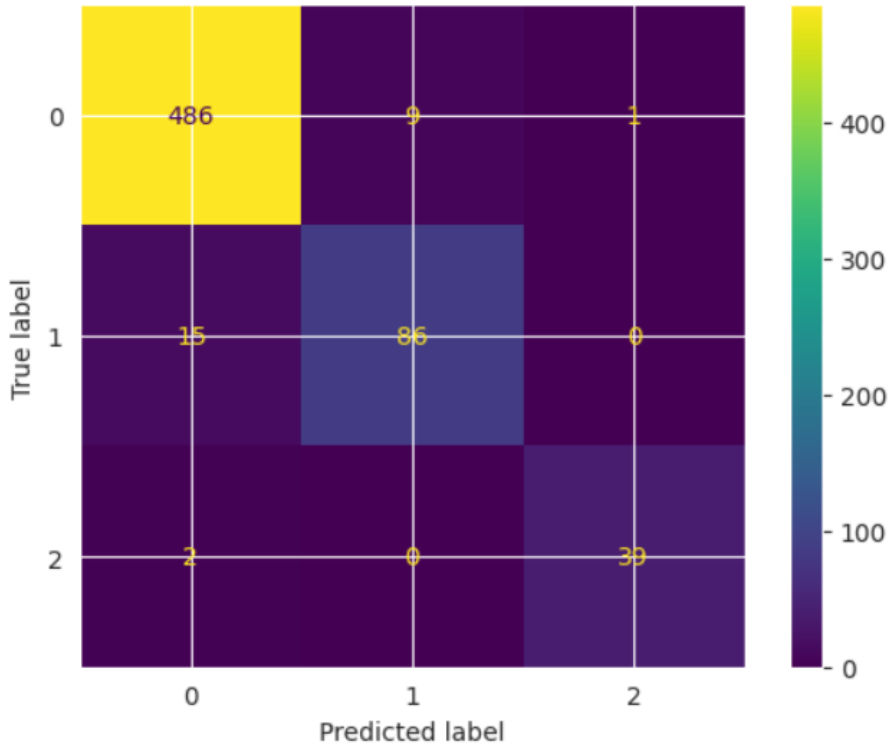
8.1 Performace Metrics

```
from collections import Counter
print("Before SMOTE:",Counter(y_train))
print("After SMOTE: ",Counter(y_train_smote))
```

```
Before SMOTE: Counter({1.0: 1159, 2.0: 194, 3.0: 135})
After SMOTE:  Counter({1.0: 1159, 3.0: 1159, 2.0: 1159})
```

```
print("For the amounts of training data is: ",X.shape)
print("Accuracy of Gradient Boosting: ",round(100 *accuracy_score(y_test, y_pred), 3))
cm=confusion_matrix(y_test,y_pred)
cm_display=ConfusionMatrixDisplay(cm).plot()
plt.show()
```

```
For the amounts of training data is:  (2126, 10)
Accuracy of Gradient Boosting:  95.768
```



```
from sklearn.metrics import mean_absolute_error,mean_squared_error,r2_score
print("MAE :",mean_absolute_error(y_test,y_pred))
print("MSE :",mean_squared_error(y_test,y_pred))
print("RMAE :",np.sqrt(mean_squared_error(y_test,y_pred)))
print("R^2 :",r2_score(y_test,y_pred))
```

```
MAE : 0.047021943573667714
MSE : 0.05642633228840126
RMAE : 0.23754227473946876
R^2 : 0.8305957324403862
```

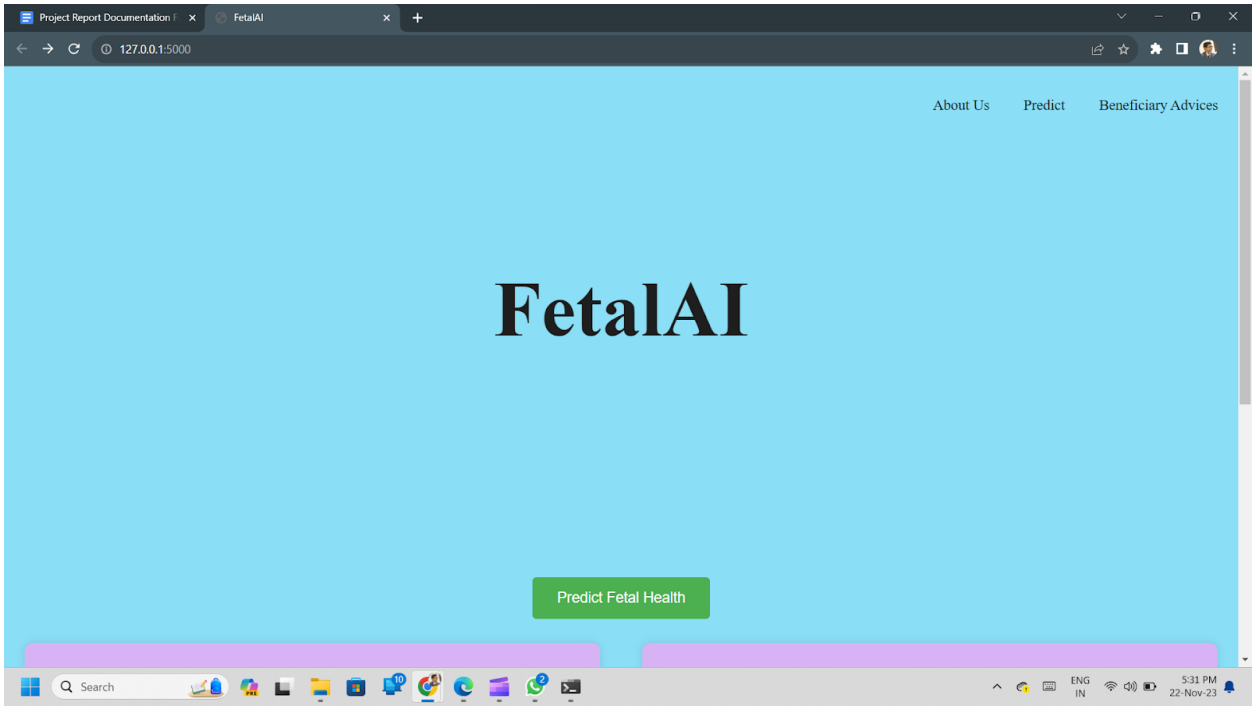
uating the model on test set

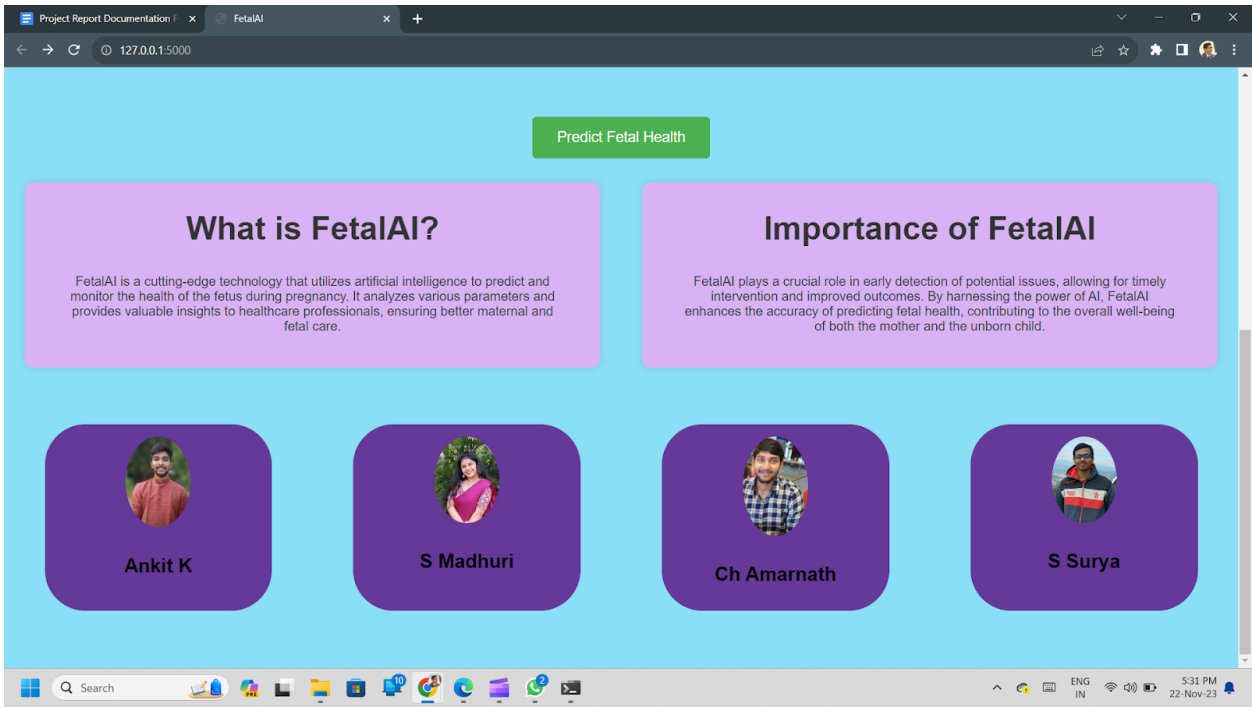
```
y_temp=gb_model.predict(X_test)
print("MAE on test set :",mean_absolute_error(y_temp,y_pred))
print("MSE on test set :",mean_squared_error(y_temp,y_pred))
print("RMAE on test set :",np.sqrt(mean_squared_error(y_temp,y_pred)))
print("R^2 on test set :",r2_score(y_temp,y_pred))
```

```
MAE on test set : 0.0
MSE on test set : 0.0
RMAE on test set : 0.0
R^2 on test set : 1.0
```

9. RESULTS

9.1 Output Screenshots


Project Report Documentation F
FetalAI
127.0.0.1:5000
About Us
Predict
Beneficiary Advices
FetalAI
Predict Fetal Health
Search
ENG
IN
5:31 PM
22-Nov-23


Project Report Documentation F
FetalAI
127.0.0.1:5000
Predict Fetal Health
What is FetalAI?
FetalAI is a cutting-edge technology that utilizes artificial intelligence to predict and monitor the health of the fetus during pregnancy. It analyzes various parameters and provides valuable insights to healthcare professionals, ensuring better maternal and fetal care.
Importance of FetalAI
FetalAI plays a crucial role in early detection of potential issues, allowing for timely intervention and improved outcomes. By harnessing the power of AI, FetalAI enhances the accuracy of predicting fetal health, contributing to the overall well-being of both the mother and the unborn child.
Ankit K
S Madhuri
Ch Amarnath
S Surya
Search
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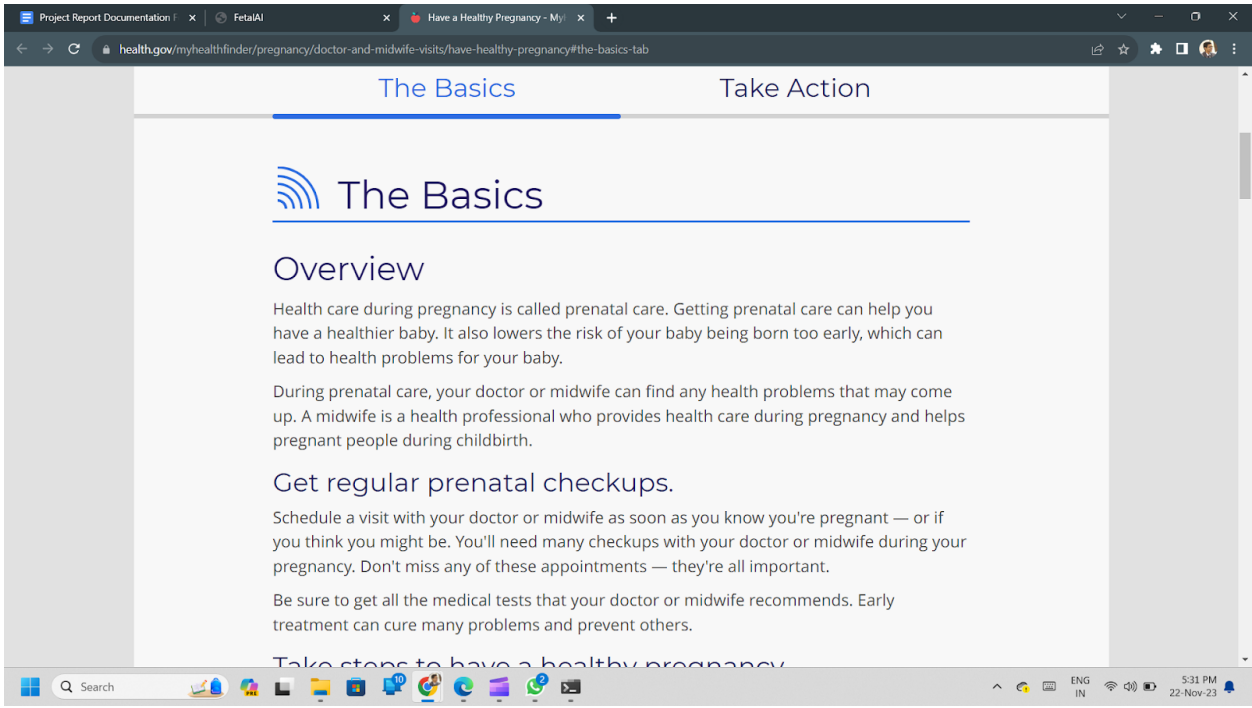
22-Nov-23


Project Report Documentation F
FetalAI
Have a Healthy Pregnancy - My
health.gov/myhealthfinder/pregnancy/doctor-and-midwife-visits/have-healthy-pregnancy#the-basics-tab
The Basics
Take Action
The Basics
Overview
Health care during pregnancy is called prenatal care. Getting prenatal care can help you have a healthier baby. It also lowers the risk of your baby being born too early, which can lead to health problems for your baby.
During prenatal care, your doctor or midwife can find any health problems that may come up. A midwife is a health professional who provides health care during pregnancy and helps pregnant people during childbirth.
Get regular prenatal checkups.
Schedule a visit with your doctor or midwife as soon as you know you're pregnant — or if you think you might be. You'll need many checkups with your doctor or midwife during your pregnancy. Don't miss any of these appointments — they're all important.
Be sure to get all the medical tests that your doctor or midwife recommends. Early treatment can cure many problems and prevent others.
Search
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22-Nov-23


Project Report Documentation F
127.0.0.1:5000/input
127.0.0.1:5000/input
FETAL HEALTH
Accelerations:
Enter Accelerations
Light Decelerations:
Enter Light Decelerations
Fetal Movements:
Enter Fetal Movements
Uterus Contractions:
Enter Uterus Contractions
Abnormal Short term Variability:
Enter Abnormal Short term Vari
Mean of Short Term Variability:
Enter Mean of Short Term Varia
Percentage of times with abnormal long term Variability:
Enter Percentage
Histogram Maximum Value:
Enter Histogram Maximum Valu
Histogram Median Value:
Enter Histogram Median Value
Histogram Number of Zeros:
Enter Histogram Number of Zer
Submit
Reset
Search
ENG
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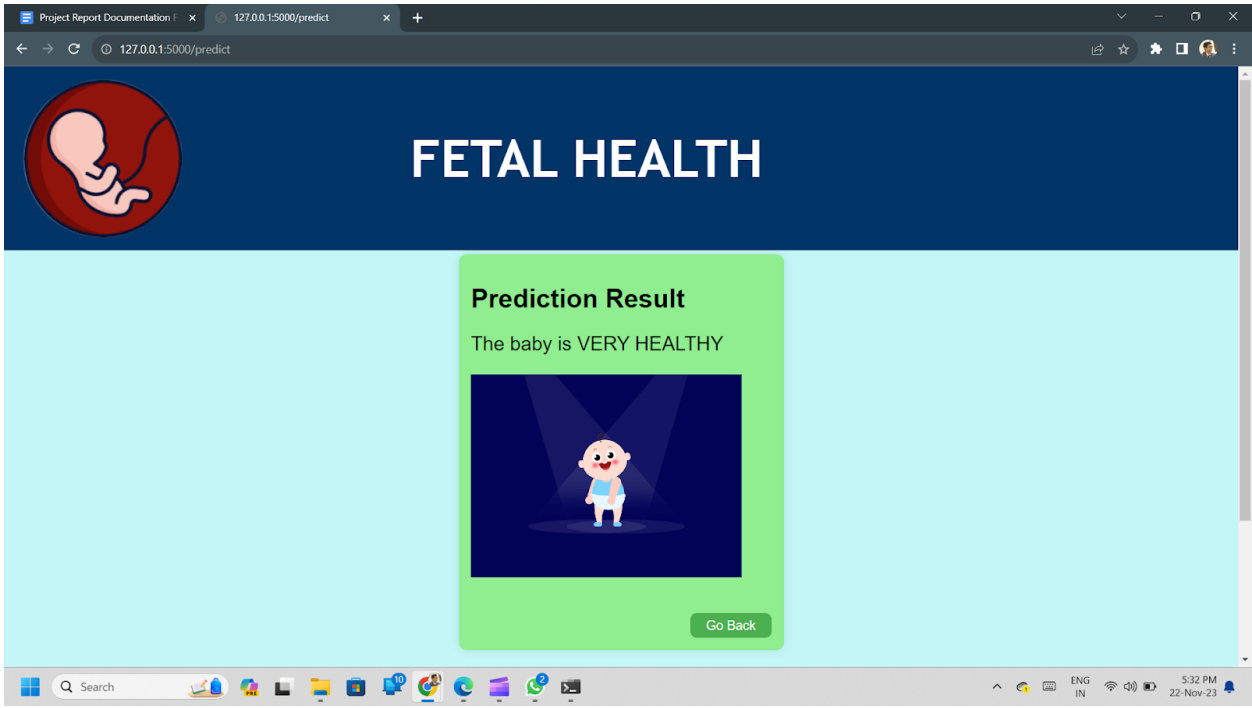
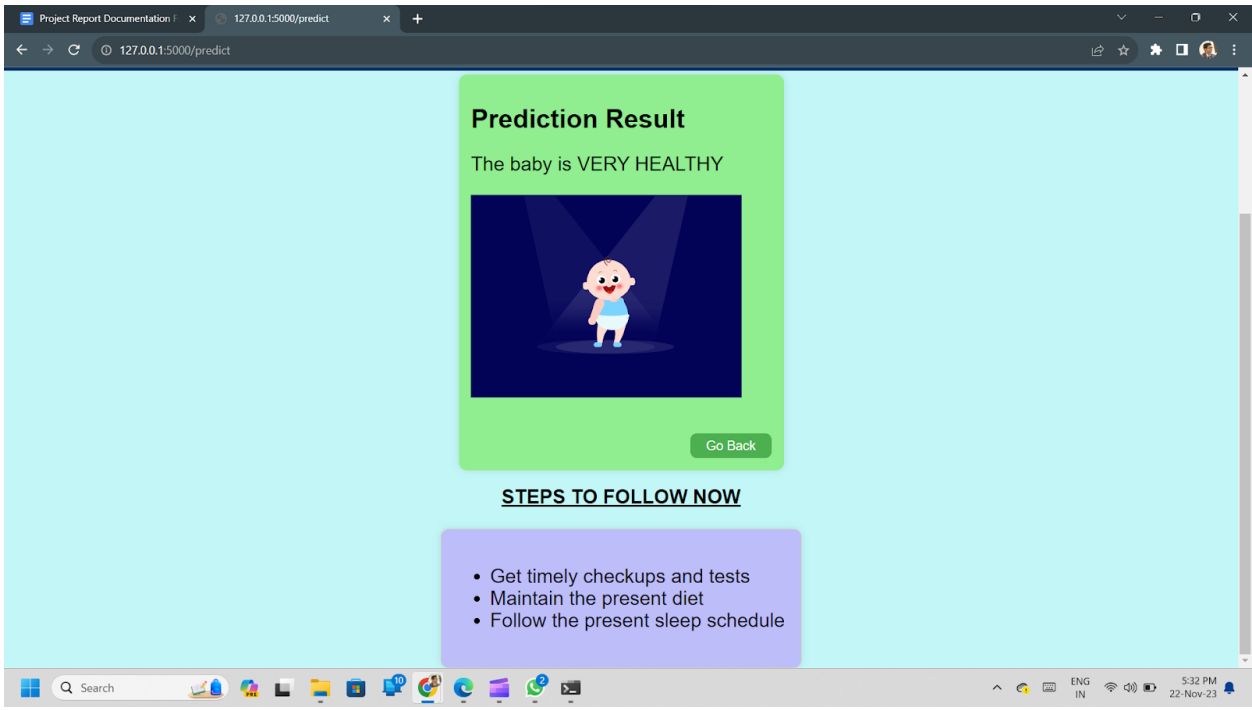
5:31 PM
22-Nov-23


Project Report Documentation F
127.0.0.1:5000/predict
127.0.0.1:5000/predict
FETAL HEALTH
Prediction Result
The baby is VERY HEALTHY
Go Back
Search
ENG
IN
5:32 PM
22-Nov-23


Project Report Documentation F
127.0.0.1:5000/predict
127.0.0.1:5000/predict
Prediction Result
The baby is VERY HEALTHY
Go Back
STEPS TO FOLLOW NOW
Get timely checkups and tests
Maintain the present diet
Follow the present sleep schedule
Search
ENG
IN
5:32 PM
22-Nov-23

10. ADVANTAGES & DISADVANTAGES

Advantages of Having an ML Model for Monitoring Fetal Health:

1. Early Detection of Abnormalities: ML models can analyze vast amounts of data, enabling early detection of potential fetal health issues, allowing for timely medical interventions.

2. Continuous Monitoring: ML models can provide continuous monitoring, offering a more comprehensive understanding of the fetal health status compared to periodic check-ups.

3. Reduced Human Error: Automation in fetal health monitoring reduces the risk of human error associated with manual interpretation of data, leading to more accurate assessments.

4. Data Integration: ML models can integrate and analyze diverse data sources, such as maternal health records and real-time monitoring, providing a holistic view of the factors influencing fetal well-being.

5. Personalized Care: ML models can adapt to individual variations, providing personalized insights into fetal health based on the specific characteristics of each pregnancy.

Disadvantages and Challenges:

1. Data Quality and Bias: ML models heavily rely on data quality. If the data used for training is biased or incomplete, the model's predictions may be inaccurate or skewed.

2. Ethical Concerns: There are ethical considerations regarding privacy, consent, and the potential psychological impact on expecting parents when using advanced monitoring technologies.

3. Dependency on Technology: Overreliance on ML models may lead to a reduction in the development of clinical skills in healthcare professionals and an overemphasis on technology.

4. Cost and Accessibility: Implementation of advanced ML-based monitoring systems may come with a high initial cost, limiting accessibility, especially in resource-constrained healthcare settings.

5. Interpretability: Some ML models, especially complex deep learning models, may lack interpretability, making it challenging for healthcare professionals to understand and trust the reasoning behind the model's predictions.

6. Unforeseen Circumstances: ML models might not account for unforeseen circumstances or rare conditions that could impact fetal health, requiring human expertise for accurate diagnosis.

11. CONCLUSION

In conclusion, leveraging Machine Learning (ML) models for monitoring fetal health offers substantial benefits in early detection, continuous monitoring, and personalized care. These models have the potential to revolutionize prenatal healthcare by providing timely insights and reducing human error. However, challenges such as data quality, ethical concerns, and the risk of over-reliance on technology need careful consideration. Striking a balance between technological advancements and maintaining the crucial role of healthcare professionals is essential. As the field evolves, addressing these challenges will be pivotal in ensuring that ML models contribute positively to improving fetal health outcomes while upholding ethical standards and accessibility in diverse healthcare settings.

12. FUTURE SCOPE

The future scope of Machine Learning (ML) in monitoring fetal health is promising and multifaceted:

1. Precision Medicine in Obstetrics:

2. Early Risk Prediction:

3. Integration with Wearable Technology:

4. Telehealth and Remote Monitoring:

5. Multi-modal Data Integration:

6. Explainable AI:

7. Global Health Impact:

8. Collaboration between Healthcare and Technology Experts:

9. Continuous Research and Innovation:

13. APPENDIX

Source Code

https://github.com/smartinternz02/SI-GuidedProject-615045-1699419733/tree/main/Fetal_AI_source_codes

GitHub : https://github.com/smartinternz02/SI-GuidedProject-615045-1699419733

Project Demo Link: https://youtu.be/rvJUvkdkcpM