

Pregnancy Apps: Are You Using the Best One?

Mama Natural



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Pregnancy Follow-Up

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“PREGNANCY FOLLOW-UP”

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Abstract

You bought the books, took the pamphlets home from the doctor's office, and printed out every possible checklist and chart you could find on the internet, and now, you're left staring at a massive pile of stuff.

If that sounds familiar, you're not alone. Parents-to-be are eager for information about the next nine months, in any form they can get it. That's why it's not uncommon to see every pregnancy-related publication stacked a mile high on the nightstand or kitchen table of an expecting mom or dad.

Unfortunately, sifting through all of that paper takes time. And more than likely, time is, and will continue to be, in short supply. The good news? There is a simple solution to your current situation, and it's called a pregnancy follow-up app.

Chapter 1: Introduction

Overview

- The world suffers from the high cost of health care, and when we talk about technology and computer science, it will be the best way to solve many of the problems of the age, as well as health and health care problems.
 - The pregnancy follow-up program is one of the most important programs that a pregnant woman needs in all months of her pregnancy. It is a special doctor for her and her health condition available to her at anytime and anywhere.
-  A pregnant woman can make it an assistant in all aspects of her life during the months of pregnancy, because the program serves her as follows:
- It is a ml model that predicts preeclampsia and maternal health risk.
 - The mother can create her own account on the program, and her data and medical history are recorded, and they are saved in her own medical record.
 - The application saves all patient data.
 - This app also works with anonymous collection of data and creation of reliable datasets.
 - Allows the mother to record the movement of her fetus during the day.

- Makes the mother check the symptoms she feels daily from a list symptoms.
- The app predicts risks based on that daily symptoms/medical history current state of health.
- The app predicts Preeclampsia based on symptoms/medical history current state of health.
- The application displays symptoms based on the patient's trimester.
- The application provides a simple medical library containing articles, videos & images like hospital bag, maternal tests, pregnancy complications, maternal vaccinations, partner support, nutrition, exercises, preparing for pregnancy and healthy pregnancy.
- The application provides baby development videos and articles, a kick counter and common questions asked by pregnant women answered by gynecologists.
- The app provides notifications to remind you of symptoms entry, upcoming appointments, library notifications, ability to decide allowed notifications.
- The application provides a notes feature for managing the doctor's office appointments, medications to be taken during the day, and the table for pregnancy.
- The application displays a daily routine she should follow to have a healthy pregnancy.

Objectives:

Track the symptoms of pre-eclampsia

What is preeclampsia?

- Preeclampsia is a disorder of pregnancy in which a person who's pregnant has high blood pressure and protein in their urine. Eclampsia is when a person with preeclampsia develops seizures (convulsions) during pregnancy. Eclampsia is a rare but serious complication of preeclampsia.
- Seizures are episodes of shaking, confusion, and disorientation caused by abnormal brain activity.
- Eclampsia typically occurs after the 20th week of pregnancy. It's rare and affects less than 3% of people with preeclampsia. Eclampsia can cause complications during pregnancy and requires emergency medical care.

How will I know if I develop preeclampsia?

In addition to high blood pressure, other signs and symptoms of preeclampsia include:

- Extra protein in the urine or other signs of kidney problems
- Severe headaches
- Changes in vision, including temporary loss of vision, blurred vision, or sensitive to light
- Upper stomach pain, usually under the ribs on the right side
- Nausea or vomiting
- Decreased levels of platelets in the blood
- Impaired liver function
- Shortness of breath, caused by fluid in the lungs

What are the risk factors for preeclampsia?

You may be at higher risk for pre-eclampsia if:

- You're pregnant with multiples.
- You have an autoimmune condition.
- You consume a poor diet or have obesity (a BMI greater than 30).
- You have diabetes, hypertension, or kidney disease.
- You're younger than 17 or older than 35.
- This is your first pregnancy.
- Family or personal history of preeclampsia or eclampsia.

The biggest risk factor for eclampsia is **preeclampsia**. Most people with preeclampsia don't develop eclampsia.

What are the warning signs of eclampsia?

Many people will have warning signs before having a seizure caused by eclampsia. Some of these signs are:

- Severe headaches.
- Difficulty breathing.
- Nausea or vomiting.
- Trouble urinating or not urinating often.
- Abdominal pain (especially on the upper right side).
- Blurred vision, seeing double or loss of vision.
- Swelling of the hands, face, or ankles.

What are the symptoms of eclampsia?

The most common symptoms of eclampsia are:

- Seizures.
- Severe distress or confusion.
- Losing consciousness.

What causes eclampsia?

- Eclampsia typically develops from preeclampsia. High blood pressure (from preeclampsia) puts pressure on your blood vessels. There can be swelling in your brain, which may lead to seizures.
- Genetics and diet can increase your risk for eclampsia.

How does pre-eclampsia affect my baby?

Pre-eclampsia shouldn't cause any long-term health problems, but it can affect the fetus. Preeclampsia or eclampsia can affect the placenta and how it functions. Your placenta delivers oxygen, blood and nutrients to the fetus. Other potential side effects are:

- Placental abruption.
- Increased risk of C-section.
- Early labor or premature birth.
- Low birth weight.

What are the complications of pre-eclampsia?

People with pre-eclampsia are at higher risk for:

- Placental abruption.
- Preterm labor.
- Blood clotting issues.
- Stroke.
- Stillbirth.
- Death.

When should I see my healthcare provider?

Go to the emergency room if you have a new seizure during pregnancy. Other symptoms that require medical attention during pregnancy are:

- Severe headaches.
- Vaginal bleeding.
- Vision loss or seeing double.
- Severe abdominal pain.
- Vomiting.
- You feel the fetus move less or not at all.

Can you recover from preeclampsia?

Yes, most people recover from preeclampsia and eclampsia after delivery. There are some things you can do to help your recovery:

- Eat a healthy diet.
- Stay as active as possible.
- Get plenty of rest.
- Attend all of your prenatal appointments.
- Try to keep your stress levels low.
- Take all of your medications as directed.
- Watch your blood pressure closely for at least two weeks after birth.

Support Pregnancy

- The mother creates a new account containing all information about her health, and her medical history to store them in the private medical record.
- The application saves all patient data.
- The application works on the anonymous collection of data and the creation of reliable datasets.
- Pregnancy follow-up is a supported Pregnancy app for busy moms dealing with some serious pregnancy brain.
- The application is available for Android.
- Can also use the support app to log appointment reminders, questions for her doctor, and milestones she reaches along the way by using the notes feature.

Accurate diagnosis

- The application must predict potential diseases based on the patient's medical history by using a maternal health risk form and a preeclampsia form.
- The application must predict the risk to the mother, based on her medical history, and her current health state by using maternal health risk form and preeclampsia form.

Guide Pregnancy

- The application has an excellent reputation for its medical accuracy and up-to-date facts about pregnancy.
- In addition to the daily and weekly guides, tracking ability, and health information, you also get some pretty amazing images of the baby's development.
- The application provides a simple medical Library containing articles, videos & images like hospital bag, maternal tests, pregnancy complications, maternal vaccinations, partner support, nutrition, exercises, preparing for pregnancy and healthy pregnancy.
- The application provides baby development videos and articles, a kick counter and common questions asked by pregnant women answered by gynecologists.
- Help the pregnant woman stay organized and educated about all of the developments and changes happening in her body.
- Provide the possibility of permanent translation of some medical terms when clicking on the word to help the mother understand these terms by providing her with a medical dictionary present in the library and providing quick definitions of highlighted words.

Improved efficiency and speed

- The application can enhance healthcare delivery with more efficiency, as it can handle multiple queries and requirements at a time.

Reduction in healthcare costs

- The cost associated with the healthcare consultation is reduced significantly with the usage of apps as the maintenance cost is less.
- The application will help her reduce her hospital visit costs, the mother needs to go to the hospital more than the number of visits allocated to her, in order to suspect any symptoms she has, so she would like to know that she is fine, as this is considered an extra cost to her.

Easy to use and convenient

- Monitor vital stats such as blood pressure, heart rate, glucose levels, stress management, sleep quality, nutrition tracking, and several other important activities.
- Record her fetus' movement during the day.
- The mother checks the symptoms she feels daily from a list of symptoms.
- The application predicts the risk to the mother her medical history, and the maternal health risk form and preeclampsia form

Save time

- It saves traveling time between home and the healthcare center and also requires fewer visits as compared to the traditional approach.
- The application saves the mother time and, she can ask the application at any time about her symptoms and make sure of her health at any time.
- It helps to reduce overcrowding in hospitals and to allow time for the doctor to assist in emergency cases only.

Seamless exchange of data

- Come with an inbuilt option to share and transfer health data across the healthcare system.
- The app provides an option for secure and hassle-free process payment options with different gateways for medical bills and subscriptions. If the pregnant woman forgets to pay the bills, these apps send notifications as a reminder.

Support Comprehensive services

- Provide one location to keep all of her baby bump information.
- The app is packed full of useful tips on every pregnancy topic you can imagine.
- The pregnant woman logs on to find out info about where you are in her pregnancy or watch videos about how her body is going to change over the course of nine months.
- Regardless of where you're at on the pregnancy knowledge continuum, there's a good chance she will find some valuable tidbits in this comprehensive app.
- The application must provide notifications for Reminders for symptom entry, Upcoming appointments, Library notifications, Ability to decide which notifications are allowed.
- The application should provide a notes feature to manage doctor's appointments, Medicine to be taken with doses and time during the day, and a Pregnancy timeline.

Purpose:

➤ The Purpose for Patients (pregnant women)

From the perspective of staying healthy in Healthcare, Apps are life-changing for patients and general users keen to live a healthy lifestyle. Our Android app comes loaded with features like:

Patient Health Education

- The app can educate patients about different health conditions by sharing useful, up-to-date information.
- The application provides a simple medical library containing articles, videos & images like hospital bag, maternal tests, pregnancy complications, maternal vaccinations, partner support, nutrition, exercises, preparing for pregnancy and healthy pregnancy.

Diagnosis

- The app is beneficial for prevention since it helps patients understand their symptoms and seek care when necessary.
- The mother can check the symptoms she feels daily from a list of symptoms.
- The application predicts the risk to the mother her medical history, and the maternal health risk form and preeclampsia form
- The application must predict potential diseases based on the patient's medical history.
- The app shall record her fetus' movement during the day.
- The application provides baby development videos and articles, a kick counter and common questions asked by pregnant women answered by gynecologists.

Reminder

- Android-based pregnant follow-up app provides reminders to take medicines, rest, follow healthy practices, and lead an active lifestyle.
- They are also used for tracking and forming healthy habits like staying hydrated, getting enough rest, etc.
- The application must provide notifications for Reminders for symptom entry, Upcoming appointments, Library notifications, Ability to decide which notifications are allowed.

Health Monitoring

- Our App helps patients with preeclampsia and general maternal health.

Mental Health

- Include Psychological aspects for meditation, self-care, stress relief, and good sleep that people use to take care of their mental health.
- Our health app development has taken leaps in the last few years and the future looks more promising than ever.

Healthy Living

- These include weight loss, fitness, exercise, and wellness apps that help people lead healthier lives.

Nutrition

- These include diet and weight loss applications, and they usually come with features like healthy recipes, trackers, and healthy eating guides.

Women's Health

- These include diet and weight loss applications, and they usually come with features like healthy recipes, trackers, and healthy eating guides.

Fetus health

- The app shall record her fetus' movement during the day. Calculate the number of his movements to ensure his health
- In addition to the possibility of calculating the age of the fetus.

Tracking

- Monitoring the patient's vital indicators, such as blood pressure, heart rate, blood sugar levels, pulse, calorie intake, and so on, is the most important element of any patient app.

Scheduling & Reminders

- It can also schedule reminders for medicine intake, sleep, water intake, daily calorie consumption targets, etc.
- It provides notifications for Reminders for symptom entry, Upcoming appointments, Library notifications, Ability to decide which notifications are allowed.

Patient Information Database

- Enable the software to store medical history and other sensitive data that patients access at any time.
- The application saves all patient data locally. This will also work for the anonymous collection of data and the creation of reliable datasets.

Secure

- Our Healthcare apps store and process a lot of personal data such as patient history, address, contact information, payment details, etc.
- It needs to comply with strict privacy and legal regulations, which vary from region to region.
- All data inside the system or its part will be protected against malware attacks or unauthorized access.
- The application shall enforce access privileges that enable anyone to modify or delete the medical data of patients.
- Defining the login flow and different user roles as system behavior or user actions to protect the admin panel from unauthorized access.
- The application shall encrypt patient data, and privet records and store them in encrypted format using an industry-approved encryption algorithm.
- The application protects the personal information of each patient and provides strict privacy related to his medical history, medications, and test results.

Extra features in our app:

- Access to information (medicines, patient history, diseases)
- Access to EHRs/EMRs
- Push Notifications

Scope:

1. Creation of the idea and its topics:

- The team members met and decided that the subject of their project should serve the medical field and its problems and solve these problems.
- They are determined to bring modern technology to the service of healthcare.
- And how to reduce its cost and save time, effort, and money spent on it.
- Their plan was to help pregnant women reduce the number of visits to the doctor, to follow up on the development of their pregnancy, the development of their fetus, and periodic check-ups.
- The team noticed that these women need very careful care in their homes, even with the availability of treatment methods in hospitals and health units, but the pregnant woman needs someone who follows her condition at home periodically, tells her medical advice about her condition, checks on the movement of her fetus, and puts a plan for her to change From her behavior and habits in sports, food, and health.
- She also needs something to remind her of the dates of important medications, the dates of her visits to the doctor, in addition to the dates of her periodic medical examinations.
- The team members were able to create an idea that combines medical science with technological science to help this pregnant woman, and that this service fulfills all the requirements of users to the fullest, and this idea was under the name of "**pregnancy follow-up**".

2. Collect user requirements

The team members created a questionnaire to collect the needs of female users, and the questionnaire contained several questions, including:

- Have you ever been pregnant or not?
- What are the problems that a pregnant woman faces?
- What are the symptoms that you felt during your pregnancy that were not understood by you?
- What are the serious symptoms that you encountered in pregnancy?
- What was annoying in the doctor's visits?
- What problems did you encounter in communicating with the doctor?

And that there are several other questions for doctors specializing in the field of obstetrics and gynecology and for health care officials, including:

- What are the main problems that the doctor faces from direct dealing with the pregnant woman?
- What are the normal symptoms that appear in a woman during her pregnancy?
- What are the risk factors that a pregnant woman may notice and then realize that it is an emergency and that she must require an ambulance?
- What are the basic data that you as a doctor require from her and through which you follow up on her condition?
- What data do you collect from the pregnant woman at each follow-up visit?
- Are pregnancy symptoms and risk factors that can affect the mother and fetus different in each month of pregnancy, or are they the same?
- What is your problem as a doctor in giving information to pregnant women, or your problem in communicating with them?
- What are the common mistakes that pregnant women can make during their pregnancy from the point of view of a doctor?

3. Choose the platform

After collecting opinions and voting from many users, the most appropriate way to present this idea is to be a mobile application, especially Android.

Advantages of android:

- Android is totally open because it is a Linux based open source
- Multitasking
- Excellent software support
- It gives you a better notification
- It lets you choose your hardware
- It has a better app market
- Frequent OS updated
- A more mature platform
- Android type of phone can also function as a router to share the internet
- It will be more secure than iPhone OS
- All applications are treated equally
- Easy to access the android the market
- Can be installed and modified RAM
- An Android-based product will be cheaper than its propriety
- Support all google services
- With google chrome, you can open many windows at once

4. Planning and analysis

- The data analyst examined the questionnaires, performed the analysis on them, and then developed the basic requirements for the mobile application.
- Then the data analyst presented these requirements to the members of the technical team and discussed them with them in detail and accurately
- so that they understand these requirements and imagine the form of the program and how to use it and the interaction between users and convert these requirements into a system design
- He also developed a feasibility study for the project and determined the estimated cost.
- so that we have a complete picture of the application before applying it in the actual form

These requirements include:

- User requirements
- System Requirements
- Domain Requirements
- Functional Requirements
- Non- Functional Requirements

5. Data collection

- The team members used datasets they've found on Kaggle and Harvard websites.
- And the main factor that the team members used in collecting data was some of the **cases** in the environment surrounding them, including relatives and friends.

5. Software Design

- After the team understood the requirements of the program, they represented these requirements in the form of a system design, which includes many diagrams that explained how users interact with each other in the program, some of the program's functions, in addition to its features.

Among these diagrams:

- Class Diagram
- Use case diagram
- Sequence diagram
- Activity diagram

6. Implementation:

- The team members applied the system design
- They did data cleaning and preprocessing
- They also used many important and effective technical tools to help them complete the project optimally
- They dealt carefully and with full awareness with the types of machine learning algorithm to choose the most suitable one

7. Testing:

- The developer responsible for the testing also examined all the functions and worked them accurately and in detail
- also used more than one method to ensure the integrity of the codes and they worked in the correct way and in the correct way, so he used some testing techniques **such as:**
 - Unit testing
 - Integration testing

General constraints:

➤ Data collection problem

- There is a problem with health care in governmental hospitals, as there was a lack of health data for pregnant women.
- After searching and moving between more than one government hospital, private clinics, and health units, we found that some hospitals do not give a full medical report to the pregnant woman, and do not give her a detailed report of her health condition, so we could not collect enough cases to train the machine learning model due to the lack of availability.
- Some private clinics do not print follow-up cards for their pregnant women, so it was very difficult to obtain accurate data.
- Some doctors and health care officials refused to help with the data collection process.
- Some hospitals refused to view some of the data of pregnant women, considering this data as very sensitive data.

➤ Problem of self-learning

- The faculty members of the Department of Gynecology refused to supervise the application or provide the project team with some of the required medical information.
- Team members had to collect data themselves from external sources, and they had to go to some government hospitals, private clinics, and some health units, which increased pressure on them and they spent a lot of time, effort, and money.
- The lack of free, reliable sources to obtain medical data led to an increase in learning time when searching for free sources.

➤ The small number of team members

- The small number of team members made more pressure and load on them.
- Many of them were forced to do a number of tasks that were not compatible with their main specialization.

➤ Loss of specialization

- Causes a very big problem in the efficiency of the application.
- A team of doctors must be available to provide the technical team with all the information and medical terminology they need.
- The unavailability of a team of doctors became an excessive burden on the members of the team, so instead of taking the information from a specialist directly, they were forced to research and self-learning, which took them excessive time and effort.

Chapter 2: Project “Planning and analysis”

➤ **Project planning:**

1. Feasibility Study

❖ Financial feasibility

Being android app software will have an associated hosting cost.

- The system will follow freeware software standards.
- No cost will be charged to the customer. Besides that there is no cost to the customer, the app will help in rescuing a pregnant woman in case of danger to avoid abortion or crowded hospitals with just fear from the pregnant women(not real danger).
- Bug fixes and maintenance tasks will have associated costs later.
- From the previous, it's clear that the app is financially feasible.

❖ Technical feasibility

Our app will have these as the main technologies and tools

1. SQLite
2. Kotlin
3. Python
4. Android Studio
5. Machine learning
6. Diagram drawing tools
 - 6.1 Excel for Gantt chart
 - 6.2 visual paradigm for sequence diagram
 - 6.3 Draw.io for use case diagram
 - 6.4 Visio 2013

Each of these technologies is freely available and technical skills are required and manageable.

Time limitations for product development and the ease of implementing using these technologies are synchronized.

Initially the application host in a free app host space, but for later implementations, it will be hosted in a paid app hosting space with sufficient bandwidth. The bandwidth required in this app is very low since it does not incorporate any multimedia aspect.

From these, it is clear that the app is technically feasible.

❖ Resources feasibility

Resource feasibility

- Programming device(laptop)
- Hosting space
- Programming tools
- Programmers

From these, it is clear that the app resources are available.

❖ Risk feasibility

In risk feasibility, there are several contexts to be discussed

1- Risk associated with the size

A. The estimated size of the product in the line of codes:

- Being an application with many numbers of stakeholders, the app will contain a significant amount of code lines. As the system does not contain any multimedia (videos, audio, graphics, animation aspect, the file sizes, and the complete project size will not exceed 200MB).

B. Estimated size of product in the estimate programs:

- Through the application support of many stakeholders, it will be constructed as a single app with a single login interface rather than having many interfaces for the user.
- Depending on the access rights, the contents will be showed or hidden.

C. Size of database created or used by the product:

- The number of relations and entities is minimized by using best practice of normalization theories.

D. Users of the product:

- Pregnant women

E. Amount of reused software (as libraries):

- Though the main logics are implemented throughout the project, we will use some libraries to incorporate additional functionalities to support file uploads, training of the model, etc...

2- Business impact risks

A. Effect of this product on hospital revenue:

- The pregnancy follow-up app can be implemented either as an individual system or can be integrated into an existing system such as a hospital system with its different departments.
- Since it automates some key features for patients the users can increase their revenue.

B. Reasonableness of delivery deadline:

- Being a 20 weeks project, the application will have to sever deadlines and deliverables that are scheduled successively.
- Depending on the coding and the design cost and effort, the deadlines are quite reasonable.

C. Number of customers who will use this product and the consistency of their needs relative to the product:

- This system can support any number of users simultaneously due to the low bandwidth requirements.

D. Number of other products with which this product must be interoperable:

- This product can be integrated with the current hospital management system with slight modifications (from the android app to the desktop app).
- Doing so will add significant value to both systems. But our app can operate independently.

E. Sophistication of end users:

- This application is designed while maintaining the complexity at a very low level.
- Usability is highly improved by providing help documents and making interfaces easy to use.

3- Development environment risks:

A. Is a software project management tool available?

- Microsoft Project will be used as the main project management tool.

B. Are tools for analysis and design available?

- The app will require several designs

- Excel for Gantt chart
- visual paradigm for sequence diagram
- Draw.io for the use case diagram
- Visio 2013

C. Are software configuration management tools available?

- Configuration management will be done using GIT which is freely available.

D. Are all the software tools integrated with one another?

- The main deliverables will be packaged under a single project.
- All stakeholders will have a single login interface.

4- Process issue risk:

- The app will follow the agile software development process.
- This provide the flexibility to accommodate changing software requirements.

5-Technical issue risks

- A. Are specific conventions for code documentation defined and used?
 - Software code and documentation code will be freely available and provided.

- B. Are configuration management software tools used to control and track change throughout the software process?
 - GIT will be used throughout the software implementation process.

6- Technology risks

- A. Is the technology to be built new?
 - All the technologies are very well established and old enough (not obsolete).

- B. Do the system requirements demand the creation of new algorithms, input, or output technology?
 - The app will have several algorithms to detect if this pregnancy is risky or not.

❖ Social/Legal feasibility

- The app uses freely available development tools and provides the system as an open-source system.

➤ **Estimated Cost**

Software development costs vary depending on the project.

Software development prices can range from a few pounds to thousands of pounds depending on the features you require, the technologies to be used, and the programming languages to be used.

We will use the techniques below to estimate the price of our project and potentially save time and money on software developer costs.

The ideal software development cost estimate will take into account the fact that we do not live in a perfect environment and that unforeseen events can occur frequently.

The project's timing and cost will be influenced by factors like the time of launching the app and the cost of each (staff training, the platform, the scope of work, the provided place to work, hardware provided, software provided, training and, any later updates).

The following elements are the most crucial to investigate:

1-the platform

- Our mission is to create a native app for one of the two platforms, which entails creating a separate codebase for Android.
- However, why not cross-platform? We could always follow the example of most people and concentrate on one platform until we reach a certain level of success and then increase our spending.
- After that, building the same software for all other platforms won't cost us anything. Maybe later increase the bandwidth of the server.

2-Evaluate the scope of work (time that after the app will able to be launched)

-Only six features at least which are:

- 1) The mother is required to regularly compare her symptoms to a list of symptoms.
- 2) Based on the mother's daily/weekly symptoms, the doctor's record of her medical history, and her present state of health, the application must forecast the risk to the mother.
- 3) The program must offer notifications for upcoming appointments, symptom entry reminders, library notifications, and the ability to control which messages are permitted.
- 4) Notes feature to organize doctor's visits should all be included in the app.

3- Outdoor work

- The estimated cost for renting a place to work in is 12,000 EGP during the whole duration of work.
- Taking in consideration the cost of traveling from one place to another.

4-hardware provided

- As the team consists of 5 members using different technologies like machine learning, android app development, and database development there is a deadly need for at least 5 hardware (laptops) with suitable specifications, each of the devices costs at least 20,000 EGP, then the budget totally will be 100,000 EGP

5-Software provided

- As all the IDEs used are free, there is a cost or license of the operating system that the developer works on, the total estimated cost for the 5 operating systems is 1000 EGP taking into consideration the operating system is windows 10

6-training cost

- It is considered as helping by knowledge, resources, more understanding of certain things, provide data for machine learning, gynecologists' consultations and others.
- The budget for all of those during the whole duration of the project is approximately 3000 EGP.

7-Team cost

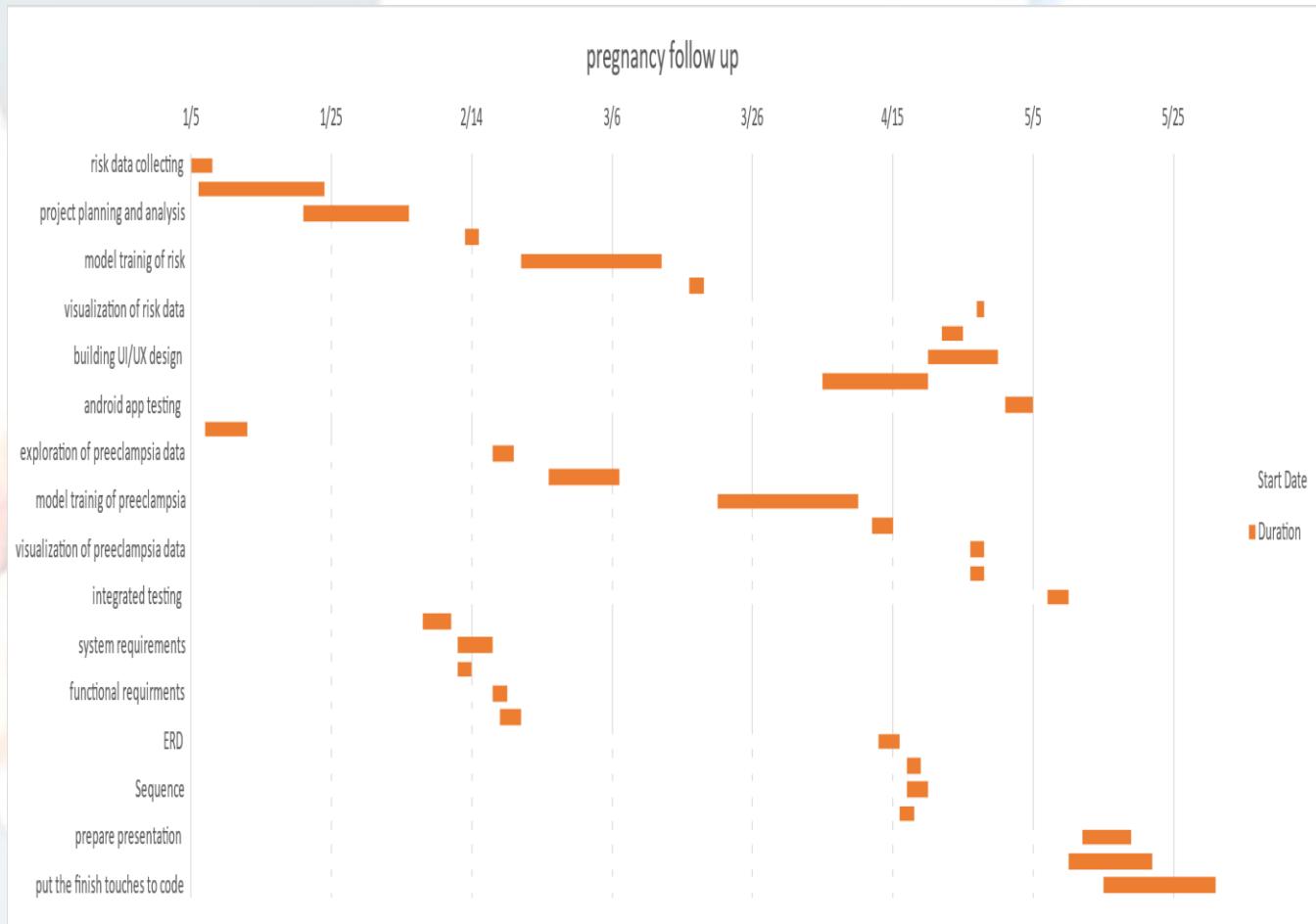
- As the internet is essential in our project and it is limited, our project consumes at least 250 GB/month which is 750~900 EGP.
- Cost of entertainment methods is 1000 EGP.
- Many roles the 5 member team is responsible for which make it highly cost like (interface design, data analysis, ML engineering, android development, database engineering, and testing).
- Development process that included (Discovery phase, collecting data, integration, maintenance, testing, etc.....) costs.

9- Technologies cost

- Cost of course to train our team in machine learning is 2000 EGP.
- Cost for training android around 2000 EGP.
- If needed later to increase the server size it will cost.

“So the estimated cost finally is 122,750 EGP”.

➤ Gantt Chart



Tasks	Start Date	End Date	Duration
risk data collecting	1/5	1/8	3
Introduction chapter	1/6	1/24	18
project planning and analysis	1/21	2/5	15
exploration of risk data	2/13	2/15	2
model trainig of risk	2/21	3/15	20
model evaluation of risk	3/17	3/19	2
visualization of risk data	4/27	4/28	1
integrate risk ML model to app	4/22	4/25	3
building UI/UX design	4/20	4/30	10
android app development	4/5	4/20	15
android app testing	5/1	5/5	4
preeclampsia data collecting	1/7	1/13	6
exploration of preeclampsia data	2/17	2/20	3
clean preeclampsia	2/25	3/7	10
model trainig of preeclampsia	3/21	4/10	20
model evaluation of preeclampsia	4/12	4/15	3
visualization of preeclampsia data	4/26	4/28	2
integrate preeclampsia model to app	4/26	4/27	2
integrated testing	5/7	5/10	3
user requirments	2/7	2/11	4
system requirements	2/12	2/17	5
domain requirments	2/12	2/14	2
functional requirments	2/17	2/19	2
non functional requirments	2/18	2/21	3
ERD	4/13	4/16	3
Use case	4/17	4/20	2
Sequence	4/17	4/21	3
activity	4/16	4/18	2
prepare presentation	5/12	5/19	7
finish last three chapters in documentation	5/10	5/22	12
put the finish touches to code	5/15	5/31	16

➤ **Analysis and Limitations of the existing system**

Limitations that make your system operate slowly?!

1. On average, a mobile app processes great amounts of data on a regular basis. Hence, if an app tries loading a huge chunk of data at once, chances are high that it will impact the app's performance which is out of our control (Low bandwidth).
2. Another possible problematic area with your slow app is its user interface and its components.

While interactive and rich UI is a trend, it can significantly slow down the work of your app. So we should balance between attractive design and good performance. (designing android app).

3. Image (and overall content) compression is one of the most common ways to improve the app's performance.

We can also cache certain images so the app won't have to load them, again and again, each time they are requested. (Android designing app)

4. An app usually contains many data templates and every time they are needed, the app has to load them.

So obviously, this impacts the app's performance and slows it down. (Android app).

5. Issues with a server are usually among the most common reasons behind a slow app. (Android app).
6. The term “code efficiency” is used to describe the consistency, speed, and programming approach employed when writing programs for an application.

It continues to be the primary component in assuring high performance because of its direct relationship to algorithmic effectiveness and the speed of runtime execution for software.

Therefore, in order to speed up the execution of the program, it is essential that the developers have a strong understanding of algorithms and always use the optimum method. (Using the wrong algorithm that may slow down the app).

7. Without the magic of Android libraries, creating an Android application is usually a tiresome task.

The time, money, and effort needed to create an Android app are reduced with the aid of libraries.

However, the developer has no control over issues that may arise with the libraries and Software Development Kit offered by the trader.

To check for defects or problems, developers must examine the code of third-party libraries. If the libraries are not carefully examined, the application could be slow.

Make sure you're using libraries that are widely used, dependable, and secure.
(Libraries from the android app must be secure and trusted).

8. A performance problems might be caused by a limitation of your device hardware.
(User phone).

9. Client-end sluggishness: The client-end application might be slow for many reasons, be it competitiveness between the programs for resources, including CPU, bandwidth, memory, and low disk space, to name a few. (Users, phone).

➤ Need for the new system

The weaknesses of the old system that let you think it is a good idea to develop a new system

1. Some data privacy risk

In the old applications, there are many security holes through which the threat of exposing personal information to hackers and sharing it with third parties is a major concern.

Some of the guidelines considered in the new app include:

• Disaster recovery:

- If a breach occurs, a disaster recovery plan ensures that employees and IT teams know the next course of action.
- It's aimed at reducing the amount of time that users are offline, thereby ensuring that your operations resume as soon as possible.

• Promote information security principles

Integrity:

-All data inside the system or its part will be protected against malware attacks or unauthorized access.

-The application shall enforce access privileges that enable anyone to modify or delete the medical data of patients.

Confidentiality:

- The application shall encrypt patient data, and private records and store them in encrypted format using an industry approved encryption algorithm.
- The application protects the personal information of each patient and provides strict privacy related to his medical history, medications, and test results.

Availability:

- application shall monitor the status and location of system components that may contain unencrypted patient data.

• Access control/management:

- This policy highlights the parties that can access sensitive information, reducing the risk of unauthorized access.
- Make sure your access management policy specifies which stakeholders are allowed access to what and under which circumstances they can share this information.

• Security testing:

- The policy should state the frequency of your cybersecurity tests. This allows you to uncover vulnerabilities before it's too late.
- Some of the security tests that you should conduct include; vulnerability scanning, security posture assessment, penetration testing, ethical hacking, cybersecurity assessments, etc.

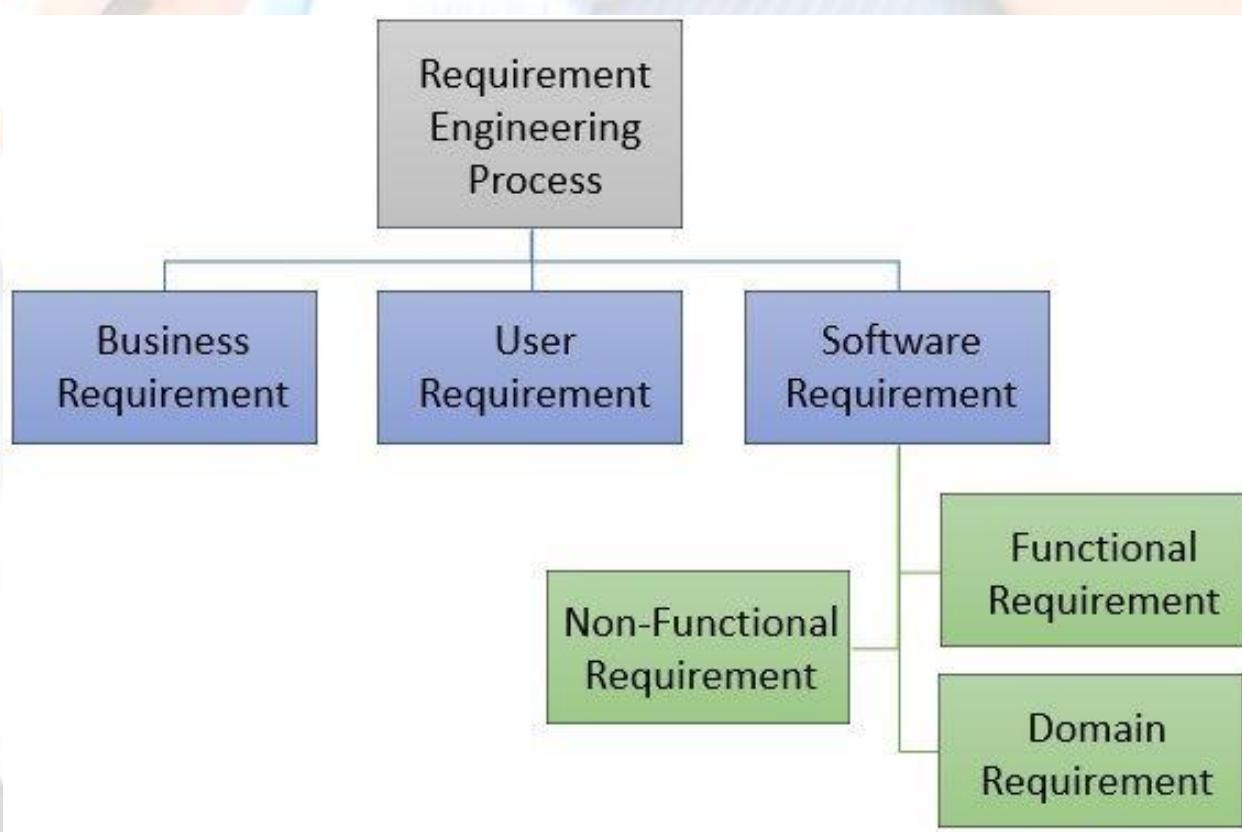
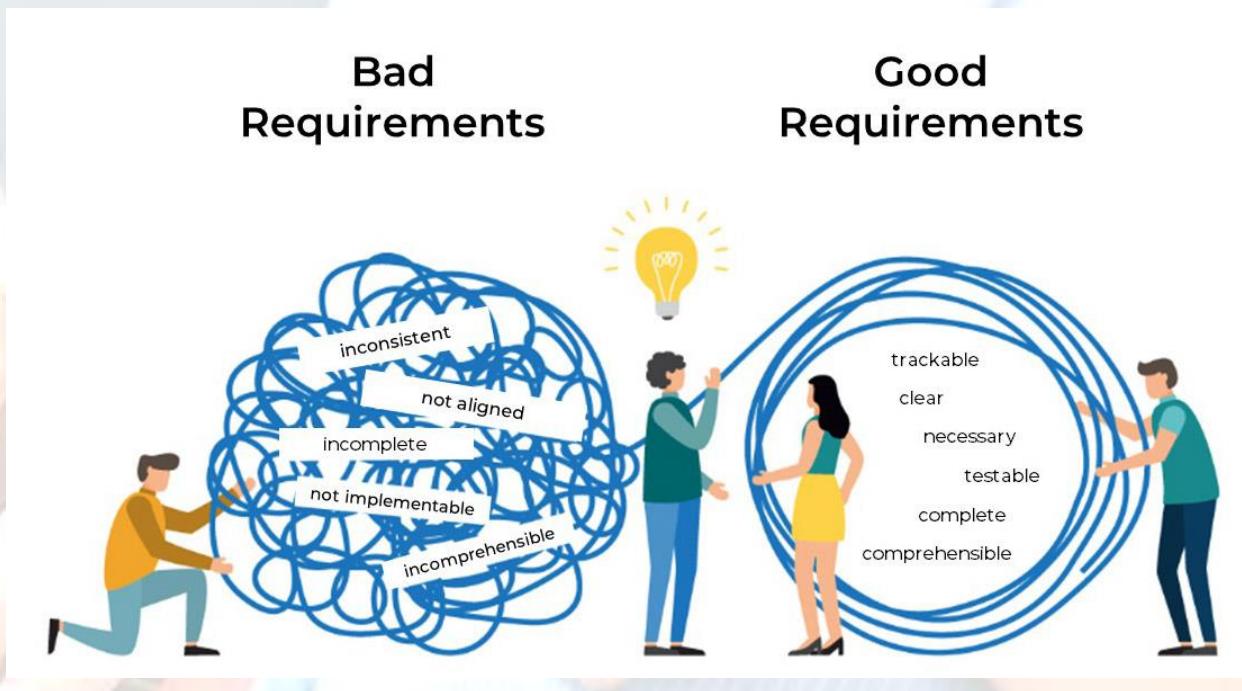
2. Poor Implementation

In the old apps the difficulty of using the application, the inability of some people to use how to use the application program, and how to deal with it.

In the new app:

- The application is more accurate, easy to use, and ultimately.
- Improve the existing methods of patient care. For clinicians and doctors, ensuring that the technology that they are using is easy to manage and understand, rather than a burden, is critical.

➤ Analysis of the new system



Functional requirements:

- **The mother** must create a new account containing all information about her health, and her medical history to store them in the private medical record.
- **The mother** must log in to the application with a unique username and password.
- **The application** must save all patient data so that the doctor can always check on his patient's past data. This will also work for the anonymous collection of data and the creation of reliable datasets.
- **The mother** shall record her fetus' movement during the day.
- **The mother** must check the symptoms she feels daily from a list of symptoms.
- **The application** must Predict the risk to the mother, Based on the daily/weekly symptoms, her medical history taken by the doctor, and her current health state.
- **The application** must predict preeclampsia and assess maternal health risk diseases based on the patient's medical history.
- **The application** provides a simple medical library containing articles, videos & images like hospital bag, maternal tests, pregnancy complications, maternal vaccinations, partner support, nutrition, exercises and preparing for pregnancy
- **The application** provides baby development videos and articles, a kick counter and common questions asked by pregnant women answered by gynecologists
- **The application** must provide notifications for Reminders for symptom entry, Upcoming appointments, library notifications.
- **The application** should provide a notes features to manage doctor's appointments, Medicine to be taken with doses and time during the day, and a Pregnancy timeline.

Non Functional requirements:

1. (Usability)

The efficiency of use:

- Goals are easy to accomplish quickly and with few or no user errors.
- The system must be efficient for the frequent user.

Intuitiveness:

- Users can easily navigate its interface.
- The interface is easy to learn and navigate; buttons, headings, and help/error messages are simple to understand.

Low perceived workload:

- The view makes the system easy to use.
- The interface appears easy to use, rather than intimidating, demanding, and frustrating.

Ease of learning:

- The system must be easy to learn for both novices and users with experience from similar systems.

Ease of remembering:

- The system must be easy to remember for the casual user.

Understandability:

- The user must understand what the system does.
- They can understand how the application organizes its content.

2. (Localization)

- The application has features that match the **geographical location** of its users **including** languages, currencies, interests, purpose, and needs.
- The application must adapt the software to both the **culture and language** of an end user, from standards of measurement and design.
- It **involves** design and UX changes to make the software look and feel natural to the target user.
- Planning the application accordingly for software localization, so that the software can be translated into other languages **without** causing extra work or time.
- Using** industry-related or complicated words and phrases in user interface and documentation may appeal to a select audience, failing to elicit positive responses in other languages or another culture.

3. (Availability)

- The percentage of time that the application is **accessible for users and operation is very high.**
- The application may be **available 98%** of the time during **a month.**
- The application must **be ready all the time** to answer patients' inquiries and questions.
- The application shall be more prepared for **emergency** situations, develops effective solutions, available for the Prediction of potential diseases based on a patient's medical history, and has a **continuous** ability to make decisions **permanently** and **at any time.**
- The dashboard interface must be available to users **99.98 percent** of the time **every month** during opening the application.
- The solution and response should be available for application maintenance purposes **all time.**
- Availability for Notifications** to Reminders for symptom entry and upcoming appointments **at any time.**

4. (Security)

Integrity:

- All data inside the system or its part will be protected against malware attacks or unauthorized access.
- The application shall enforce access privileges that enable anyone to modify or delete the medical data of patients.
- defining the login flow and different user roles as system behavior or user actions to protect the admin panel from unauthorized access.

Confidentiality:

- The application shall encrypt patient data, and private records and store them in encrypted format using an industry-approved encryption algorithm.
- The application protects the personal information of each patient and provides strict privacy related to his medical history, medications, and test results.

Availability:

- application shall monitor the status and location of system components that may contain unencrypted patient data.

Privacy:

- Actors must understand and control how their information is used.

5. (Reliability)

- The **percentage of probability of failure** must be low, and the system functions normally most of the time.
- The system must perform without failure in **95 percent** of use cases during a month.

6. (Maintainability)

- The mean time to restore the system following a system failure must not be greater than 10 minutes.
- The application includes all corrective maintenance time and delays time.
- The application shall have 75 percent maintainability for 24 hours, this means that there's a 75 percent chance the component must be fixed in 24 hours.

7. (Compatibility)

- The software tools and resources that are used very efficiently.
- The system must coexist with another system in the same environment.
- The application that is installed on an operating system must be compatible with its firewall or antivirus protection.
- The application must support android devices running on different versions.

8. (performance)

- The system must be quite fast, and the system shall not take much time to return the results.
- The program should support minimum 1000 users and must provide 6 seconds or less response time.
- The application should load in less than 3 seconds at all times.
- The application must be: Flexible, easy, sufficient, safe, adequate, user-friendly, usable, appropriate, fast, portable, lightweight, small, quick, easy, and clear.

System requirements:

-The Application must have order for hardware and software requirements to run smoothly and efficiently, these requirements include:

Software system requirements:

Android version: 6.0.1

Resolution: 1080x1920

Baseband version: 20234, 20234

Custom version: CUSTC185D002

Hardware system requirements:

Processor type: Octa-core

CPU: Octa-core 1.5GHz

Memory size: 16.00 GB

Free space: 2.2 GB

RAM: 2.0GB

Domain requirements

Six Domains Of Healthcare Quality



- The six domains of healthcare quality outlined by the Institute of Medicine are patient safety, effectiveness, patient-centered, timeliness, efficiency, and equity.
- Each of these is important for ensuring that patients receive high-quality care.
- Efforts to improve healthcare quality must be coordinated and strategic to achieve maximum impact.

1. Patient Safety

- The application must ensure that people who receive healthcare services are treated with respect and understanding.
- Patients must be able to trust the healthcare system to provide them with safe, high-quality care.
- Healthcare providers in the system must take all feasible steps to protect patients from harm, including preventing medical mistakes and injuries.

2. Effectiveness

- A healthcare service must achieve its intended purpose very well.
- The app must provide the desired benefits for patients and ensure to be safe.
- Healthcare providers must use the most appropriate treatments and procedures to achieve the desired results.

3. Patient-centered

- The app must work with patients to identify their needs and ensure that their concerns are taken into account when planning and delivering health services.
- The app must promote an individualized approach to healthcare and strives to ensure that patients have control over their healthcare decisions.

4. Timeliness

- The app should provide timely care which means providing health services as soon as possible.
- Providing it when it comes to emergency services, which must be available whenever and wherever they are needed.
- The app must care about timely routine medical care, such as check-ups and treatments.
- Delivering health services on schedule keeps patients safe and allows them to receive the best possible care.
- The app must avoid delays in care that can have serious consequences for patients:
 - ❖ Delayed treatments can cause serious harm or even death.
 - ❖ Delays in diagnosing a serious illness can lead to severe complications

Efficiency

- The leader must measure how well the developers use resources to produce output.
- The tech team should effort to improve efficiency and aim to identify ways to reduce unnecessary costs or increase production while maintaining or improving quality standards.

Equity

- Our Healthcare systems should be equitable, meaning that no one group of people receives better or worse care than another.
- All members of society should have access to appropriate healthcare regardless of age, gender, ethnicity, religion, sexual orientation, socioeconomic status, physical ability, Geographic location, or other factors.
- The application must care about the definition of "equity" as "the absence of systematic differences between groups of individuals within a population based on socially determined characteristics. These characteristics include gender, age, race, ethnicity, religion, socio-economic status, disability, sexual orientation, geographic location, and other factors.

User requirements

The pregnancy follows up application provides daily and monthly care for pregnant women from that filled up by the pregnant woman itself.

- You can check your safety and the baby's safety from home there is no need for reservation of an appointment with the doctor and waiting for just checking your health.
- Early rescue in case of danger that is may be unknown for the mother (the most reason for abortion).
- Provide psychological support through articles
- You can make sure of your baby safety by counting number of movement during the day
- Enrichment you as a user with sufficient basic medical information that may help you
- Provide sports that fit you in this time of your life
- Defend against common rigors about pregnancy through articles written by doctors
- At the start of each months the app will notify you with expected symptoms that normally appear
- remembering you of your appointments and drugs through notification

➤ **Advantages of the new system**

- **Mobile health apps** are defined as medical and public health practices supported by smartphones, tablets, or other mobile communication devices. They provide a new, innovative way to deliver healthcare services outside traditional care settings. They are expected to be a potential resource to enhance healthcare professionals' productivity and improve patients' health outcomes.
- Mobile healthcare is the future and whether you're the patient or the doctor, you will definitely be able to enjoy countless benefits from using **mobile health apps** in daily life.

These benefits include:

1. Improved Patient Engagement

- Our Health apps facilitate engagement through patient-focused care, personalized experiences & knowledge sharing between providers and patients.
- Patients can access and monitor their medical records/prescription details from the convenience of their own homes without visiting hospitals.

2. Minimize Risks of Misdiagnosis

- Managing patients' records manually is prone to diagnostic errors, inaccuracies, and time-consuming. But the health apps nullify all such potential challenges that might prove fatal for the patient.
- Helps store an accurate report of the patient's health condition digitally in the app this assists doctors to prescribe the right medicine with the correct dosage and chemical compositions. In situations when a patient hops from one healthcare provider to another, this data can be extracted easily to make quick medical decisions.

3. Improved Prescription Alerts

- Various health apps include set-up electronic reminders that alert patients about their medication, upcoming appointments with specialists, renew prescriptions, and more. This gives patients a lot more control over their therapy without worrying about missing a therapy session.
- Eliminates a major chunk of tedious & repetitive administrative work and provides a better experience to patients with automated reminders.

4. Enhanced Data Management

- Healthcare organizations process tons of personal information every day. So, it is necessary to properly organize it. When integrated with EHR, healthcare apps automatically record valuable patients' information from connected devices in the system or wearables.
- This enables healthcare providers to create a comprehensive profile of each patient and become HIPAA compliant.

5. Accurate Patient Diagnostics

- Healthcare mobile apps with their intelligent health diagnostic approach minimize errors that may prove fatal for the patient. With accurate health

6. Power to monitor your health

- By using our application, you have the power to monitor your own daily symptoms and risks of preeclampsia and other diseases during pregnancy.
- You can also read more information about many related topics which gives you the power to control your own health.

7. Encourage a healthy lifestyle

- As more and more people are becoming conscious about maintaining a healthy lifestyle, healthy life apps are the most popular Health apps right now.
- With the popularity of advanced digital accessories such as smartwatches and fitness trackers, healthy life apps are mainly designed to enable people to stay in shape, follow strict diets, or improve their sleep cycle.
- They allow users to track their sleep, body mass, food intake, heart rate, blood pressure, calorie intake, and other personal data.
- Having such data will help individuals set safe and reasonable fitness goals. Additionally, with the help of these apps, they can increase their chances to attain the healthy lifestyle they want. Moreover, users can share these data with their personal trainers or friends to obtain more advice and support.



Our app considers a Healthy Living & Wellness app which includes many features and characteristics that have the ability to help a pregnant woman, follow up on her pregnancy and the status of her fetus, and help her make the right decision regarding her health condition.

These features **include:**

- For pregnant people that may have experienced a previous pregnancy loss and need additional support navigating any subsequent pregnancies.
- Our pregnancy follow-up app is a standout option, as it features miscarriage support, including trackers for unusual symptoms and emotional well-being.
- The app includes social and partner support as well as a feature that allows users to upload pregnancy symptoms, weight, medication, and other health data.

- This app is a nurture app that has additional fun features including images and a simple medical Library containing articles, videos & images.
- Features fetal development images and updates on the baby's size.
- Includes both a baby kick counter and contraction tracking.
- Includes a library feature for common activities, products, and foods.
- Helps users track blood pressure, weight gain, tummy growth, and baby movement, which you can save and show your doctor at future appointments.
- Allows you to convert data on your pregnancy to a record to show your doctor at your next visit.
- Features checklists for each trimester so you can prepare for childbirth.
- With daily articles on pregnancy and weekly advice from obstetricians, the pregnancy follow-up app and Baby Tracker is a smart choices to keep track of all aspects of your pregnancy.
- The app features an event diary to log appointments and weekly updates on your baby's size and development.
- There's also a baby kick counter and ideas for healthy meals during pregnancy.
- Includes questions to ask your doctor at particular appointments.
- Visuals of your baby in the womb are more detailed than many other apps.
- In-depth safety information about different products, foods, and, activities.



My data is safe:

- The application saves all patient data so that the doctor can always check on his patient's past data. This will also work for the anonymous collection of data and the creation of reliable datasets.

It protects me from the risk factors that affect my condition:

- Predict the risk to the mother, based on her medical history, and her current health state by using the maternal health risk form and preeclampsia form.
- Check the symptoms she feels daily from a list of symptoms.

Keep track of my medical history:

- Predict preeclampsia and other diseases based on the patient's medical history.

It provides me with information:

- The application provides a simple medical library containing articles, videos & images like hospital bag, maternal tests, pregnancy complications, maternal vaccinations, partner support, nutrition, exercises and preparing for pregnancy
- The application provides baby development videos and articles, a kick counter and common questions asked by pregnant women answered by gynecologists

Organizes my appointments:

- Provide a notes feature to manage medicine to be taken with doses and time during the day and a Pregnancy timeline.

Making sure my fetus is okay:

- Record her fetus' movement during the day.

➤ **Risk and Risk Managements**

Technology permeates our lives more than ever, as technological advances continuously emerge.

Every industry has been upended and transformed, including the health and medical industry.

While any innovation may seem like progress, there are certainly both advantages and disadvantages of technology in healthcare.



➤ **Cybersecurity Risks in Healthcare:**

- One of the biggest advantages of using technology in healthcare is the ease with which data is generated, stored, and transferred between systems and parties.
- When it works well (and when parties adhere to HIPAA compliance), this proliferation in data allows for better healthcare management: from diagnosis to treatment.
- It opens up the potential risk for data to be accessed by third parties. Whether intentionally breached by malicious actors or accidentally exposed, cases abound of patient data making its way into the wrong hands.

- And by relying on external cloud service providers to manage their data infrastructure, those without advanced expertise in cybersecurity may be opening up the patients who use their systems to risk.
- Altered Data may Inadvertently Lead to Incorrect Healthcare Decisions.
- Cybersecurity risk doesn't just pertain to the exposure of private data or the ransoms that are sometimes associated with data breaches. The risks related to altered data can have serious consequences.
- Patients and healthcare professionals that are relying on data to make treatment decisions depend on correct and accurate datasets. If data is deleted or altered it can lead to a wrong diagnosis or treatment plan, or other adverse events.
- Whether or not cybersecurity contributes to the disadvantages of technology in healthcare is yet to be seen, as thankfully, there are no documented cases of medical apps being hacked for such a purpose. That said, the risk needs to remain at the forefront.

Data privacy:

- The health apps continuously collect and analyze the health data of the person.
- The threat of the exposure of personal information hackers and sharing it with third parties is a major concern.
- Over the past few years, several stances, news, and updates regarding the leakage of health data have been reported by the reported app manufacturers.

Lack of Empathy in Patient and Doctor Interaction:



- Utilizing technology can help keep healthcare professionals and patients connected, even when they are not physically present together. For example, by leveraging data and technology, it is possible to provide and update a treatment plan on an ongoing basis, rather than via one-off consultations.
- The use of such tools has kept the healthcare system going and ensured that patients receive a continuum of care during these trying times.
- Similarly, remote patient monitoring can lower healthcare costs by identifying potential issues earlier and avoiding complications down the road. Remote monitoring and telehealth also allow for addressing the clinician shortages that have plagued many countries including here in the United States, specifically in remote areas.
- However, the way in which technology has become the interface between patients and providers has the potential to cause issues. Without responsible patient/doctor relationship monitoring, the benefits will not outweigh the negative impact of technology in healthcare.
- Patients interacting with technology instead of a live care provider dealing with dashboards on connected medical devices and computers removes the human touch of treatment, resulting in a lack of empathy toward patient care.

Risk of Miscommunication:

- Especially for the elderly and the most vulnerable patients, relying on technology as the interface of care can cause confusion and frustration, and can result in confusion, treatment plans not being understood properly, or patient non-compliance.
- Resistance from doctors due to perceived loss of control over the care process.
- Potential loss of revenue for healthcare providers.
- Lack of good-quality scientific research into e-health impacts.

Frustration with Poor Implementation

- As we continue to discuss the pros and drawbacks of medical technology in healthcare, it brings to mind the popular saying: “technology is great — when it works.”
- 80% of Americans have at least one frustrating experience with technology each day.
- The disadvantages of technology in healthcare to be outweighed by the benefits, systems must be accurate, easy to use, and ultimately, improve on the existing methods of patient care. For clinicians and doctors, ensuring that the technology that they are using is easy to manage and understand, rather than a burden, is critical.

Missing Data and Bad Data

- If you don't migrate clean, relevant data from your old system into your new ERP, that will lead to substantial problems for your users.
- Possible consequences: Users cannot do their work in the new system. Or users learn that they cannot trust the data in the new system. Poor user adoption and errors in accounts may result.

Too Much Reliance on Technology

- As technologies such as Artificial Intelligence and Machine Learning become more prevalent, care must be taken to ensure healthcare professionals understand the limitations of these technologies.
- AI/ML systems may lead to complacency among clinicians potentially resulting in failure to cross-check or consider alternatives to the system's predictions.
- If technology is not improving healthcare – through speed, efficiency, or accuracy – then the continued adoption of technology within healthcare is not likely to last!

Accuracy of Data:

- The information and advice provided by healthcare apps is also an important concern with healthcare apps.
- Different apps use different methods and tools to analyze health data. In some cases, the data measured with the apps are found to be varying when compared with the MedTech devices.
- Internet accessibility, the high cost of smartphones, lack of regulatory approval, and the high cost of in-purchase applications are some of the other key factors hampering penetration of the mobile health apps in the market, faltering their demand.

Healthcare app is not accessible to everyone:

- As these and other smart device ownership figures demonstrate, not all adults use smart devices, meaning that mHealth is inaccessible to many consumers.
- This includes large numbers of individuals who would likely benefit significantly from helpful technology: the elderly.

Ways to Reduce Cybersecurity Risk:

1. Encrypt Your Data and Create Backups:

- Make sure all your sensitive data is encrypted. Saving your data in normal-text format only makes it easy for hackers to access.
- Data encryption, on the other hand, limits data access to parties that have the encryption key. Also ensures that even when unauthorized parties gain access to the data, they can't read it.
- Some data encryption software even lets you know when other people try to alter or tamper with the information.
- You should also conduct regular backups for your important information.
- Sometimes cybersecurity breaches can result in data loss.
- When this happens, and you don't have a reliable and secure backup, it could result in operational disruptions that could cause your organization a lot of lost revenue.
- One of the most effective data backup strategies is the 3-2-1 rule. Based on this strategy, you should have at least 3 copies of your data stored. 2 of them should be stored on different media, and one should be in an offsite location.

2. Users Training

- One of the common ways malicious hackers gain access to your database is through phishing emails sent to your users. In fact, statistics show that over 3.4 billion phishing emails are sent globally. These emails contain malicious malware in the form of links that give hackers access to user data, including login credentials.
- You should also emphasize the importance of checking email addresses before replying to them and checking links before clicking on them. Finally, don't forget to highlight the app policy when it comes to sharing sensitive information, even on social media.

3. Keep Your Systems and Software Updated

- Software and system updates highly impact your cyber security and digital safety. This is because they not only add new features but also fix bugs and help patch security flaws and vulnerabilities that can be exploited.
- Malicious hackers write code that they use to exploit the vulnerabilities. Most of the time, this code is packaged in the form of malware which can affect your entire system. So, make sure you use a patch management system to automatically manage all updates and uphold information security.

4. Use Strong Passwords

Some of the security risk mitigation strategies you should implement when it comes to passwords include:

- All passwords should contain at least 8 characters.
- They should contain alphanumeric characters.
- They shouldn't contain any personal information.
- They should be unique and never used before.

Ways to manage the risk of data privacy:

1. Integrity:

- All data inside the system or its part will be protected against malware attacks or unauthorized access.
- The application shall enforce access privileges that enable anyone to modify or delete the medical data of patients.
- Defining the login flow and different user roles as system behavior or user actions to protect the admin panel from unauthorized access.

2. Confidentiality:

- The application shall encrypt patient data, and private records and store them in encrypted format using an industry.
- Approved encryption algorithm.
- The application protects the personal information of each patient and provides strict privacy related to his medical history, medications, and test results.

Ways to manage the risk of Miscommunication

Make a list.

- Before communicating with the doctor, patient must write down any questions or concerns she has about her health.

Ask for definitions.

- If your doctor uses a word you do not understand, ask him or her to re-explain using plain language.
- Many words sound alike or have different meanings when talked about in health care. For example, whereas the word “negative” has bad implications outside a doctor’s office, when a test comes back negative, it is good news. It is okay to say you don’t understand.

Know your goals.

- Ask your doctor to define your health care goals. For example, if your doctor tells you to check your blood pressure to make sure it is within normal range, you will need to know what “normal” means.

Do the talking.

- After your doctor has finished explaining something to you, explain it back to your doctor. This will help you remember it and help to make sure both you and your doctor understand the information in the same way.

Picture it.

- A picture can be worth a thousand words. Ask your doctor to draw a picture or give you an illustration of the concept he or she is talking about. For example, a doctor might suggest certain exercises for someone with low back pain. A drawing may be far easier to understand than a spoken description.

Slow it down.

- If your healthcare provider speaks quickly, ask him or her to speak slowly so that you do not miss information.

Don't be shy.

- If you have concerns regarding treatment, tell your healthcare provider. He or she may have information that will relieve your concerns, or there may be alternative treatments.

Consider taking a partner.

- Bringing a trusted family member or friend can be a big help when it comes to understanding information and remembering instructions once back at home.

Ask for a recap.

- At the end of your appointment, ask your doctor to repeat the main points and type or write down take-home instructions.

Follow-up.

- If you get home and cannot remember instructions, contact your doctor. If your physician offers communication via secure email, you will have the added bonus of a written copy of the answer.
- Regular email does not provide complete privacy of your health information. If you have questions about whether your doctor uses secure email, be sure to ask.

Ways to manage the risk of Poor Implementation

- Systems must be accurate, easy to use, and ultimately, improve on the existing methods of patient care.
- For clinicians and doctors, ensuring that the technology that they are using is easy to manage and understand, rather than a burden, is critical.

Ways to manage the risk of Missing Data and Bad Data

- Once you've identified what data you need, make sure that data gets cleaned and properly formatted
- Migrate only the data you need.
- Clean and format all the data you migrate.

Ways to manage the risk of the accuracy of Data:

1: Create a centralized database

- Store and organize data in one place so that it can be easily accessed by whoever needs it.

2: Don't put pen to paper

- Type notes to reduce mistakes. These days, most people actually type faster than they write, and it is easier to read than handwriting, too! According to a study, 1.5 million patients in the US are affected by medication errors resulting from illegible handwriting. So, it's easy to see how this leads to problems with clean record keeping. It's also easier to add to typed notes and you can track additions over time.

3: Assign permissions to change data

- Establish procedures for who has permission in your organization to change data. This will limit the chances of information being edited incorrectly and protect your company's intellectual property.

4: Keep data sources in sync

- Make sure that the most recent version of a file is easy to find whenever data is being updated from multiple sources at different times – especially when the information needs to be accessed while an update is in progress. This is much easier with a cloud-based digital database, as updates are in real-time.

5: Standardize the data entry process

- Define a structured process for employees to follow when entering data. A company-wide guide to data entry and standard operating procedures will ensure consistency and data quality from the moment information is entered into each record type within the organization.

6: Simplify the data entry process

- Restrict the number of options within a field to limit potential errors and help standardize information. With digital data entry, it is as simple as providing a drop-down list of fields, where only one is available for selection. This also has the advantage of standardizing formatting in your organization.

7: Merge duplicate data

- Streamline your database by merging duplicate files. Simply deleting duplicates can lead to the accidental loss of information. A digital database allows data to be updated to the most recent version instantly while keeping a track of changes, eradicating unnecessary duplicate records.

8: Get staff on board with your data procedures

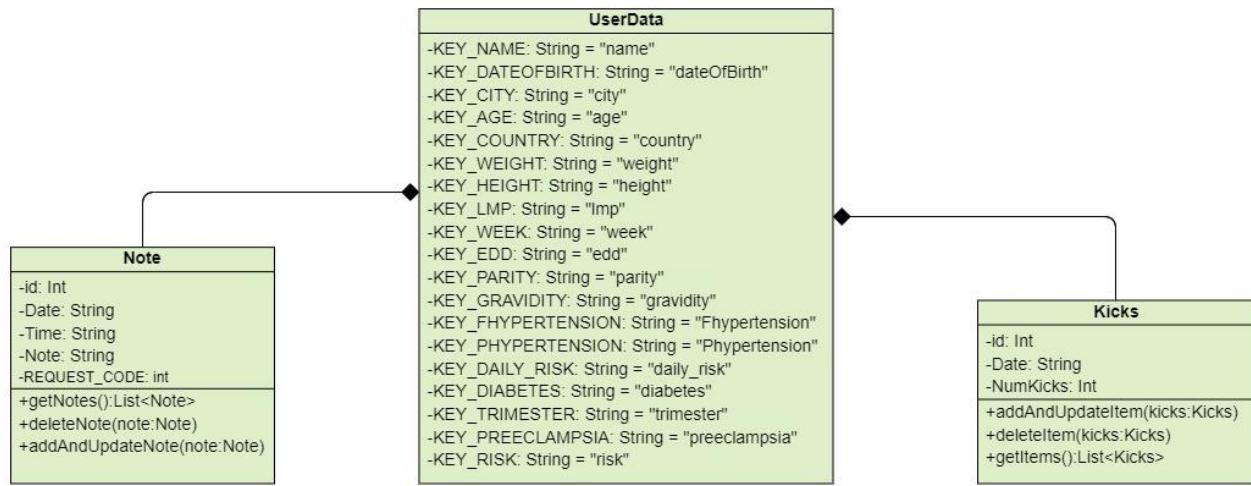
- Establish best practices for record keeping and data entry as an integral part of your employees' job roles. If you are introducing a new system, such as an ELN, provide plenty of training and ongoing support to encourage user adoption.

9: Audit data regularly

- Proactively perform data audits on a regular basis to see what information needs to be fixed and which areas of your data entry process need improvement. Integrating audits into your data management will help to mitigate security and compliance issues.

Chapter 3: Software Design

➤ Class Diagram



➤ Class diagram description

We have 3 classes

1. UserData class
2. Note data class
3. Kicks data class

“Note” and “UserData” are in a composition relation which means that each UserData object can have a Note object and the latter object is entirely dependent on the presence of UserData.

“Kicks” and “UserData” are in a composition relation which means that each UserData object can have a Kicks object and the latter object is entirely dependent on the presence of UserData.

All the classes contain getters and setters not shown in the diagram.

Class: UserData

This is a class that contains personal and medical information about the mother. This includes the following private attributes:

- KEY_NAME: Contains a string referring to the mother's name.
- KEY_DATEOFBIRTH: Contains a string referring to the mother's date of birth.
- KEY_CITY: Contains a string referring to the city the mother is living in.
- KEY AGE: Contains a string referring to the mother's age.
- KEY_COUNTRY: Contains a string referring to the country the mother is living in.
- KEY_WEIGHT: Contains a string referring to the mother's weight.
- KEY_HEIGHT: Contains a string referring to the mother's height.
- KEY_LMP: Contains a string referring to the mother's date of last missed period.
- KEY_WEEK: Contains a string referring to the mother's gestational week.
- KEY_EDD: Contains a string referring to the expected delivery date.
- KEY_PARITY: Contains a string referring to how many times the mother has given birth to a fetus with a gestational age of 24 weeks or more
- KEY_GRAVIDITY: Contains a string referring to how many times the mother has been pregnant.
- KEY_FHYPERTENSION: Contains a string containing a binary value to whether or not the mother's family has a history of hypertension.
- KEY_PHYPERTENSION: Contains a string containing a binary value to whether or not the mother's has a personal history of hypertension.
- KEY_DAILY_RISK: Contains a string referring to the result of the daily risk application.
- KEY_DIABETES: Contains a string containing a binary value to whether or not the mother's has a personal history of diabetes.
- KEY_TRIMESTER: Contains a string referring to the mother's current trimester.
- KEY_PREECLAMPSIA: Contains a string referring to the result of the preeclampsia application.
- KEY_RISK: Contains a string referring to the result of the maternal health risk application.

Data Class: Note

This is a data class that contains information about the stored notes by the mother. This includes the following private attributes:

- Id: unique for each note
- Date: date specified by the mother.
- Time: time specified by the mother.
- Note: text input by the mother.
- REQUEST_CODE: code for each note which is used for notifications.

Notes are for reminders and notifications, they are unlimited in number.

Operations of “Notes” class are:

- getNotes which returns a list of all notes stored previously.
- deleteNote which takes a specified note as input and deletes it
- addAndUpdateNote which takes a specified note as input and checks if it exists then it's updated with the new information, if it doesn't exist then it's created and stored.

Data Class: Kicks

This is a data class that contains information about the stored kicks by the mother. This includes the following private attributes:

- Id: unique for each note
- Date: date of the kick.
- NumKicks: how many kicks at the specified date

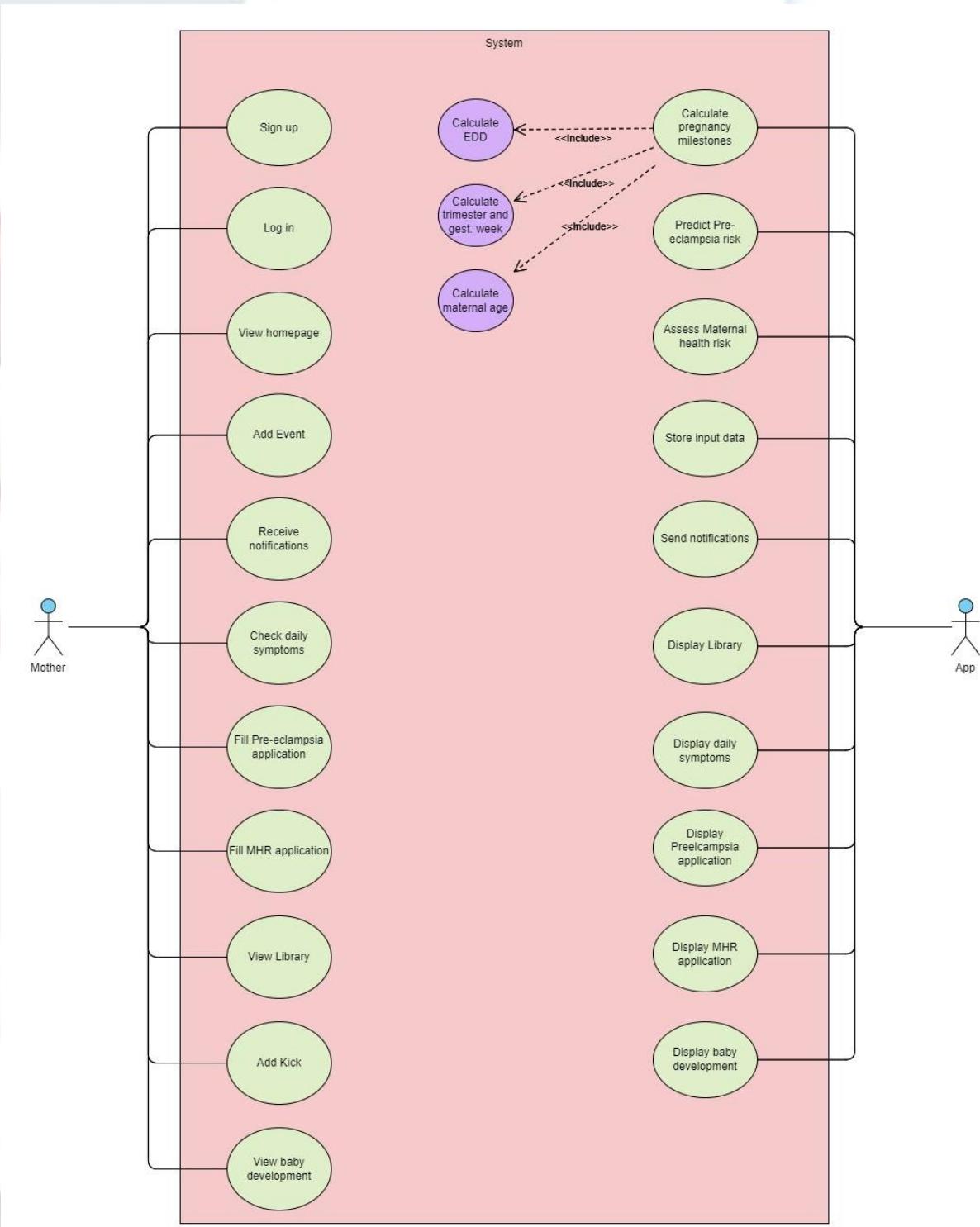
Kicks is so the mother can monitor her fetus' movement and keep record of his kicks to show the doctor in her next ANC visit

Operations of “Kicks” class are:

- getItems which returns a list of all kicks stored previously.
- deleteItem which takes a specified kick item as input and deletes it
- addAndUpdateItem which takes a specified kick item as input and checks if it exists then it's updated with the new information, if it doesn't exist then it's created and stored.

➤ Use case diagram

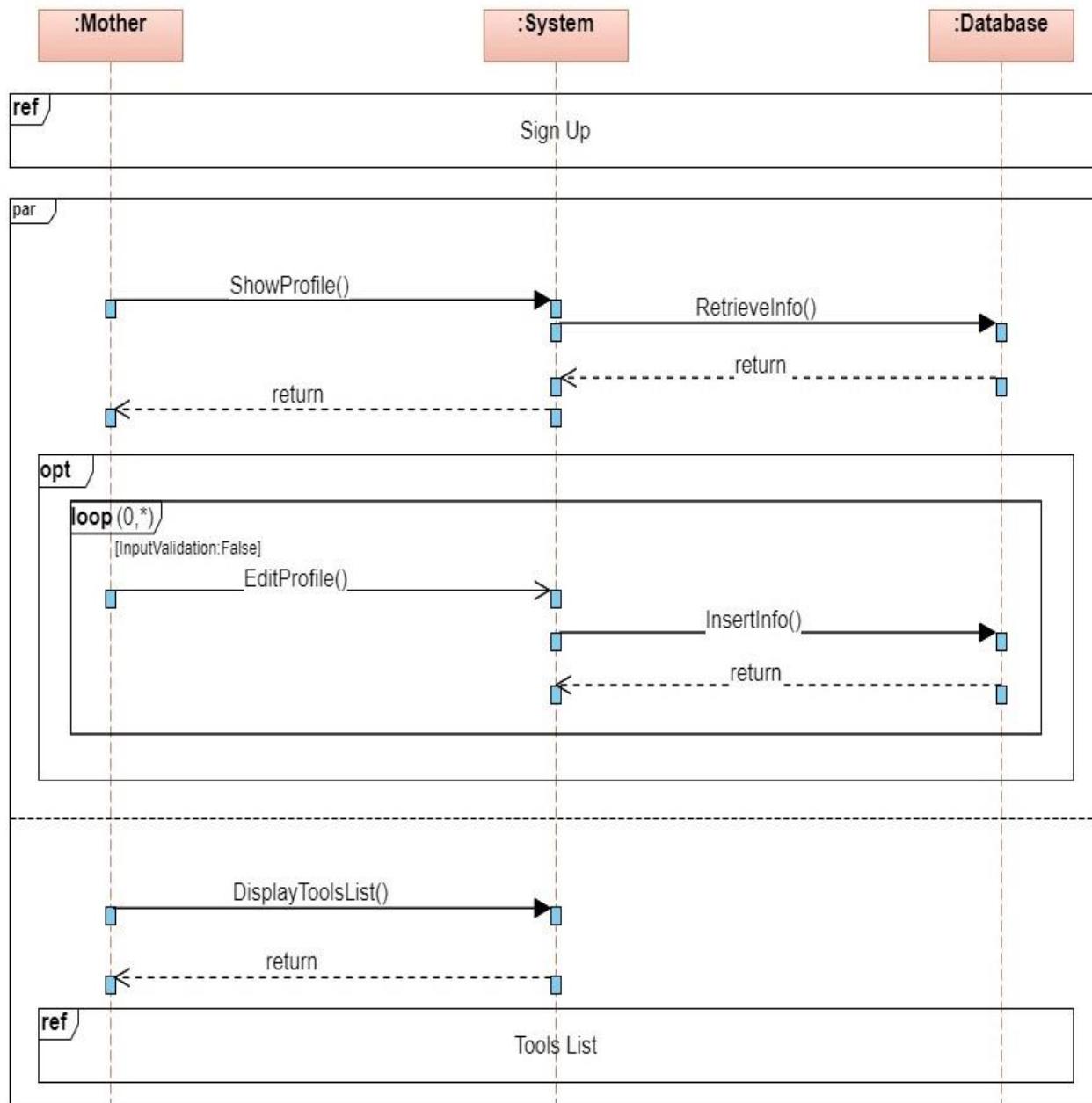
➤ Use case

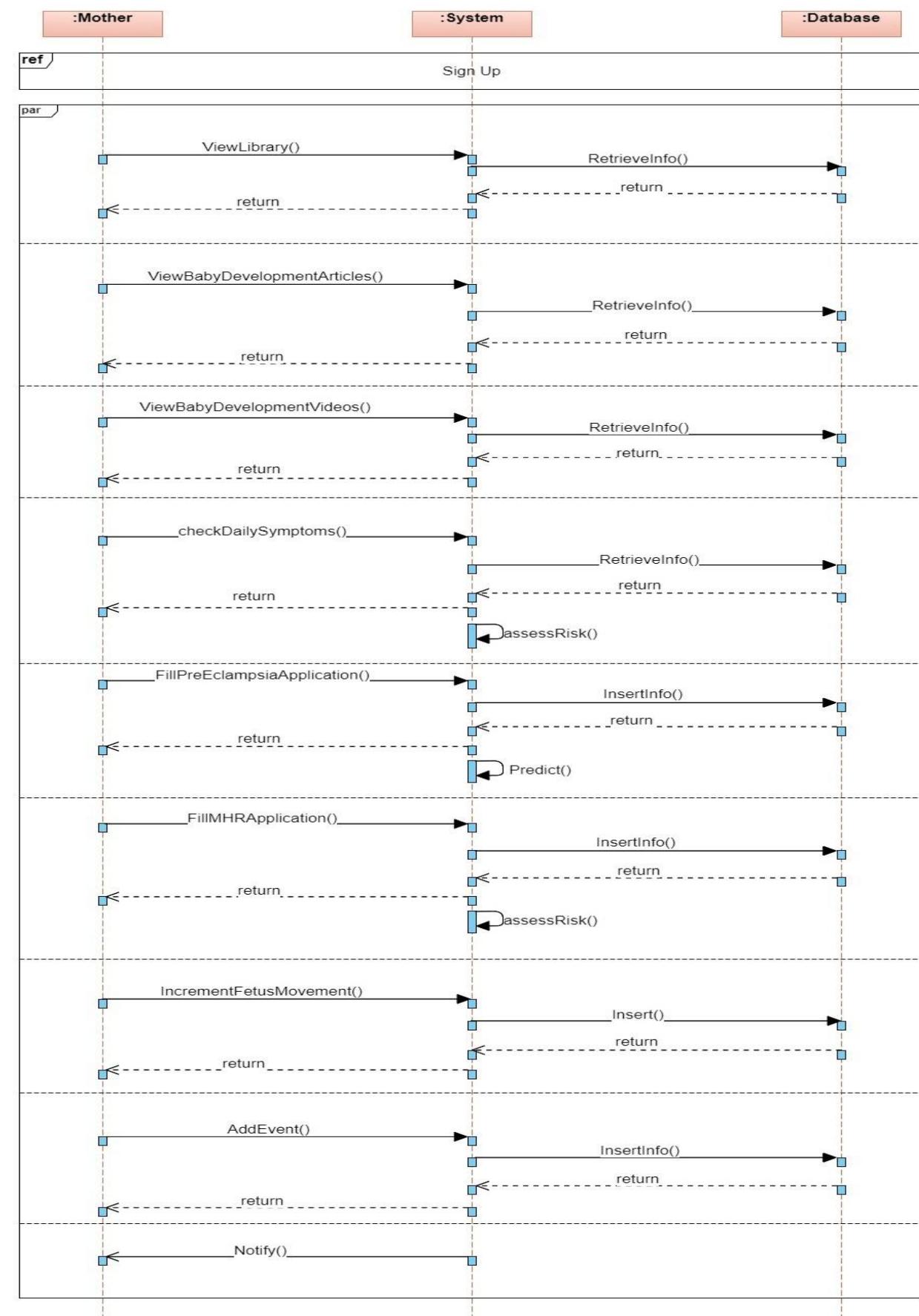


➤ Use case description

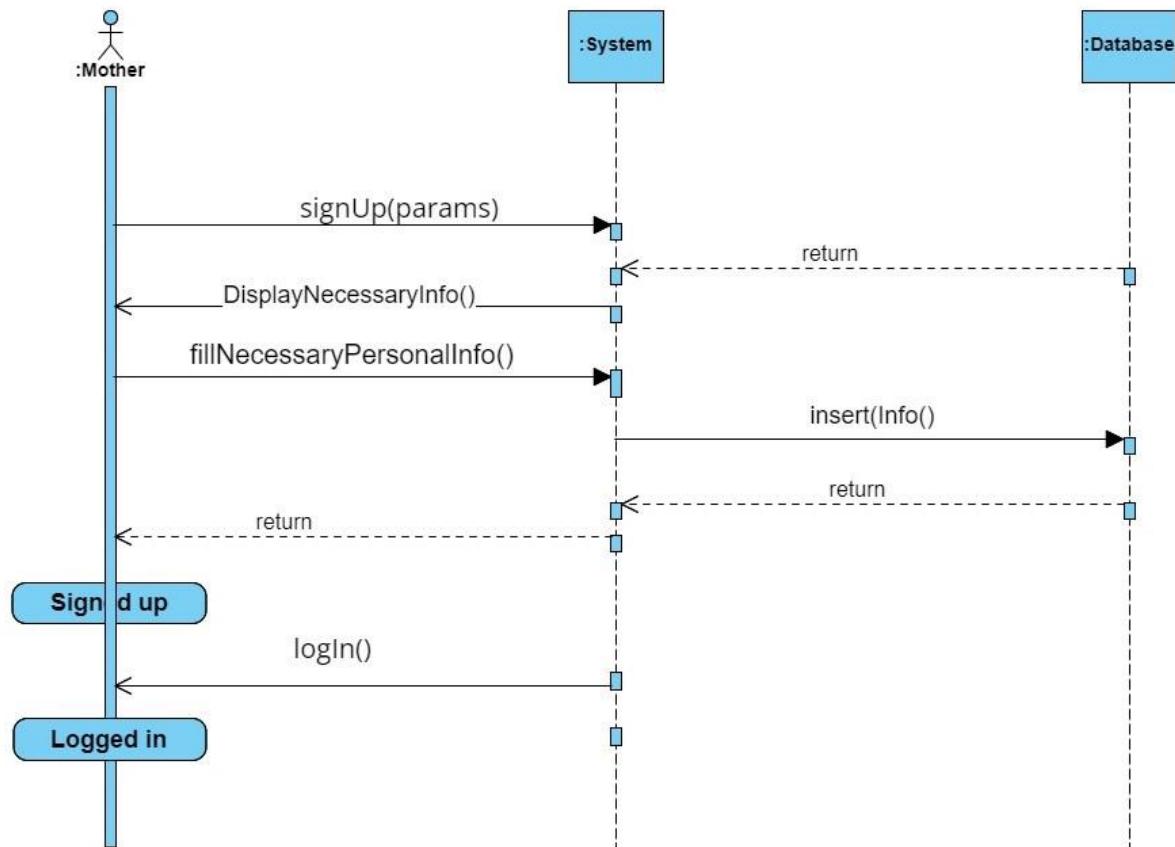
Identifier	M1
Name	Overall Use-Case
Initiator	Mother
Pre-Conditions	The mother should install the application on her phone
Post-Conditions	<ol style="list-style-type: none"> 1. The mother's data is stored. 2. The risk prediction and assessment are accurate.
Main Success Scenario	<p>The mother signs up, her information is validated and stored by the system, she's immediately logged in and the system calculates the pregnancy milestones and displays to the mother the homepage, the mother goes to add event, the system stores the event and sends a notification of the event at the specified time by the mother, the mother receives those notifications successfully.</p> <p>The system displays the daily symptoms based on the expected symptoms of the mother's current trimester. The mother can check to see if each symptom is either a normal change or a risk.</p> <p>The system displays the preeclampsia application. The mother fills the preeclampsia application, the system then stores data and predicts whether or not the mother will get preeclampsia.</p> <p>The system displays the maternal health risk application. The mother fills the maternal health risk application, the system then stores data and assesses maternal health risk.</p> <p>The system displays library and the mother can view this library.</p> <p>The mother adds babies' kicks and the system stores this data.</p> <p>The system displays baby development in two forms articles and videos and the mother can view both of them.</p>
Goal	<ol style="list-style-type: none"> 1. The mother is successfully logged in 2. The mother can use the features of the app like prediction of pre-eclampsia and assessment of maternal risk 3. The mother can follow up daily on her pregnancy. 4. The mother can view the library. 5. The mother can get notifications. 6. The mother can record her fetus kick counts.

➤ Sequence diagram





d Sign Up



✓ **Sequence diagram description**

Sign up sequence diagram

- First things first, the mother has to sign up to use the application.
- When the mother opens the application, she finds a sign up form that she fills.
- After the mother's sign up is successful, she immediately finds a "Necessary Info" tab, this is the information that is absolutely necessary for the operating of the app such as last missed period and maternal date of birth and such.
- Without these information, this application is useless therefore it's not optional for the mother to fill it but rather obligatory.
- After filling the necessary information form, the mother is immediately logged in.
- The system calculates "Mother milestones" such as maternal age, expected due date and trimester, then displays the homepage.

Homepage sequence diagram

- After the mother has signed up and been logged in, She's currently on the homepage.
- There are a few shortcuts on the homepage which we won't be going into details about. We will instead see the main tabs that the mother can view.
- To show that the mother can choose whichever tab first, we used a par fragment which is used to indicate that any of the operands can be executed first.
- For the first operand, the mother chooses the profile tab, the system retrieves her info and returns it. She can edit her profile optionally hence the opt fragment
- For the second operand, the mother chooses the tools tab, which the system returns and now we move on to the "Tools List" sequence diagram.

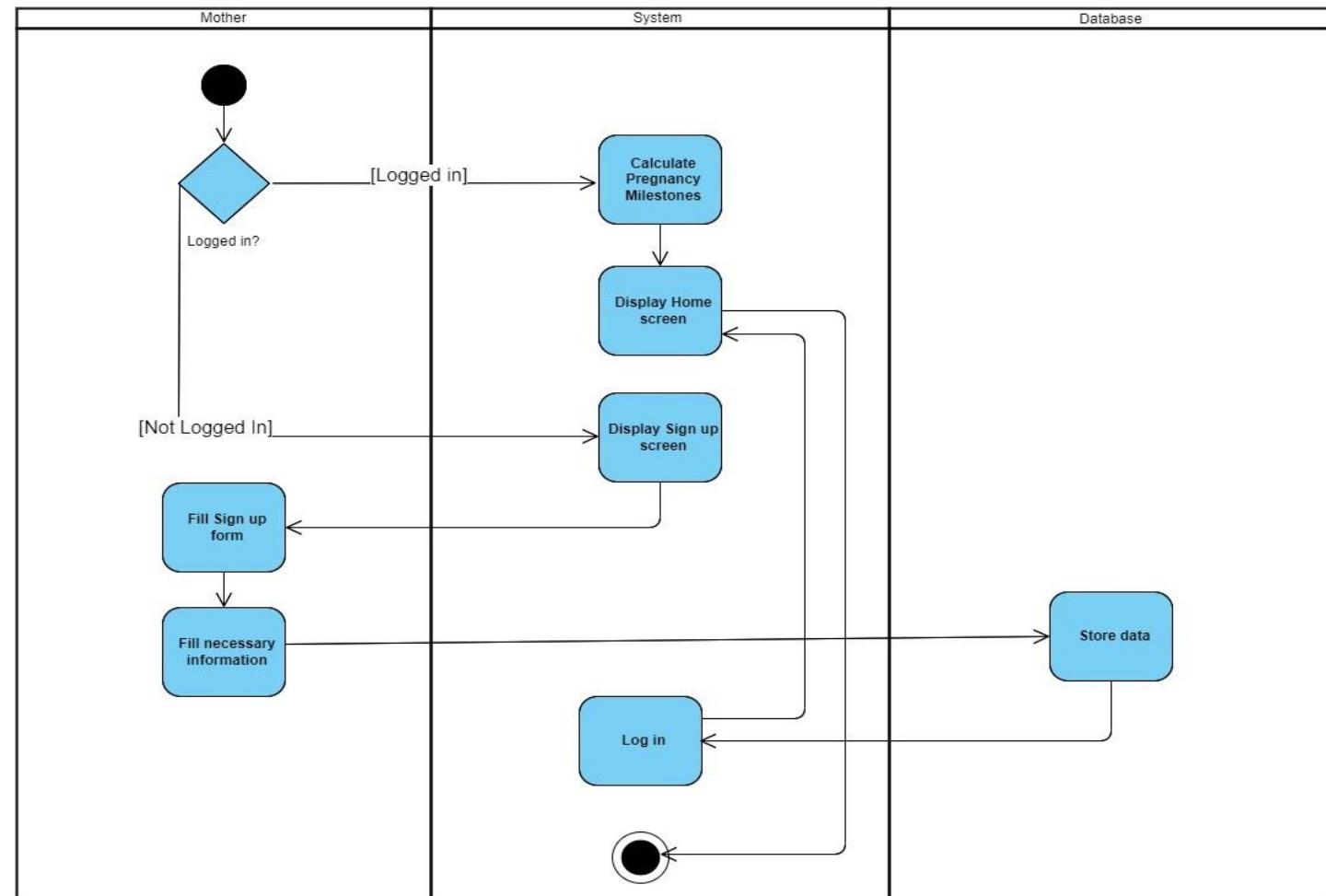
Tools List sequence diagram

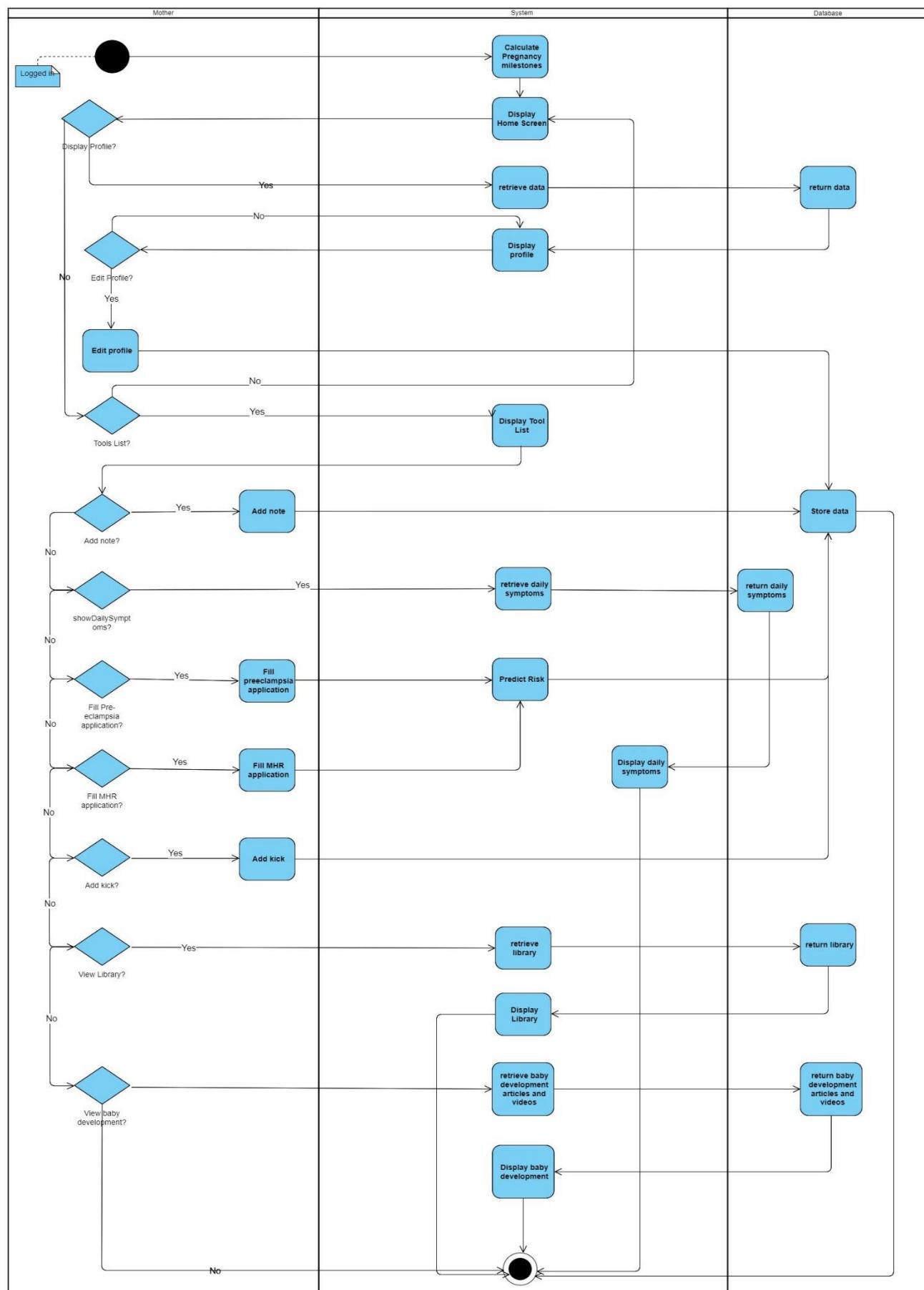
The tools list allows the mother to do any of the following in any order:

1. View library which the system retrieves from the database.
2. View baby development articles which the system retrieves from the database.
3. View baby development videos which the system retrieves from the database.
4. Check the daily application which the system displays based on the mother's current trimester. The mother can then check to see if each symptom is a risk or a normal change.
5. Fill the preeclampsia application then the system assesses the risk based on the input.
6. Fill the maternal health risk application then the system assesses the risk based on the input.
7. Increment the fetus movement aka the kicks of the baby which is then inserted into the database by the system.
8. Add event/note which are inserted into the database.

The system also notifies the mother at either scheduled or personal notifications added by the mother.

➤Activity diagram





✓ **Activity diagram description**

Sign up activity diagram

First the system checks if user is already logged in or not.

If they're logged in then the system displays the home screen immediately (this includes calculating pregnancy milestones).

If they're not logged in then they're redirected to the sign up screen where they fill the sign up form then fill necessary information which the system stores into the database then they're immediately logged in by the system itself and redirected to the home screen.

Mother activity diagram

The state of the mother is “Logged in” at the beginning of the diagram

First the system calculates the pregnancy milestones such as gestational week, trimester, expected due date and maternal age then displays the home screen for the mother.

If the mother wants to see her profile then the system retrieves her personal data from the database and then displays her profile.

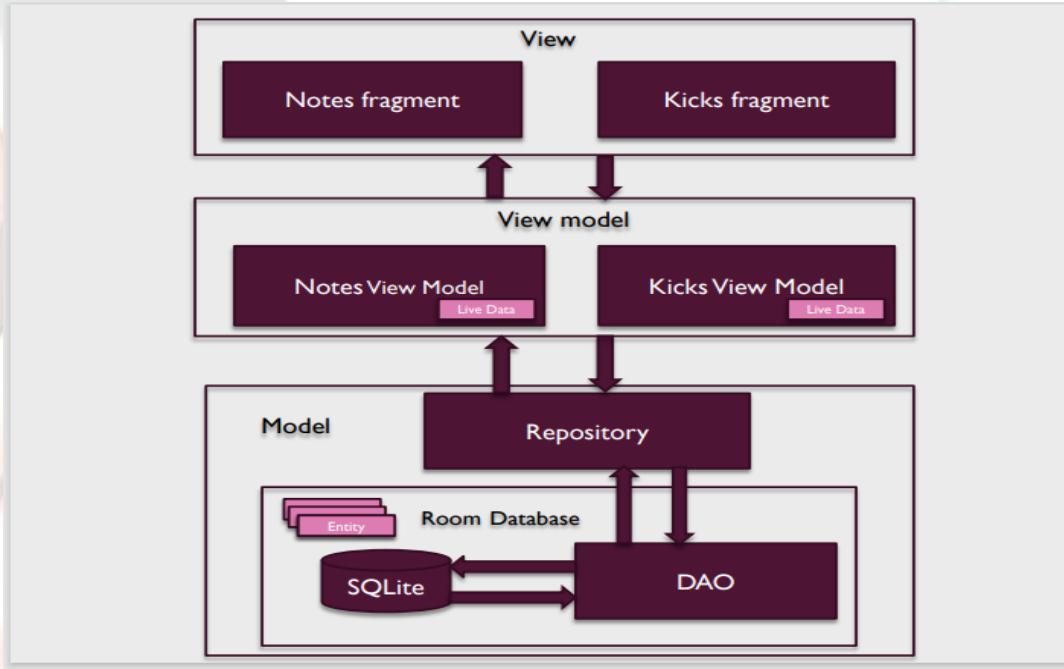
Then if she wants to edit her profile she changes the values by clicking on them and fills the textboxes with the new data. The system then stores this new data into the database

If the mother doesn't want to display her profile then she can choose to display tool list after which the system displays the tools list which enables the mother to do the following:

1. If she wants to add note then she enters the note input which the system stores into the database.
2. If she wants to check daily symptoms then the system displays the symptoms expected in her current trimester and she can check to see if each symptom is either a risk or a normal change.
3. If she wants to fill preeclampsia application then she enters the daily application input which the system first predicts risk based upon then stores the input and results into the database.
4. If she wants to fill MHR application then she enters the daily application input which the system first predicts risk based upon then stores the input and results into the database.
5. If she wants to add kick then she enters the kick input which the system stores into the database.
6. If she wants to view library then the system retrieves library for her from the database and displays it.
7. If she wants to view baby development then the system retrieves the specific articles/videos for her from the database and displays it.

Chapter 4: Implementation

➤ Software architecture



- MVVM architecture (Model-View-ViewModel) is the software design pattern that separates the graphical user interface from the business logic of an application.

MODEL

- The model represents the data model (Room Database). It communicates with the ViewModel and lacks awareness of the View.

VIEW

- The View represents the user interface of the application (Fragments, Activities). It communicates with the ViewModel through data binding and is unaware of the Model.

VIEWMODEL

- The ViewModel is the link between the View and the Model.

➤ Workflow

❖ The data

Maternal Health Risk Data

Age: (Age in years when a woman is pregnant).

- If you're 17 years old or younger or 35 years old or older, your pregnancy could generally be considered "high-risk." Women tend to have a window of time when it's easier on their body to grow a baby and give birth. While it's possible to have a perfectly healthy pregnancy outside this window of time, teenage pregnancy and advanced maternal age pregnancy tend to have more complications.
- If you're 35 years old or older and pregnant, you're considered to be of advanced maternal age, or AMA. This can put your pregnancy in the high-risk category for a number of reasons, including an increased risk of complications for you and your baby. The chance that these complications can occur with future pregnancies only increases with the age.
- Conditions related to advanced maternal age are usually caused by an abnormal number of chromosomes, or aneuploidy. This causes conditions such as Down syndrome, trisomy 18 and trisomy 13.

- AMA can also influence the likelihood of premature delivery. Premature babies are born before their organs have finished growing and can experience a higher chance of lung, intestinal and development issues like:
 - Pulmonary hypoplasia
 - Bronchopulmonary dysplasia
 - Retinopathy of prematurity
 - Necrotizing enterocolitis
 - Infections (group B strep and E. coli)
 - Failure to thrive
 - Apnea and bradycardia
 - Central nervous system complications of bleeding or poor perfusion
- Advanced maternal age also increases the mother's risk of complications, such as:
 - Hypertension (high blood pressure)
 - Preeclampsia
 - Gestational diabetes
 - Placenta previa and placenta accrete
 - Eclampsia
 - Stroke
 - Myocardial infarction (heart attack)
 - Liver disorders
 - End-organ damage

Systolic BP: (Upper value of Blood Pressure in mmHg, another significant attribute during pregnancy).

Why is high blood pressure a problem during pregnancy?

High blood pressure during pregnancy poses the following risks:

- Less blood flow to the placenta. If the placenta doesn't get enough blood, the fetus might receive less oxygen and fewer nutrients. This can lead to slow growth (intrauterine growth restriction), low birth weight, or premature birth. Babies born early can have breathing problems, increased risk of infection, and other complications.
- Placental abruption. In this condition, the placenta separates from the inner wall of the uterus before delivery. Preeclampsia and high blood pressure increase the risk of placental abruption. Severe abruption can cause heavy bleeding, which can be life-threatening for you and your baby.
- Intrauterine growth restriction. High blood pressure might result in slowed or decreased fetal growth.
- Injury to other organs. Poorly controlled high blood pressure can result in injury to the brain, eyes, heart, lungs, kidneys, liver, and other major organs. In severe cases, it can be life-threatening.
- Premature delivery. Sometimes an early delivery is needed to prevent life-threatening complications from high blood pressure during pregnancy.
- Future cardiovascular disease. Having preeclampsia might increase the risk of future heart and blood vessel (cardiovascular) disease. The risk of future cardiovascular disease is higher if you've had preeclampsia more than once. It's also higher if you've had a premature birth due to having high blood pressure during pregnancy.

How will I know if I develop high blood pressure during pregnancy?

Monitoring your blood pressure is an important part of prenatal care. If you have chronic hypertension, your health care provider will consider these categories for blood pressure measurements:

- Elevated blood pressure. Elevated blood pressure is a systolic pressure ranging from 120 to 129 millimeters of mercury (mm Hg) and a diastolic pressure below 80 mm Hg. Elevated blood pressure tends to get worse over time unless steps are taken to control it.
- **Stage 1 hypertension.** Stage 1 hypertension is a systolic pressure ranging from 130 to 139 mm Hg or a diastolic pressure ranging from 80 to 89 mm Hg.
- **Stage 2 hypertension.** This stage is more severe. It's a systolic pressure of 140 mm Hg or higher or a diastolic pressure of 90 mm Hg or higher.
- After 20 weeks of pregnancy, blood pressure that's higher than 140/90 mm Hg without any other organ damage is considered to be gestational hypertension. Blood pressure needs to be taken and documented on two or more occasions, at least four hours apart.

Diastolic BP: (Lower value of Blood Pressure in mmHg, another significant attribute during pregnancy).

- Most women experience low blood pressure during pregnancy and this spans out in the first 24 weeks of the gestation period. Low blood pressure occurs as a result of more blood being rerouted to the fetus.
- It also occurs as the blood vessels expand in this stage to accommodate more blood.
- Sometimes, low blood pressure occurs because of sitting or lying down for too long or because of spending prolonged periods in hot water tubs.
- During their pregnancy, women are advised to regularly consult a doctor and take all the recommended tests to ensure that no condition is left unattended that could cause damage to the mother or the fetus.
- Other factors that could cause low blood pressure during pregnancy are:
 - Allergic reactions
 - Neurological factors
 - Shortness of breath
 - Nausea
 - Fatigue
 - Dehydration
 - Lack of oxygen to the blood
 - Ruptured arteries
 - Problems with the heart
 - Blood clots
 - And other Endocrine gland related issues.

What effects could low pressure have in pregnancy?

- The effects of low pressure on pregnancies are more indirect than direct. Often, due to fatigue and shortness of breath, the pregnant mother could faint and fall causing internal bleeding and injury to the baby leading to irreparable damage to the fetus.
- Low blood pressure could reduce the rate at which the fetus receives a continuous supply of blood. Low blood pressure in pregnant women could cause brain damage to the fetus and could also result in stillbirth in a few cases.

BS: Blood glucose levels are in terms of a molar concentration, mmol/L.

Birth Defects

- The organs of the baby form during the first two months of pregnancy, often before a woman knows that she is pregnant. Blood sugar that is not in control can affect those organs while they are being formed and cause serious birth defects in the developing baby, such as those of the brain, spine, and heart.

An Extra Large Baby

- Diabetes that is not well controlled causes the baby's blood sugar to be high. The baby is "overfed" and grows extra large. Besides causing discomfort to the woman during the last few months of pregnancy, an extra large baby can lead to problems during delivery for both the mother and the baby.
- The mother might need a C-Section to deliver the baby. The baby can be born with nerve damage due to pressure on the shoulder during delivery.

C- Section (Cesarean Section)

- A C-section is a surgery to deliver the baby through the mother's belly. A woman who has diabetes that is not well controlled has a higher chance of needing a C-section to deliver the baby.
- When the baby is delivered by a C-section, it takes longer for the woman to recover from childbirth.

High Blood Pressure (Preeclampsia)

- When a pregnant woman has high blood pressure, protein in her urine, and often swelling in fingers and toes that don't go away, she might have preeclampsia. It is a serious problem that needs to be watched closely and managed by her doctor.
- High blood pressure can cause harm to both the woman and her unborn baby. It might lead to the baby being born early and also could cause seizures or a stroke (a blood clot or a bleed in the brain that can lead to brain damage) in the woman during labor and delivery. Women with type 1 or type 2 diabetes have high blood pressure more often than women without diabetes.

Early (Preterm) Birth

Being born too early can result in problems for the baby, such as breathing problems, heart problems, bleeding into the brain, intestinal problems, and vision problems. Women with type 1 or type 2 diabetes are more likely to deliver early than women without diabetes.

Low Blood Sugar (Hypoglycemia)

- People with diabetes who take insulin or other diabetes medications can develop blood sugar that is too low. Low blood sugar can be very serious, and even fatal, if not treated quickly. Seriously low blood sugar can be avoided if women watch their blood sugar closely and treat low blood sugar early.
- If a woman's diabetes was not well controlled during pregnancy, her baby can very quickly develop low blood sugar after birth. The baby's blood sugar must be watched for several hours after delivery.

Heart Rate: A normal resting heart rate in beats per minute.

- During pregnancy, the woman's heart must work harder because as the fetus grows, the heart must pump more blood to the uterus. By the end of pregnancy, the uterus is receiving one fifth of the woman's prepregnancy blood supply. During pregnancy, the amount of blood pumped by the heart (cardiac output) increases by 30 to 50%.
- As cardiac output increases, the heart rate at rest speeds up from a normal prepregnancy rate of about 70 beats per minute to as high as 90 beats per minute. During exercise, cardiac output and heart rate increase more when a woman is pregnant than when she is not.
- At about 30 weeks of pregnancy, cardiac output decreases slightly. Then during labor, it increases by an additional 30%. After delivery, cardiac output decreases rapidly at first, then more slowly. It returns to the prepregnancy level about 6 weeks after delivery.

- During pregnancy, the amount of blood in your body increases significantly. Your heart works harder to pump the extra blood throughout your body and to the fetus. This extra work can result in heart palpitations.
- Although they can be alarming, most pregnancy heart palpitations aren't dangerous. They usually go away after delivery. Less commonly, heart palpitations can be a sign of a serious health problem, such as arrhythmia (abnormal heart rhythm).
- If you have palpitations along with chest pain, trouble breathing, dizziness or confusion, get immediate medical help.

When should I see my healthcare provider about heart palpitations during pregnancy?

- Tell your provider about your symptoms. Although it's rare for heart palpitations during pregnancy to be dangerous, you should talk to your provider so they can monitor your health.
- Get help right away if you have heart palpitations and:
 - Chest pain or discomfort.
 - Difficulty breathing, shortness of breath or other breathing problems.
 - Dizziness or confusion.
 - Loss of consciousness or fainting (syncope).
 - Severe swelling (edema) in your limbs, especially your legs, ankles, and feet.
 - Unusual or sudden fatigue.

Risk Level: Predicted Risk Intensity Level during pregnancy considering the previous attribute.

Preeclampsia risk data

Maternal age:

- Overall risk for severe morbidity in the setting of preeclampsia is highest at the extremes of maternal age.
- However, specific pregnancy complications are not distributed evenly across ages, with eclampsia most common among younger women and acute renal and heart failure more common among older women.

Gravidity:

- Is defined as the number of times that a woman has been pregnant.

Parity:

- Is defined as the number of times that she has given birth to a fetus with a gestational age of 24 weeks or more, regardless of whether the child was born alive or was stillborn.

A multiplicity of pregnancy:

- Is defined as the last time the mother gave birth to her, she gave birth to one child or twins.

Tobacco use:

- Is defined as the mother smoking tobacco before, during pregnancy, or not.

Time of tobacco use:

- Is defined as the number of times the mother used tobacco before or during pregnancy, or not

Health Effects of Smoking and Secondhand Smoke on Pregnancies

- Women who smoke have more difficulty becoming pregnant and have a higher risk of never becoming pregnant.
- Smoking during pregnancy can cause tissue damage in the unborn baby, particularly in the lung and brain, and some studies suggest a link between maternal smoking and cleft lip.
- Studies also suggest a relationship between tobacco and miscarriage. Carbon monoxide in tobacco smoke can keep the developing baby from getting enough oxygen. Tobacco smoke also contains other chemicals that can harm unborn babies.

Health Effects of Smoking and Secondhand Smoke on Babies

- Mothers who smoke are more likely to deliver their babies early. Preterm delivery is a leading cause of death, disability, and disease among newborns.
- One in every five babies born to mothers who smoke during pregnancy has a low birth weight. Mothers who are exposed to secondhand smoke while pregnant are more likely to have lower birth weight babies. Babies born too small or too early are not as healthy.
- Smoking doubles your risk of abnormal bleeding during pregnancy and delivery. This can put both you and your baby in danger.

Alcohol use:

- Is defined as if the mother used alcohol before or during pregnancy, or if she did not use alcohol at all

Time of alcohol use:

- Is defined as the number of times the mother used alcohol before or during pregnancy, or not.

How does alcohol affect my unborn baby?

- When you drink, alcohol passes from your blood through the placenta to your baby.
- A baby's liver is one of the last organs to develop and does not mature until the later stages of pregnancy.
- Your baby cannot process alcohol well, and exposure to alcohol can seriously affect their development.
- Drinking alcohol during pregnancy increases the risk of miscarriage, premature birth, and your baby having a low birth weight. It can also affect your baby after they're born.
- Drinking during pregnancy can cause your baby to develop a serious condition called foetal alcohol spectrum disorder (FASD).
- FASD can cause problems with:
 - learning and behavior
 - joints, bones, muscles and some organs
 - managing emotions and developing social skills
 - hyperactivity and impulse control
 - communication, such as problems with speech

Diabetes personal history:

- Is defined as if the mother was diabetic, or had some symptoms of diabetes before pregnancy Diabetes.

Family history:

- If you have a mother, father, sister, or brother with diabetes, you are more likely to get diabetes yourself. You are also more likely to have prediabetes. Talk to your doctor about your family health history of diabetes. Your doctor can help you take steps to prevent or delay diabetes and reverse prediabetes if you have it.
- A detailed history must be taken of previous pregnancies, weight changes, and family history of diabetes mellitus. GDM is usually asymptomatic but classic symptoms of diabetes mellitus may be present.
- A detailed history must be taken. Specific areas of focus when obtaining a history include:
 - Recent weight change
 - Previous history of impaired glucose test
 - Obstetric history
 - Family history of diabetes mellitus

Gestational diabetes and preeclampsia have numerous similarities. Both of them:

- Are dangerous health conditions that develop in the second half of the pregnancy
- Require close monitoring and treatment
- Usually, go away after a woman gives birth
- Carry risks of developing related conditions in the future (diabetes and hypertension accordingly)
- Have similar risk factors
- Have many similar symptoms

These two conditions are closely related to each other. Gestational diabetes increases the risk of preeclampsia since high glucose levels can cause high blood pressure.

Gestational diabetes may cause preeclampsia

- When blood with high glucose content makes its way through your body, it can cause serious damage to the blood vessels and kidneys.
- Both of these organs play a significant role in regulating your blood pressure. When damage occurs, the BP rises, and you can develop hypertension.

Hypertension personal history:

- Defined as If the mother suffers from high blood pressure or some symptoms of high or low blood pressure before pregnancy or not

Hypertension family history: (Genetics and Family History)

- When members of a family pass traits from one generation to another through genes, that process is called heredity.
- Genes likely play some role in high blood pressure, heart disease, and other related conditions. However, it is also likely that people with a family history of high blood pressure share common environments and other potential factors that increase their risk.
- The risk for high blood pressure can increase even more when heredity combines with unhealthy lifestyle choices, such as smoking and eating an unhealthy diet.

Traditional treatment use:

- Whether the mother was taking a certain medication before or during pregnancy, or not taking any medications

Specific treatment if using traditional:

- The name of the medicine which the mother is taking

Purpose of use traditional treatment:

- The purpose of this medicine or what is the reason for this medicine such as:
 - Appetite
 - Iron supplement
 - Back pain
 - Chest/heartburn

Case type:

- It is defined as the type of condition if it is diagnosed as pre-eclampsia or if it is in a healthy condition.

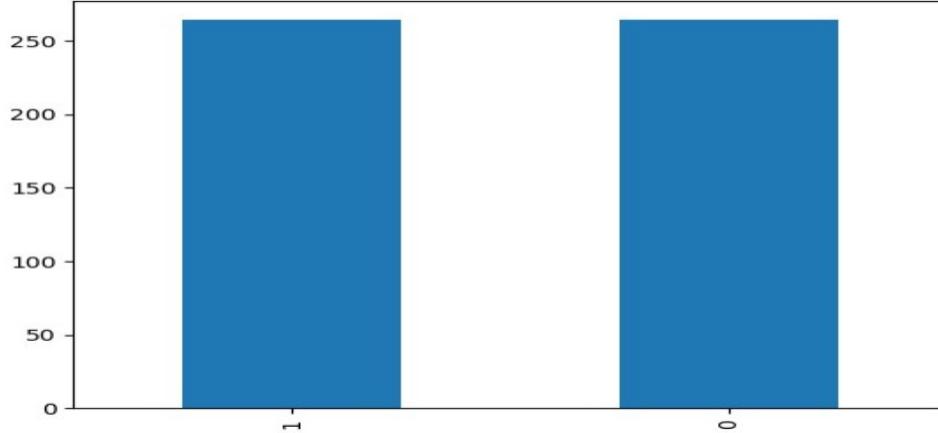
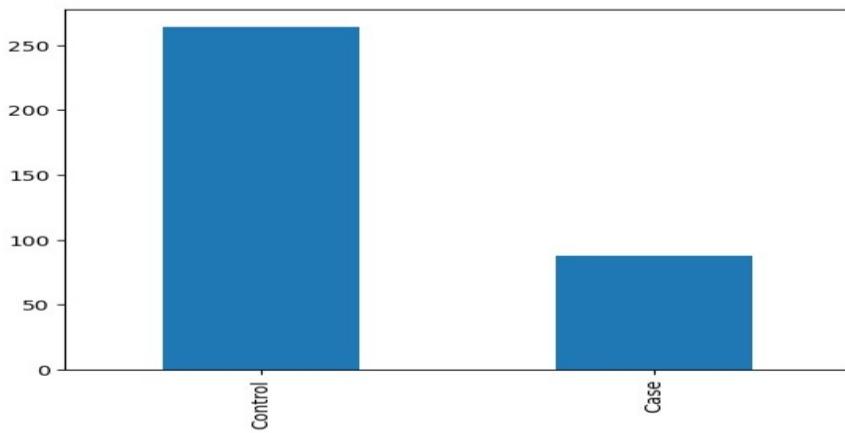
Case control:

- It is defined as that the condition has been controlled or I actually have preeclampsia.

❖ *preprocessing and data cleaning*

- Handling Categorical Variables: Converting categorical variables into a numerical representation that can be processed by algorithms like case control , tobacco use, alcohol use
- Handling Imbalanced Data: Addressing imbalance between case and control number by oversampling

In [102]: <Axes: >



Handling missing values:

- Identifying and dealing with missing values, which involves imputing missing values based on the KNN technique.

Removing duplicate columns:

- Identifying duplicate columns by comparison and then removing one of them that is not in a better form to avoid redundant information

Feature selection (dimensionality reduction):

- Is done by removing columns with weak correlation (calculated for both categories and numerical data with tetra-choric and correlation) with the output after considering Context and domain knowledge
- It is done by removing columns with weak correlation (calculated for both categorical and numerical data with different types of methods like Spearman correlation and tetra-choric correlation) with the output after considering context and domain knowledge
- Tetra-choric correlation how it works: Tetra-choric correlation is a statistical measure used to assess the relationship between two dichotomous (binary) variables. It is an extension of the Pearson correlation coefficient, which is used for continuous variables
- Suppose we have the following 2×2 table with two variables, x and y, that both take on two values:
- The formula to calculate the tetra-choric correlation between the two variables in this table is: $\text{Tetra-choric correlation} = \text{COS}(\pi/(1+\sqrt{(ad/bc)}))$

Spearman how it works:

Step 1: Rank the data

- For each variable, rank the data from lowest to highest, assigning ranks based on their relative positions. If there are ties (i.e., multiple data points with the same value), assign them the average rank.

Step 2: Calculate the differences in ranks

- Calculate the difference in ranks for each paired observation. These differences represent the deviations in the ranks of the two variables.

Step 3: Calculate the squared differences in ranks

- Square each of the differences in ranks calculated in Step 2.

Step 4: Calculate Spearman's rho

- Compute the sum of the squared differences in ranks from Step 3. Then, apply the following formula:

Where d^2 difference in ranks and n number of paired observation

- That related more to after delivery like mode of delivery and removing columns that contain personal information that will not help like study hospital, country of residence

Finally

```
df_preeclampsia.shape
```

```
(352, 88)
```

- Data move from here to here

```
: clean_preeclampsia.shape
```

```
: (528, 18)
```

❖ ALGORITHMS

- Machine learning is a data analytics technique that teaches computers to do what comes naturally to humans and animals: learn from experience.
- Machine learning algorithms use computational methods to directly "learn" from data without relying on a predetermined equation as a model.
- As the number of samples available for learning increases, the algorithm adapts to improve performance.
- ML is one of the most exciting technologies that one would have ever come across. As it is evident from the name, it gives the computer that makes it more similar to humans: The ability to learn.

Features of Machine learning

- Machine learning is data driven technology. Large amount of data generated by organizations on daily bases. So, by notable relationships in data and organizations makes better decisions.
- Machine can learn itself from past data and automatically improve.
- From the given dataset it detects various patterns on data.
- For the big organizations branding is important and it will become more easy to target relatable customer base.
- It is similar to data mining because it is also deals with the huge amount of data.

There are four main categories of Machine Learning algorithms: supervised, unsupervised, semi-supervised, and reinforcement learning.

1. Supervised Learning:

- Is applicable when a machine has sample data supervised learning technique helps us to predict future events with the help of past experience and labeled examples.
- It analyses the known training dataset, and later it introduces an inferred function that makes predictions about output values. Further, it also predicts errors during this entire learning process and also corrects those errors through algorithms.

2. Unsupervised Learning:

- Machine is trained with some input samples or labels only, while output is not known the training information is neither classified nor labeled.
- It helps in exploring the data and can draw inferences from datasets to describe hidden structures from unlabeled data

3. Reinforcement Learning:

- Is a feedback-based machine learning technique, in this type of learning, agents (computer programs) need to explore the environment, perform actions, and on the basis of their actions, they get rewards as feedback.
- For each good action, they get a positive reward, and for each bad action,
- The goal of a Reinforcement learning agent is to maximize the positive rewards. Since there is no labeled data, the agent is bound to learn by its experience only.

4. Semi-supervised Learning:

- Is an intermediate technique of both supervised and unsupervised learning. It performs actions on datasets having few labels as well as unlabeled data.
- However, it generally contains unlabeled data, it also reduces the cost of the machine learning model as labels are costly, it may have few labels. Further, it also increases the accuracy and performance of the machine learning model.

The Two most common category of supervised learning are classification and regression:

1. Classification:

- Inputs are divided into two or more classes, and the learner must produce a model that assigns unseen inputs to one or more (multi-label classification) of these classes and predicts whether or not something belongs to a particular class. This is typically tackled in a supervised way.
- Classification models can be categorized in two groups: Binary classification and Multiclass Classification. Spam filtering is an example of binary classification, where the inputs are email (or other) messages and the classes are “spam” and “not spam”.

2. Regression:

- It is also a supervised learning problem, that predicts a numeric value and outputs are continuous rather than discrete. For example, predicting stock prices using historical data.

The Two most common category of Unsupervised learning are Clustering , Density estimation and Dimensionality reduction:

1. Clustering:

- Here, a set of inputs is to be divided into groups. Unlike in classification, the groups are not known beforehand, making this typically an unsupervised task.
- As you can see in the example below, the given dataset points have been divided into groups identifiable by the colors red, green, and blue.

2. Density estimation:

- The task is to find the distribution of inputs in some space.

3. Dimensionality reduction:

- It simplifies inputs by mapping them into a lower-dimensional space.
- Topic modeling is a related problem, where a program is given a list of human language documents and is tasked to find out which documents cover similar topics.

➤ Model Training

- Our project depends on “classifying things” into sub-categories.<<*Classification*>>
- Classification is a machine learning task that involves assigning a class label to a given input based on a set of training data. The goal of classification is to build a model that can accurately predict the class label for new, unseen data.
- Classification is of **4 types:**

1. Binary Classification:

- When we have to categorize given data into 2 distinct classes

2. Multiclass Classification:

- The number of classes is more than 2.

3. Multi-label classification:

- The training set is composed of instances each associated with a set of labels, and the task is to predict the label sets of unseen instances through analyzing training instances with known label sets.

4. Imbalanced Classification:

- Refers to classification tasks where the number of examples in each class is unequally distributed.

- So because we are using Preeclampsia data into 2 classes[‘Preeclampsia’ , ‘healthy’] and risk data into 3 classes [‘High risk’ , ‘Mid risk’ , ‘Low risk’] , we are using binary classification for preeclampsia and multi-label Classification for risk.
- **Learning from multi-label data** can be achieved through different approaches, such as data transformation, adaptation of traditional classification methods, and use of ensembles of classifiers
- In this work, we focus on the data transformation and method adaptation approach.
- The data transformation method is based on transformation techniques that transform the original multi label data into one or more binary or multiclass datasets.
- On the other hand, the adaptation method consists of adapting existing classification algorithms, so that they can process multi-label data and produce several outputs instead of one.
- Achieved through assuming that each sample is assigned to more than one label a patient can be high risk for diseases or mid risk or low risk but not all at the same time.
- Some models that can be **adapted to multilabel classification** are **Decision Tree Classifier**, **Extra Tree Classifier**, **Random Forest Classifier**, **K-Nearest Neighbors Classifier**, **Gradient Boosting Classifier** , and **Xgboost Classifier**.

➤ **Decision tree:**

- Is a non-parametric supervised learning algorithm which can be used to solve classification task.
- It has a tree structure consisting of a root node, branches, internal nodes, and leaf nodes.
- It employs a divide-and-conquer strategy, which is a recursive partitioning of the problem into two or more sub-problems until it becomes simple enough to be solved directly.
- Thus, the decision tree classifier splits the data in a top-down, recursive manner until all, or the majority of records have been classified under the specific class labels.

➤ **The Extra Tree:**

- Classifier is a variation of a Decision Tree Classifier. It consists of an extremely randomized tree classifier.
- It strongly randomizes both the attribute and the cut-point choice while splitting a tree node.

➤ **Random Forest Classifier:**

- Is also a tree-based method that consists of a large number of individual decision trees that operate as an ensemble.
- It is an extension of the bagging method as it utilizes both bagging and feature randomness to create an uncorrelated forest of decision trees.
- In the bagging method, a random sample of data is selected from a training set for replacement.
- Then, several data samples are generated and they are used to train the models independently. The feature randomness (also known as the random subspace method) generated a random subset of features, which ensures the low correlation between the different decision trees generated.
- This is an important difference between decision trees and random forests: while decision trees consider all the possible feature splits, random forests only select a subset of those features.

➤ **K-Nearest Neighbors (KNN)**

- Classifier is an instance-based learning algorithm. It is a lazy learning algorithm, as it delays the induction or generalization process until classification is performed.
- KNN algorithm assumes that instances within a dataset will generally exist in close proximity to other instances that have similar properties.
- KNN works by finding the distances between an unclassifier instance and all the instances in the data, selecting the specified number of examples (K) closest to it, and then determining its label by identifying the most frequent label of its neighbors.

➤ **The Gradient Boosting Classifier**

- Are a group of machine learning algorithms that combine many weak learning models together to create a strong predictive model.
- The Gradient Boosting Classifier depends on a loss function.
- A custom loss function can be used, and many standardized loss functions are supported by gradient boosting classifiers, but the loss function has to be differentiable. [Classification algorithms frequently use logarithmic loss]

➤ **The XG-Boost Classifier**

- Is a refined and customized version of a gradient boosting decision tree system, created with performance and speed in mind.
 - XG-Boost actually stands for "eXtreme Gradient Boosting", and it refers to the fact that the algorithms and methods have been customized to push the limit of what is possible for gradient boosting algorithms.
 - It designed to be highly efficient, flexible and portable. XGBoost provides a parallel tree boosting (also known as GBDT, GBM) that solve many data science problems in a fast and accurate way.
- Also **Learning from Binary data** can be less effective, especially in predicting minority class examples. **achieved through** assuming that each sample is assigned to one and only one label a patient can be either a case or control but not both at the same time. Or being a risky patient or healthy one .Some models that can be adapted to binary classification are **naïve bias Classifier**, **Logistic regression** and **Svm Classifier**.

➤ **The naïve bias Classifier**

- It works on Bayes' theorem(theorem is based on the probability of a hypothesis) with an independence assumption among predictors.
- Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature.
- It belongs to the family of generative learning algorithms, which means that it models the distribution of inputs for a given class or category. We use a multi class NB prediction feature to predict the probability of multiple classes of target variable.
- There are three types of NB models:

1. Gaussian Naive Bayes:

gaussian nb is used in classification tasks and it assumes that feature values follow a gaussian distribution.it supports continuous values and has an assumption that each class is normally distributed.

2. Multinomial Naive Bayes:

It is used for discrete counts.it is an event-based model that has features as vectors where sample(feature) represents frequencies with which certain events have occurred.

3. Bernoulli Naive Bayes:

The binomial model is useful if your feature vectors are boolean (i.e. zeros and ones). And it is an event-based where features are independent Boolean.

➤ **Logistic regression**

- We may have continuous or categorical independent variables, we can use the logistic regression modeling technique to predict the outcome when the outcome variable is binary.
- Is a statistical model (also known as logit model) is often used for classification and predictive analytics.
- Logistic regression estimates the probability of an event occurring, such as voted or didn't vote, based on a given dataset of independent variables.

➤ **Kernel Support Vector Machine Classifier:**

- The algorithm tries to find the optimal hyperplane which can be used to classify new data points. The SVM finds the most similar examples between classes. Those will be the support vectors. **Kernel SVM [Radial Basis Function (RBF)]** : it has localized and finite response along the entire x-axis.]
- The kernel functions return the inner product between two points in a suitable feature space. Thus by defining a notion of similarity, with little computational cost even in very high-dimensional spaces.

➤ **The Voting Classifier**

- Is a machine-learning algorithm used by Keglers to boost the performance of their model and climb up the rank ladder.
- Voting Classifier can also be used for real-world datasets to improve performance ,In hard voting (also known as majority voting), every individual classifier votes for a class, and the majority wins.
- In statistical terms, the predicted target label of the ensemble is the mode of the distribution of individually predicted labels.

- We used as an estimator the Decision Tree Classifier, Extra Tree Classifier, Random Forest Classifier, K-Nearest Neighbors Classifier, Gradient Boosting Classifier , Xgboost Classifier, naïve bias Classifier, Logistic regression and Svm Classifier. We tested this method to evaluate the performance of models. A training set was used to train all these models.

➤ Model Validation

Evaluation of multi label classifiers for Risk data:

After training the models, we use the test set to evaluate their performance. Model selection was evaluated by the **accuracy** [1] (fraction of instances that the model classified correctly), **precision**[2] (proportion of positive identifications that were actually positive), **recall**[3] (proportion of the positive class that was correctly classified), **F1 score**[4] (harmonic mean of precision and recall), **Hamming loss** (proportion of misclassifications), **fbeta_score** (the weighted harmonic mean of precision and recall), **Jaccard score** (the size of the intersection divided by the size of the union of two label sets), **Zero-one loss**. (return the fraction and number of misclassifications),and **matthews_corrcoef** [5](measure of the quality of multiclass classifications.)

$$➤ \text{Accuracy} = \frac{TN+TP}{TN+FP+FN+TP}$$

$$➤ \text{Precision} = \frac{TP}{TP+FP}$$

$$➤ \text{Recall} = \frac{TP}{TP+FN}$$

$$➤ \text{F1 score} = 2 \times \frac{\text{Precision} \times \text{Sensitivity}}{\text{Precision} + \text{Sensitivity}}$$

$$➤ \text{MCC} = \frac{(TP \times TN - FP \times FN)}{\sqrt{(TP+FP)(TP+FN)(TN+FP)(TN+FN)}}$$

Evaluation of binary classifiers for Preeclampsia data:

- If the model successfully predicts the patients as positive (preeclampsia) this case is called True Positive (TP).
- If the model successfully predicts patients as negative (healthy), this is called True Negative (TN). The binary classifier may misdiagnose some patients as well.
- If a diseased patient is classified as healthy by a negative test result, this error is called False Negative (FN).
- Similarly, if a healthy patient is classified as diseased by a positive test result, this error is called False Positive (FP).

We can evaluate a binary classifier based on the following parameters:

True Positive (TP):

- The patient is diseased and the model predicts "Preeclampsia"

False Positive (FP):

- The patient is healthy but the model predicts "Preeclampsia"

True Negative (TN):

- The patient is healthy and the model predicts "healthy"

False Negative (FN):

- The patient is diseased and the model predicts "healthy"

- Prediction was performed at 40 weeks of pregnancy.

The prediction **accuracy** of the model in terms of true positive rate (TPR), false-positive rate (FPR), were estimated by the **AUC-ROC** (measure the quality of a classification model), **accuracy[1]** (fraction of instances that the model classified correctly), **precision [3]** (proportion of positive identifications that were actually positive), **F1 score [5]**(harmonic mean of precision and sensitivity), **recall or Sensitivity [4]** (proportion of the positive class that was correctly classified), , **specificity [2]**(proportion of actual negative cases that are correctly identified), and **matthews_corrcoef [6]**(measure of the quality of binary classifications.)

$$\text{➤ Accuracy} = \frac{TN+TP}{TN+FP+FN+TP}$$

$$\text{➤ Specificity} = \frac{TN}{TN+FP}$$

$$\text{➤ Precision} = \frac{TP}{TP+FP}$$

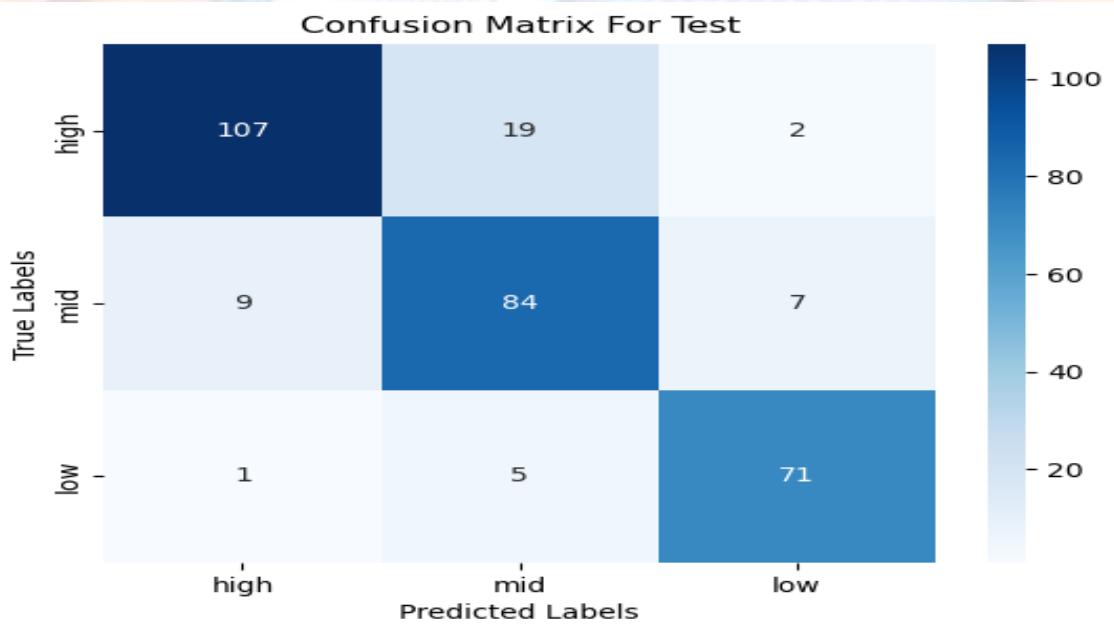
$$\text{➤ Recall or Sensitivity} = \frac{TP}{TP+FN}$$

$$\text{➤ F1 score} = 2 \times \frac{\text{Precision} \times \text{Sensitivity}}{\text{Precision} + \text{Sensitivity}}$$

$$MCC = \frac{(TP \times TN - FP \times FN)}{\sqrt{(TP+FP)(TP+FN)(TN+FP)(TN+FN)}}$$

► Results

- The voting classifier model was found to achieve the best performance metrics of all models, it takes the highest accuracy of the models and uses the majority from the 3 models [Extratree, X G BOOST, Random Forest, and Voting as determined by the accuracy value.
- The higher the accuracy, the better the Risk model is in discerning if patients are at high or mid, or low risk. risk model achieved 86.55737704918033% accuracy, 0.87 in precision, 0.87 in the recall, 0.87 in F1 score, and 13.442622950819672 %in Hamming loss.
- These metrics were better than the baseline model metrics. We decoded the output of the model and calculated the confusion matrix to see how good the prediction of the classes was.



Confusion matrix for the voting classifier model. The multi-label output was decoded to see the prediction performance for each class for risk data.

model	Accuracy	Train accuracy	Precision	Recall	F1 Score	fbeta_score	Jaccard score	hamming loss	zero_one_loss	matthews_corrcoef
Random Forest	84.590163934 42623 %	92.6657263751763 %	high risk 0.88 low risk 0.91 mid risk 0.76 macro avg 0.85 weighted avg 0.85	high risk 0.92 low risk 0.80 mid risk 0.84 macro avg 0.86 weighted avg 0.85	high risk 0.90 low risk 0.85 mid risk 0.80 macro avg 0.85 weighted avg 0.85	high risk 0.8852867 low risk 0.77205882 mid risk 0.887931 0.03	high risk 0.81609195 low risk 0.74637681 mid risk 0.66141732	15.40983606 557377 % 5573767 %	15.40983606 5573767 %	76.81419547220418 %
Extra Tree	86.557377049 18033%	92.6657263751763 %	high risk 0.90 low risk 0.89 mid risk 0.81 macro avg 0.87 weighted a vg 0.87	high risk 0.91 low risk 0.86 mid risk 0.84 macro avg 0.87 weighted a vg 0.87	high risk 0.90 low risk 0.88 mid risk 0.82 macro avg 0.87 weighted a vg 0.87	high risk 0.89974293 low risk 0.88709677 mid risk 0.81395349	high risk 0.82352941 low risk 0.78014184 mid risk 0.7	13.44262295 0819672 % 0819672 %	13.44262295 0819672 %	79.48554193319724 %
Decision Tree	83.606557377 04919 %	92.2426952045134 %	high risk 0.85 low risk 0.91 mid risk 0.75	high risk 0.94 low risk 0.79 mid risk 0.82	high risk 0.89 low risk 0.85 mid risk 0.78	high risk 0.86330935 low risk 0.76492537 mid risk 0.88286713	high risk 0.8 low risk 0.64566929 mid risk 0.73188406	16.39344262 295082 % 2950815 %	16.39344262 2950815 %	75.42017847878743 %
XG boost	83.934426229 50819 %	92.6657263751763 %	high risk 0.87 low risk 0.91 mid risk 0.75 macro avg 0.84 weighted a vg 0.85	high risk 0.94 low risk 0.80 mid risk 0.82 macro avg 0.85 weighted a vg 0.84	high risk 0.90 low risk 0.85 mid risk 0.78 macro avg 0.84 weighted a vg 0.84	high risk 0.8801956 low risk 0.88541667 mid risk 0.75925926	high risk 0.81818182 low risk 0.73913043 mid risk 0.640625	16.06557377 0491802 % 0491802 %	16.06557377 0491802 %	75.86321926233629 %
Logistic Regression	63.278688524 590166 %	60.9308885754584 %	high risk 0.82 low risk 0.56 mid risk 0.67	high risk 0.70 low risk 0.91 mid risk 0.30	high risk 0.75 low risk 0.69 mid risk 0.42	high risk 0.78869048 low risk 0.53797468 mid risk 0.60710195	high risk 0.60227273 low risk 0.26356589 mid risk 0.53	36.72131147 5409834 % 5409834 %	36.72131147 5409834 %	47.02919781756339 %
KNN	77.049180327 86885 %	90.2679830747531 8%	high risk 0.86 low risk 0.81 mid risk 0.67	high risk 0.83 low risk 0.73 mid risk 0.77	high risk 0.85 low risk 0.77 mid risk 0.72	high risk 0.85790885 low risk 0.6875 mid risk 0.79391892	high risk 0.73563218 low risk 0.55797101 mid risk 0.62666667	22.95081967 2131146 % 213115 %	22.95081967 213115 %	65.19005201817563 %
SVM	81.967213114 7541 %	92.3836389280677 %	high risk 0.86 low risk 0.82 mid risk 0.79	high risk 0.86 low risk 0.80 mid risk 0.81	high risk 0.86 low risk 0.81 mid risk 0.80	high risk 0.86 low risk 0.82 mid risk 0.79	high risk 0.75 low risk 0.68666667 mid risk 0.66393443	18.03278688 52459 % 5245898 %	18.03278688 5245898 %	72.41849985472003 %

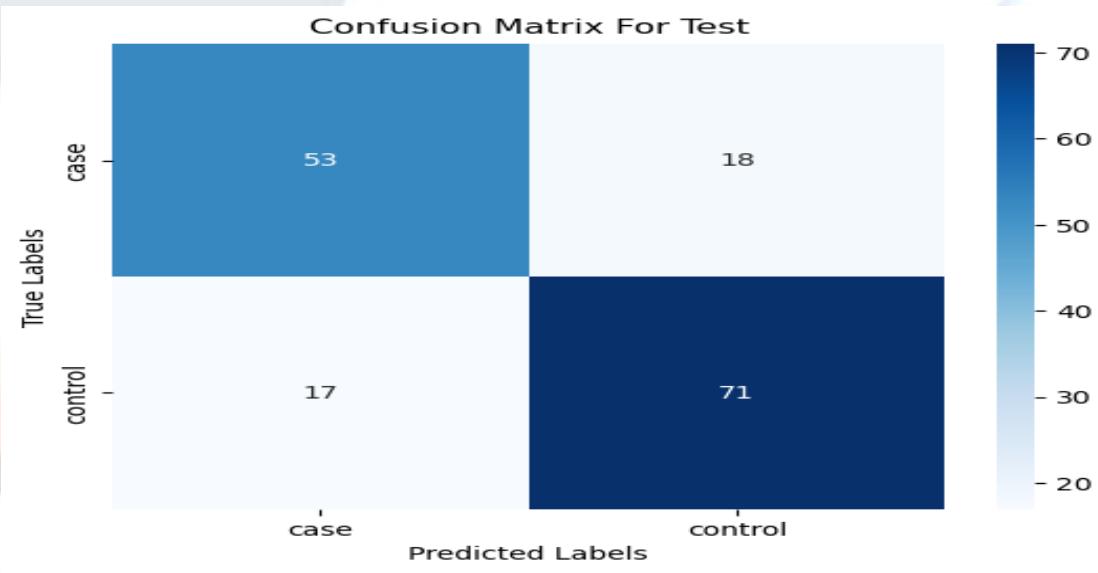
Naïve Bias (Bernoulli)	BernoulliNB: 41.96721311475 41%	BernoulliNB: 39.21015514809591%	high risk 0.00 low risk 0.42 mid risk 0.00	high risk 0.00 low risk 1.00 mid risk 0.00	high risk 0.00 low risk 0.47477745 mid risk 0.00	high risk 0.00 low risk 0.41967213 mid risk 0.00	high risk 0.00 low risk 0.41967213 mid risk 0.00	56.03278688 5245905 %	56.03278688 5245905 %	0.0%
(Gaussian)	GaussianNB: 59.01639344262 295%	GaussianNB: 63.61071932299013%	high risk 0.81 low risk 0.58 mid risk 0.36	high risk 0.66 low risk 0.86 mid risk 0.19	high risk 0.73 low risk 0.69 mid risk 0.25	high risk 0.77507599 low risk 0.62217195 mid risk 0.30448718	high risk 0.57303371 low risk 0.53140097 mid risk 0.14179104	40.98360655 737705 %	40.98360655 737705 %	37.116328268418016 %
(Multinomial)	MultinomialNB: 49.50819672131 1476%	MultinomialNB: 55.71227080394923%	high risk 0.49 low risk 0.54 mid risk 0.44	high risk 0.49 low risk 0.52 mid risk 0.46	high risk 0.49 low risk 0.53 mid risk 0.45	high risk 0.49350649 low risk 0.54032258 mid risk 0.44230769	high risk 0.32758621 low risk 0.36413043 mid risk 0.28930818	50.49180327 868853 %	50.49180327 868852 %	22.82214281480548 %
Gradiant	78.360655737 70492%	87.3060648801128 3%	high risk 0.84 low risk 0.82 mid risk 0.69	high risk 0.90 low risk 0.80 mid risk 0.68	high risk 0.87 low risk 0.81 mid risk 0.69	high risk 0.85185185 low risk 0.81730769 mid risk 0.68548387	high risk 0.76666667 low risk 0.68 mid risk 0.51908397	21.63934426 2295083 %	21.63934426 229508 %	66.99043522640059 %
Voting	86.55737704918 033%	92.6657263751763%	high risk 0.91 low risk 0.89 mid risk 0.81 macro avg 0.87 weighted avg vg 0.87	high risk 0.91 low risk 0.86 mid risk 0.84 macro avg 0.87 weighted avg vg 0.87	high risk 0.91 low risk 0.87 mid risk 0.82 macro avg 0.87 weighted avg vg 0.87	high risk 0.90909091 low risk 0.88141026 mid risk 0.81395349	high risk 0.83333333 low risk 0.77464789 mid risk 0.7	13.44262295 0819672 %	13.44262295 0819672 %	79.46168302806498 %

Table for Performance metrics for all models evaluated.<<Risk>>

➤ *voting classifier*

- The voting classifier model was found to achieve the best performance metrics of all models, it takes the highest accuracy of 3 models and uses the majority from the 3 models [Kernel SVM,XGBOOST,KNN] , as determined by the accuracy value.
 - The higher the accuracy, the better the preeclampsia model is in discerning between patients with preeclampsia and healthy ones.
 - The model achieved 78.61635220125787% in accuracy, 0.79 in precision, 0.79 in recall, 0.79 in the F1 score, 78.641165173 % in the AUC ROC, and 21.3836477987 % in Hamming loss.

- These metrics were better than the baseline model metrics. We decoded the output of the model and calculated the confusion matrix to see how good the prediction of the classes was.



Confusion matrix for the voting classifier model. The binary output was decoded to see the prediction performance for two classes for preeclampsia data.

model	Accuracy	Train accuracy	roc_auc_score	Precision	Recall	F1Score	specificity	fbeta_score	jaccard_score	hamming_loss	zero_one_loss	matthews_corrcoef
Random Forest	67.924528301 88679%	78.86178861 788617%	67.912575 22964841 %	Preeclampsia 0.69 healthy 0.67	Preeclampsia 0.68 healthy 0.68	Preeclampsia 0.69 healthy 0.67	67.53246 75324675 4 %	Preeclampsia 0.68965517 0.52336449 healthy 0.66838046	Preeclampsia 0.52336449 0.66838046 healthy 0.50485437	32.0754716981 13205 % 8113205 %	32.07547169 8113205 %	35.813808002004 66 %
Extra Tree	67.295597484 27673%	79.13279132 791328%	67.223630 02850808 %	Preeclampsia 0.68 healthy 0.67	Preeclampsia 0.70 healthy 0.65	Preeclampsia 0.69 healthy 0.66	64.93506 49350649 3 %	Preeclampsia 0.68181818 0.52293578 healthy 0.66312997	Preeclampsia 0.52293578 0.49019608	32.7044025157 2327 % 5723274 %	32.70440251 5723274 %	34.485513550 26568 %
Decision Tree	75.471698113 20755 %	88.34688346 883469 %	75.120038 41229193 %	Preeclampsia 0.78 healthy 0.73	Preeclampsia 0.78 healthy 0.72	Preeclampsia 0.78 healthy 0.72	71.83098 59154929 6 %	Preeclampsia 0.7702703 0.63888889 healthy 0.72649573	Preeclampsia 0.7702703 0.63888889 healthy 0.56666667	24.5283018867 92452 % 679245 %	24.52830188 679245 %	50.312602436392 14 %
XG boost	77.358490566 03774%	85.63685636 856369%	77.753831 41762453 %	Preeclampsia 0.72 healthy 0.83 macro avg 0.78 weighted avg 0.78	Preeclampsia 0.82 healthy 0.74 macro avg 0.78 weighted avg 0.77	Preeclampsia 0.77 healthy 0.78 macro avg 0.77 weighted avg 0.77	73.56321 83908046 %	Preeclampsia 0.7375 healthy 0.81012658	Preeclampsia 0.62105263 healthy 0.64	22.6415094339 62266 % 396226 %	22.64150943 396226 %	55.287445896078 125 %
Logistic Regression	66.666666666 66666 %	56.60377358 490566 %	58.618758 00256081 %	Preeclampsia 0.69 healthy 0.51	Preeclampsia 0.40 healthy 0.77	Preeclampsia 0.50 healthy 0.61	77.46478 87323943 7 %	Preeclampsia 0.59931507 0.33653846 healthy 0.54671968	Preeclampsia 0.33653846 healthy 0.44354839	43.3962264150 9434 % 509434 %	43.39622641 509434 %	18.358966402737 213 %
KNN	76.729559748 42768 %	82.92682926 829268 %	76.939655 1724138 %	Preeclampsia 0.72 healthy 0.81 macro avg 0.77 weighted avg 0.77	Preeclampsia 0.79 healthy 0.75 macro avg 0.77 weighted avg 0.77	Preeclampsia 0.75 healthy 0.78 macro avg 0.77 weighted avg 0.77	74.71264 36781609 2 %	Preeclampsia 0.73453608 0.7985258 healthy 0.6372549	Preeclampsia 0.60638298 0.6372549 healthy	23.2704402515 72328 % 157232 %	23.27044025 157232 %	53.640073405074 58 %
SVM	77.358490566 03774%	88.34688346 883469 %	77.296484 00380108 %	Preeclampsia 0.77 healthy 0.77 macro avg 0.77 weighted avg 0.77	Preeclampsia 0.75 healthy 0.81 macro avg 0.77 weighted avg 0.77	Preeclampsia 0.78 healthy 0.76 macro avg 0.77 weighted avg 0.77	75.32467 53246753 3 %	Preeclampsia 0.77751196 0.76923077 healthy 0.61702128	Preeclampsia 0.64356436 0.61702128 healthy	22.6415094339 62266 % 396226 %	22.64150943 396226 %	54.653593198972 786 %

Naive Bias (Bernoulli)	BernoulliNB: 52.83018867924 52%	BernoulliNB: 62.3306233062 3306%	55.209667 0934699 % 56.322023 04737517 % GaussianNB: 53.45911949685 535%	Preeclampsia 0.64 healthy 0.48 Preeclampsia 0.68 healthy 0.49 Preeclampsia 0.65 healthy 0.48	Preeclampsia 0.33 healthy 0.77 Preeclampsia 0.30 healthy 0.83 Preeclampsia 0.30 healthy 0.80	Preeclampsia 0.44 healthy 0.59 Preeclampsia 0.41 healthy 0.61 Preeclampsia 0.41 healthy 0.60	77.46478 87323943 83.09859 15492957 8 % 80.28169 01408450 7 %	Preeclampsia 0.27894615 healthy 0.52182163 Preeclampsia 0.26 healthy 0.53153153 Preeclampsia 0.25419355 healthy 0.52102377	Preeclampsia 0.27894615 healthy 0.42307692 Preeclampsia 0.26 healthy 0.44360902 Preeclampsia 0.25490196 healthy 0.42857143	47.1698113207 5472 % 46.5408805031 44656 % 47.7987421393 6478 %	47.16981132 075472 % 46.54088050 3144656 % 47.79874213 836478 %	11.498780811462 362 % 14.739138417151 94 % 11.258859105099 71 %
Gradient	56.603773584 90566 %	56.63956639 566395 %	57.847640 16471333 %	Preeclampsia 0.88 healthy 0.53	Preeclampsia 0.18 healthy 0.97	Preeclampsia 0.30 healthy 0.68	97.40259 74025974 1 %	Preeclampsia 0.5 healthy 0.58139535	Preeclampsia 0.17857143 healthy 0.52083333	43.3962264150 9434 %	43.39622641 509434 %	25.383571792018 156 %
Voting	78.61635220125 787 %	89.7018970189 7019 %	78.641165 17285532 % macro avg=0.78 weighted avg=0.79	Preeclampsia 0.82 healthy 0.75 macro avg=0.78 weighted avg=0.79	Preeclampsia 0.78 healthy 0.79 macro avg=0.79 weighted avg=0.79	Preeclampsia 0.80 healthy 0.77 macro avg=0.78 weighted avg=0.79	78.87323 94366197 1 %	Preeclampsia 0.81367925 healthy 0.75471698	Preeclampsia 0.66990291 healthy 0.62222222	21.3836477987 4214 %	21.38364779 8742132 %	57.045437237693 754 %

Table of Performance metrics for all models evaluated.<<preeclampsia>>

➤ Summary

- The key differences between these classification matrices lie in the specific aspect of classification performance that they measure.
- Accuracy gives an overall measure of correct predictions, precision focuses on positive predictions, recall emphasizes capturing positive instances, specificity highlights accurately identifying negative instances, F1 Score balances precision and recall, and AUC-ROC evaluates the model's performance across different thresholds, considering both true positive and false positive rates.
- The choice of which matrix to use depends on the specific evaluation needs and the class distribution of the problem at hand.

➤ **Discussion**

- This review assessed the latest ML methods for preeclampsia prediction. Our goal was to define the data types and techniques that were employed in preeclampsia prediction, as well as the methods that delivered meaningful outcomes.
- We constructed an ML model for the early prognosis of preeclampsia and risk factors for diseases.
- After comparison The methods used in the study were[Kernal SVM, KNN , XGBOOST and Voting] in preeclampsia model , [Random Forest , Extra Tree XGBOOST and Voting] in risk model.
- We used voting algorithm to show higher accuracy than the other methods for data types. Voting using the data resulted in 86.55737704918033 %accuracy in risk and 78.61635220125787%in preeclampsia .the prediction for both data were done using supervised classification machine learning

❖ parameters and hyper-parameters

	Definition	Default	Implemented
Voting classifier			
1. estimators:	Invoking the fit method on the VotingClassifier will fit clones of those original estimators	-----	Pre-eclampsia: 1. KNN 2. XGBoost 3. SVM Risk: 1. XGBoost 2. Random Forest 3. Extra Tree
2. weights:	Sequence of weights (float or int) to weight the occurrences of predicted class labels (hard voting) or class probabilities before averaging (soft voting)	None	Pre-eclampsia: No weights Risk: [2,1,1] to Extra tree, XGBoost, Random forest respectively
3. voting:	If 'hard', uses predicted class labels for majority rule voting. Else if 'soft', predicts the class label based on the argmax of the sums of the predicted probabilities	Hard	Hard in both pre-eclampsia and risk
KNN			
1. n_neighbors	Number of neighbors to use by default	5	1 in pre-eclampsia
2. algorithm	algorithm used to compute the nearest neighbors	Auto	brute
3. metric	Metric to use for distance computation.	minkowski	cosine
SVM			
1. c:	Regularization parameter. The strength of the regularization is inversely proportional to C. Must be strictly positive. The penalty is a squared L2 penalty.	1.0	Pre-eclampsia: 10
2. gamma:	Kernel coefficient	scale	Pre-eclampsia: 1
3. kernel:	Specifies the kernel type to be used in the algorithm.	RBF	Pre-eclampsia: RBF
Random_forest & Extra Tree			
1. n_estimators	The number of trees in the forest.	100	Risk: 100
2. random_state	Controls both the randomness of the bootstrapping of the samples used when building trees (if bootstrap=True) and the sampling of the features to consider when looking for the best split at each node (if max_features < n_features).	None	Risk: 1

❖ SOFTWARE TOOLS

1. *Anaconda Navigator*

- is a desktop graphical user interface (GUI) included in Anaconda® Distribution that allows you to launch applications and manage anaconda packages, environments, and channels without using command line interface (CLI) commands.
- Navigator can search for packages on Anaconda.org or in a local Anaconda Repository. Anaconda Navigator enables users to run programs and control Anaconda packages, environments, and channels without using command-line tools.
- Besides, Navigator's capabilities include searching for packages, setting them up in a system, running them, and updating them.

2. *Jupyter Notebook*

- Is a web-based interactive development environment for notebooks, code, and data its flexible interface allows users to configure and arrange workflows in data science, scientific computing, computational journalism, and machine learning.
- Is the original web application for creating and sharing computational documents. It offers a simple, streamlined, document-centric experience

3. *Spyder*

- Is an open source scientific environment written in Python, for Python, and designed by and for scientists, engineers, and data analysts.
- It features a unique combination of the advanced editing, analysis, debugging, and profiling functionality of a comprehensive development tool with the data exploration, interactive execution, deep inspection, and beautiful visualization capabilities of a scientific package.

4. Android Studio.

Is the official Integrated Development Environment (IDE) for Android app development based on the powerful code editor and developer tools, Android Studio offers even more features that enhance your productivity when building Android apps, such as:

- A flexible Gradle-based build system
- A fast and feature-rich emulator
- A unified environment where you can develop for all Android devices
- Live Edit to update code in emulators and physical devices in real-time
- Code templates and GitHub integration to help you build common app features and import sample code
- Extensive testing tools and frameworks
- Lint tools to catch performance, usability, version compatibility, and other problems
- C++ and NDK support
- Built-in support for Google Cloud Platform, making it easy to integrate Google Cloud Messaging and App Engine

5. Numpy

- Numpy (Numerical computing tools) is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.
- Moreover, Numpy forms the foundation of the Machine Learning stack. Numpy offers comprehensive mathematical functions, random number generators, linear algebra routines, Fourier transforms, and more.
- Open-source. Distributed under a liberal BSD license, Numpy is developed and maintained publicly on GitHub by a vibrant, responsive, and diverse community.

6 .Panadas

- As an open-source software library built on top of Python specifically for data manipulation and analysis, Pandas offers data structure and operations for powerful, flexible, and easy-to-use data analysis and manipulation
- Pandas strengthens Python by giving the popular programming language the capability to work with spreadsheet-like data enabling fast loading, aligning, manipulating, and merging, in addition to other key functions.
- Pandas is prized for providing highly optimized performance when back-end source code is written in Python.

1. Sklearn

- Scikit-learn (Sklearn) is the most useful and robust library for machine learning in Python.
- It provides a selection of efficient tools for machine learning and statistical modeling including classification, regression, clustering, and dimensionality reduction via a consistency interface in Python. This library, which is largely written in Python, is built upon NumPy, SciPy, and Matplotlib.
- Sklearn is the gold standard for Machine Learning (ML) in the Python ecosystem.

2. Mat-plot lib

- Used in Visualization with Python , Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python.
- Matplotlib makes easy things easy and hard things possible:
 - Create publication-quality plots.
 - Make interactive figures that can zoom, pan, and update.
 - Customize visual style and layout.
 - Export to many file formats.
 - Embed in JupyterLab and Graphical User Interfaces.
 - Use a rich array of third-party packages built on Matplotlib.

3. Seaborn

- Python Seaborn library is a widely popular data visualization library that is commonly used for data science and machine learning tasks.
- You build it on top of the matplotlib data visualization library and can perform exploratory analysis. You can create interactive plots to answer questions about your data.

4. Data-prep

- Is an intelligent data service for visually exploring, cleaning, and preparing structured and unstructured data for analysis, reporting, and machine learning.
- Because Dataprep is serverless and works at any scale, there is no infrastructure to deploy or manage. Your next ideal data transformation is suggested and predicted with each UI input, so you don't have to write code.

5. **Scipy**

- SciPy provides algorithms for optimization, integration, interpolation, eigenvalue problems, algebraic equations, differential equations, statistics, and many other classes of problems.
- SciPy is a scientific computation library that uses NumPy underneath. SciPy stands for Scientific Python. It provides more utility functions for optimization, stats and signal processing.
- SciPy is open source so we can use it freely.

6. **XG-Boost**

- Stands for Extreme Gradient Boosting, is an open-source Python library that provides a gradient boosting framework.
- Is a scalable, distributed gradient-boosted decision tree (GBDT) machine learning library. It provides parallel tree boosting and is the leading machine learning library for regression, classification, and ranking problems.
- XG-Boost builds upon: supervised machine learning, decision trees, ensemble learning, and gradient boosting.

7. Python

- Is an interpreted, object-oriented, high-level programming language with dynamic semantics
- Its high-level built in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together.
- Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse.
- The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms, and can be freely distributed.

8. Kotlin

- Is a modern statically typed programming language used by over 60% of professional Android developers that helps boost productivity, developer satisfaction, and code safety.
- Kotlin is an open-source, statically-typed programming language that supports both object-oriented and functional programming.
- Kotlin provides similar syntax and concepts from other languages, including C#, Java, and Scala, among many others.
- Kotlin does not aim to be unique—instead, it draws inspiration from decades of language development. It exists in variants that target the JVM (Kotlin/JVM), JavaScript (Kotlin/JS), and native code (Kotlin/Native).

9. Java.

- Java is a widely-used programming language for coding web applications. It has been a popular choice among developers for over two decades, with millions of Java applications in use today.
- Java is a multi-platform, object-oriented, and network-centric language that can be used as a platform in itself.
- It is a fast, secure, reliable programming language for coding everything from mobile apps and enterprise software to big data applications and server-side technologies.

10. Chaquopy

- Is a framework that can help developers run Python scripts from Java/Kotlin code in Android apps unlike other cross-language libraries, there are no hassles of NDK or native code and the installation is easy.
- In this story, we'll explore Chaquopy, its architecture and use with Kotlin code. Chaquopy uses C-Python, an implementation of Python written in C language.
- Chaquopy provides everything you need to include Python components in an Android app, including:
 - Full integration with Android Studio's standard Gradle build system.
 - Simple APIs for calling Python code from Java/Kotlin, and vice versa.
 - A wide range of third-party Python packages, including SciPy, OpenCV, TensorFlow and many more.

11. local database using Room

- Apps that handle non-trivial amounts of structured data can benefit greatly from persisting that data locally.
- The most common use case is to cache relevant pieces of data so that when the device cannot access the network, the user can still browse that content while they are offline.
- The Room persistence library provides an abstraction layer over SQLite to allow fluent database access while harnessing the full power of SQLite. In particular, Room provides the following benefits:
 - Compile-time verification of SQL queries.
 - Convenience annotations that minimize repetitive and error-prone boilerplate code.
 - Streamlined database migration paths.
 - Room database: Simplifies database work and serves as an access point to the underlying SQLite database .The Room database uses the DAO to issue queries to the SQLite database

12. Shared Preferences

- Is what Android and iOS apps use to store simple data in an allocated space.
- This data exists even when the app is shut down and starts up again; we can still retrieve the value as it was.
- The data stored in Shared Preferences can be edited and deleted.
- Shared Preferences stores the data in a key-value pair the primary purpose of Shared Preference is to store user-specified configuration details, such as settings, and to keep the user logged in to the app.

13. View Binding

- Is a Part of Android Jetpack.is a feature that makes it easier to write code that interacts with views
- Once view binding is enabled in a module, it generates a binding class for each XML layout file present in that module.
- An instance of a binding class contains direct references to all views that have an ID in the corresponding layout. In most cases, view binding replaces find-View-By-Id

14. Navigation component

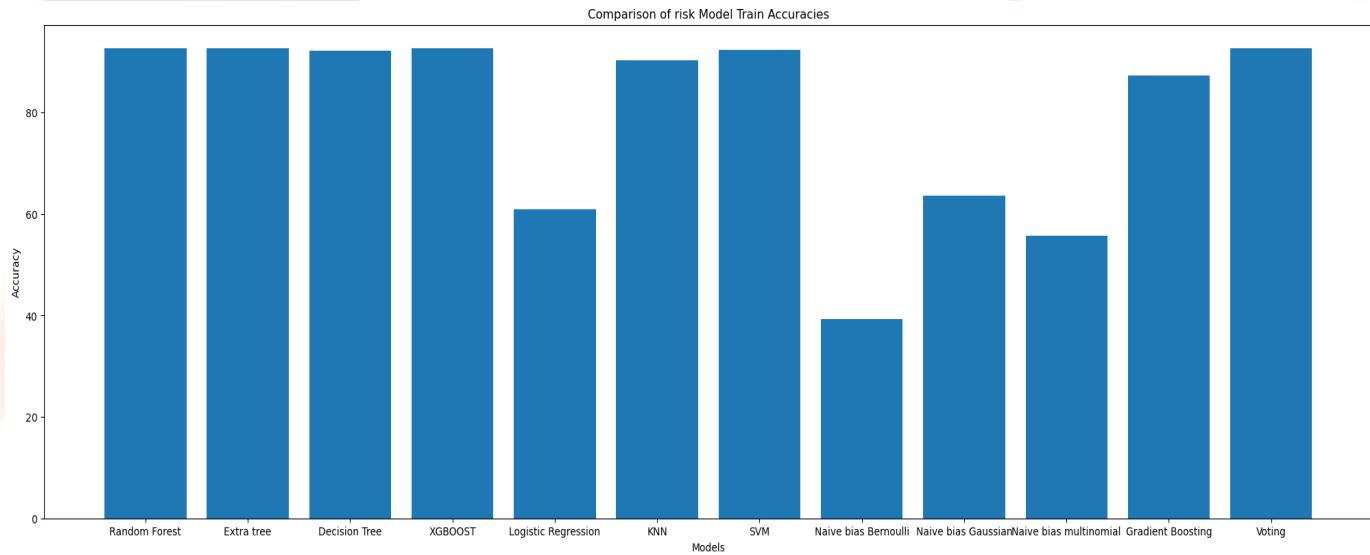
- Are the API and the design tool in Android Studio makes it much easier to create and edit navigation flows throughout your application.
- With the Navigation component, we now have standard APIs, plus a visual tool in the IDE, to help make the entire process clearer, easier, and more consistent.
- Android Jetpack's Navigation component helps you implement navigation, from simple button clicks to more complex patterns, such as app bars and the navigation drawer

15. Kotlin-coroutines

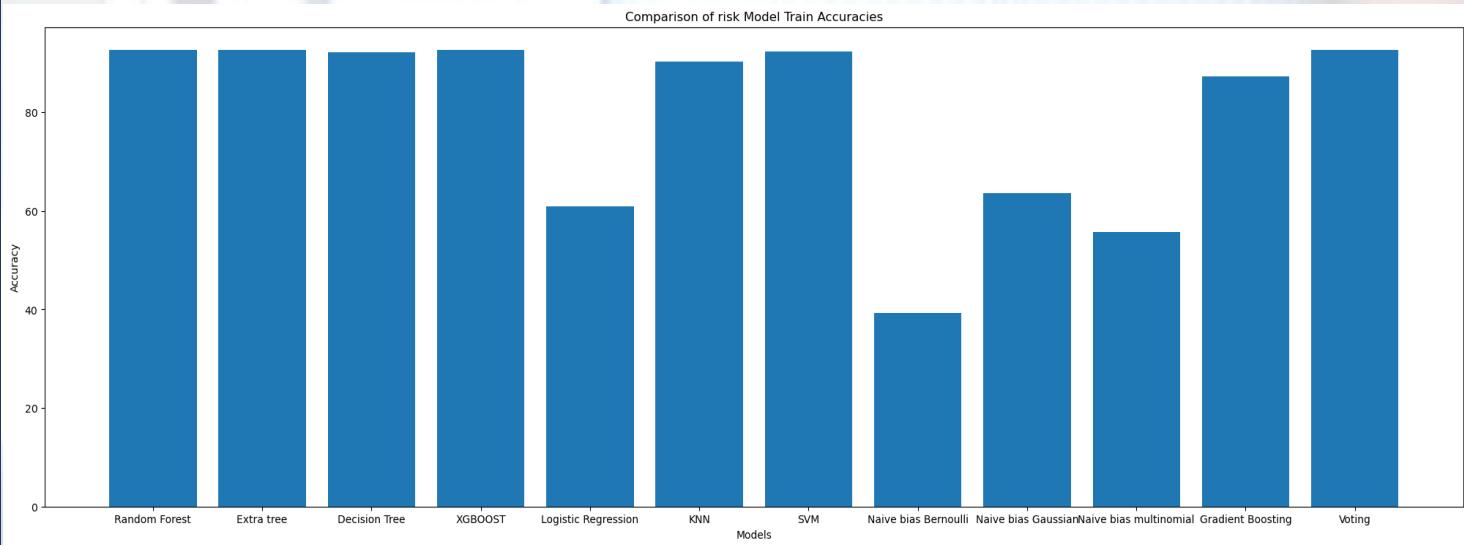
- A coroutine is a concurrency design pattern that you can use on Android to simplify code that executes asynchronously.
- Coroutines were added to Kotlin in version 1.3 and are based on established concepts from other languages. On Android, coroutines help to manage long-running tasks that might otherwise block the main thread and cause your app to become unresponsive. Over 50% of professional developers who use coroutines have reported seeing increased productivity.

❖ *Visualization:*

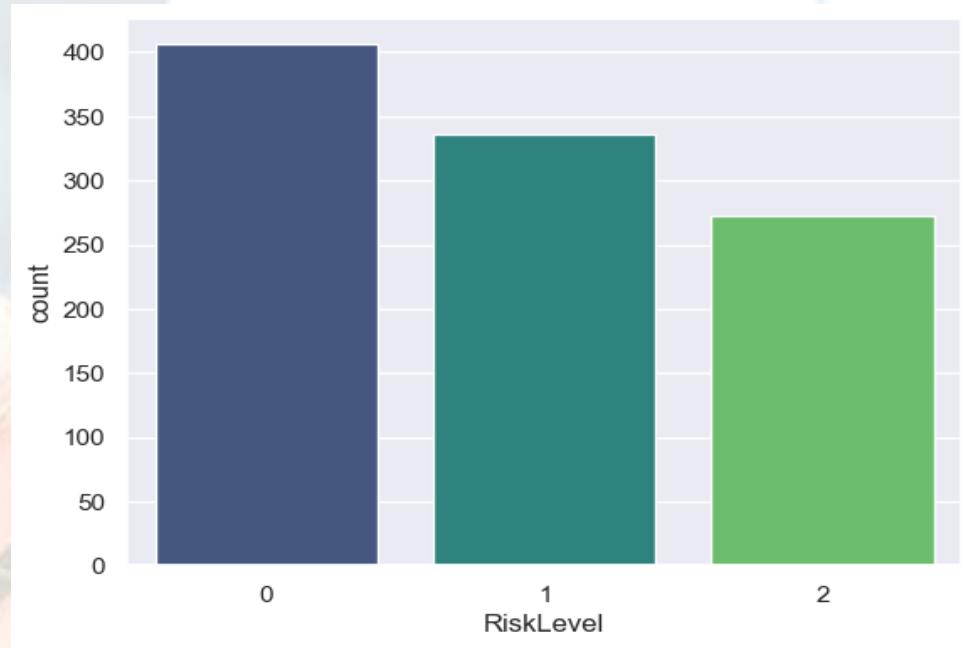
- *The figure shows the comparison of risk model accuracies*



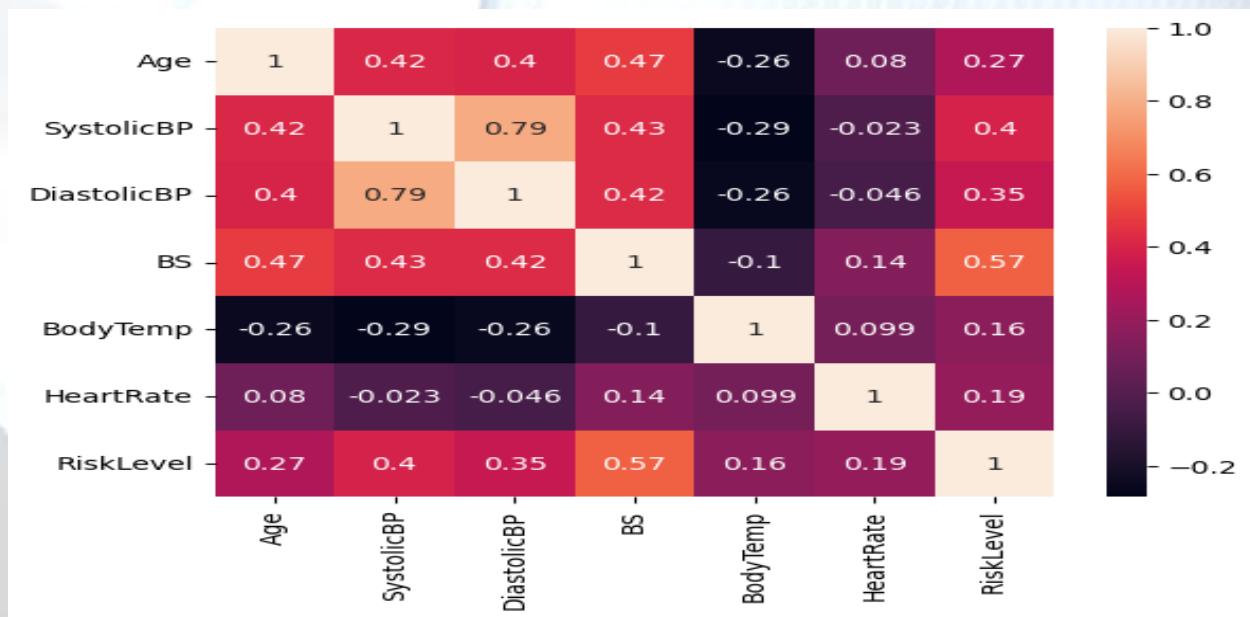
- *The figure shows the comparison of risk train model accuracies*



- The figure shows The par chart which shows the number of risk level different values in the data

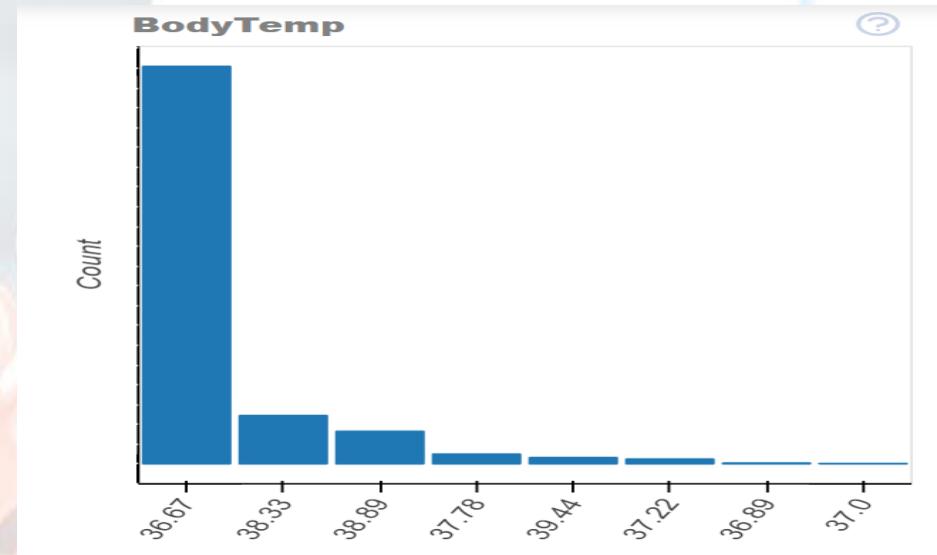


- The figure shows the Heat-map in which the value of each data point is indicated using colors, the warm colors representing high-value data points and the cool colors represent low-value data points.

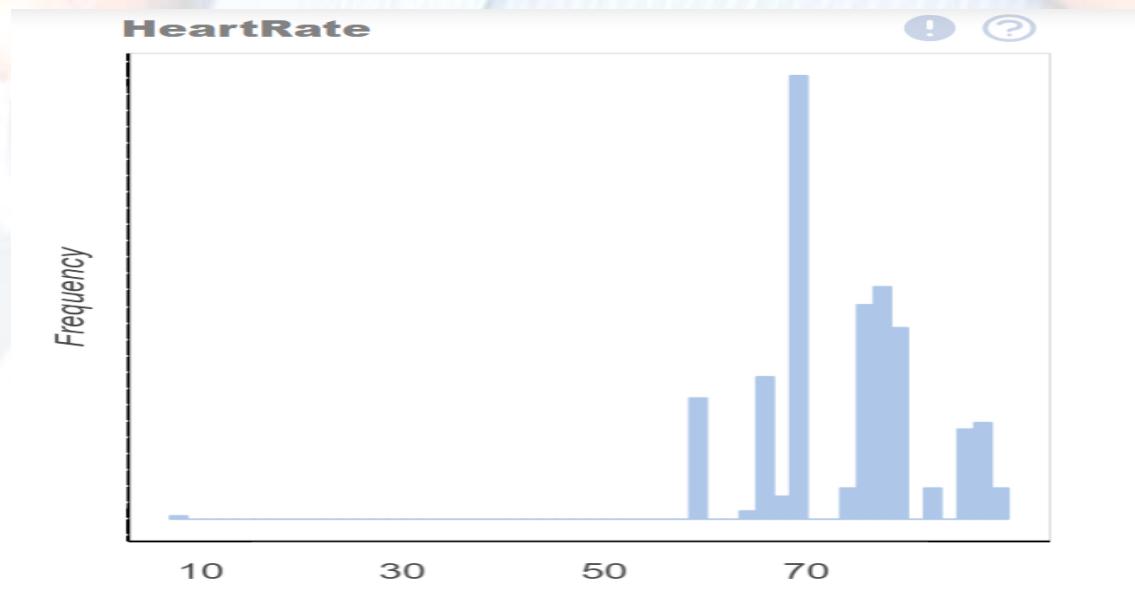


❖ risk coulmns vizualization:

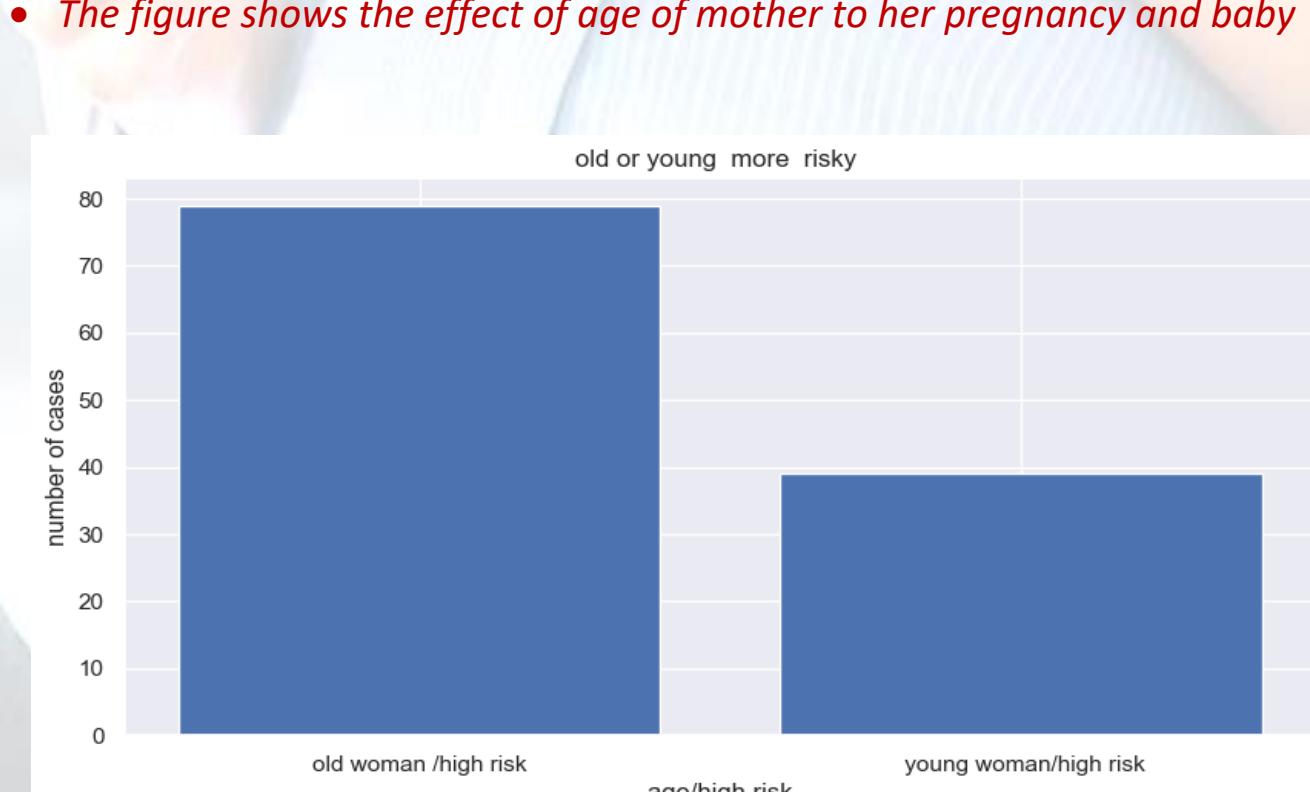
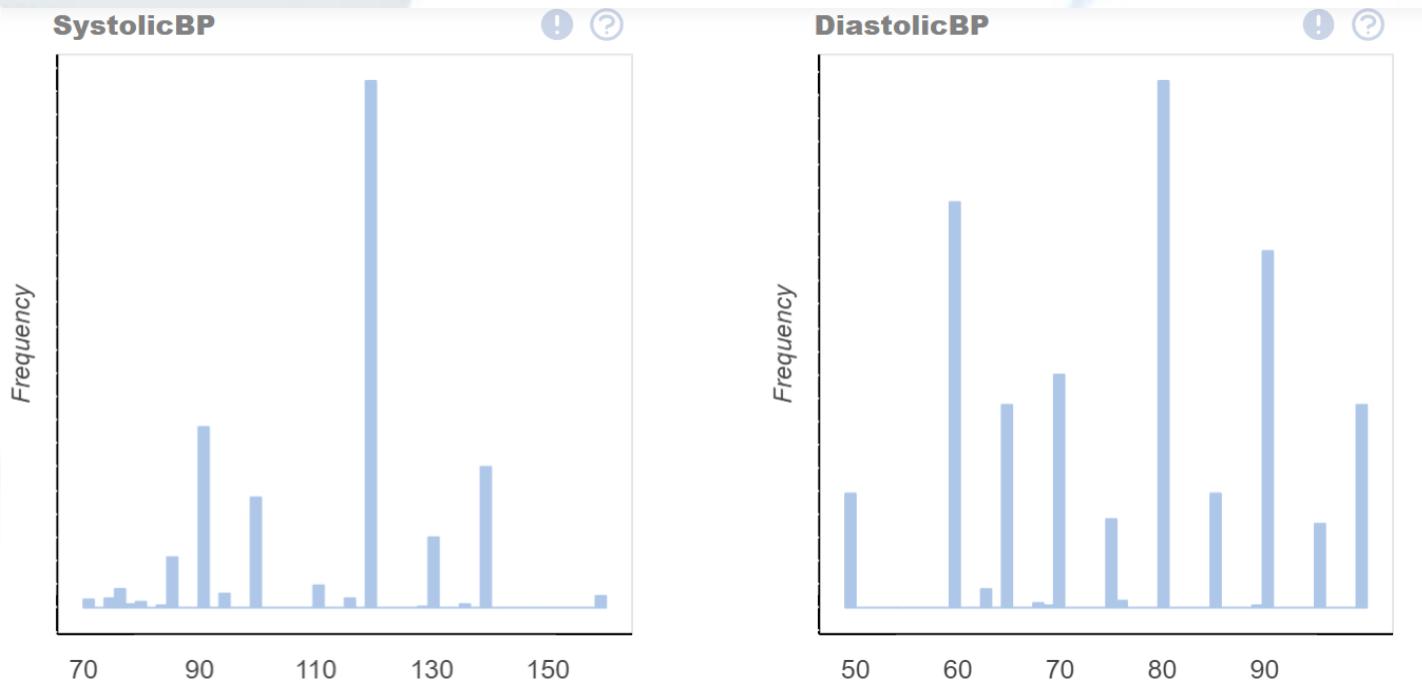
- *The figure shows the body temperature values in the data*



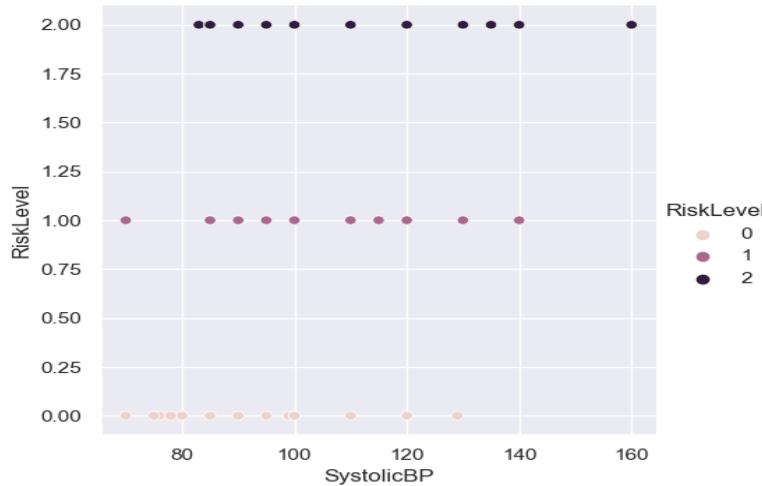
- *The figure shows the heart rate values in the data*



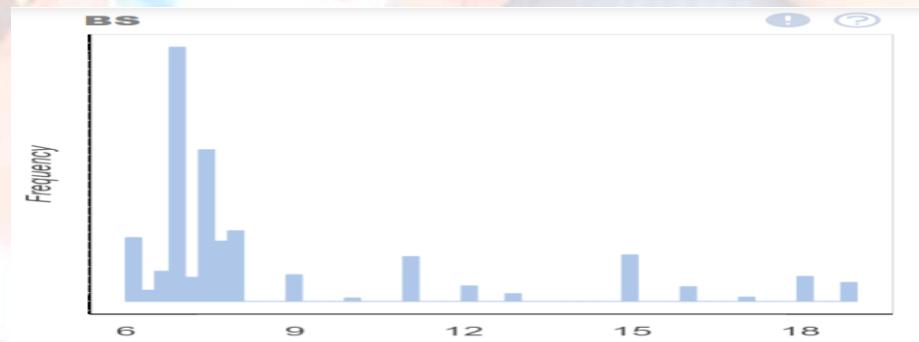
- The figure shows The blood pressure values in the data



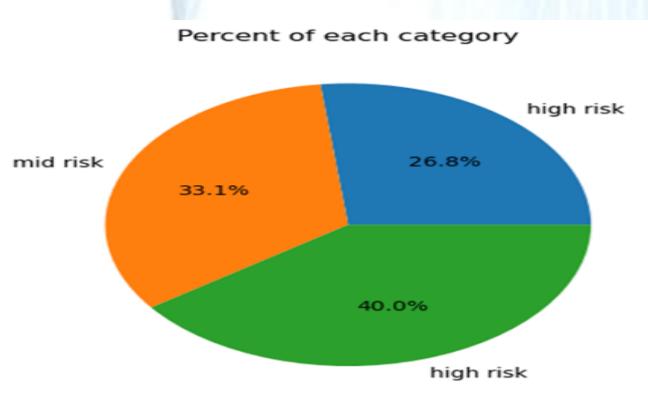
- The figure shows the relational plot of systolic-BP and risk level



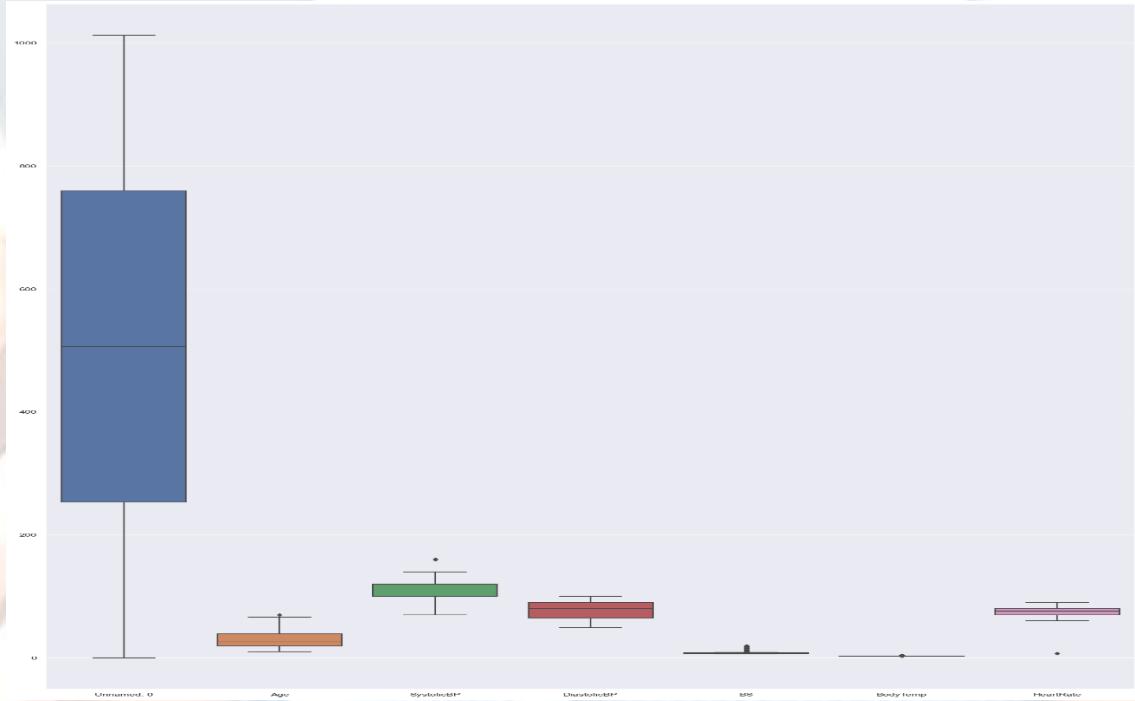
- The figure shows the blood sugar values



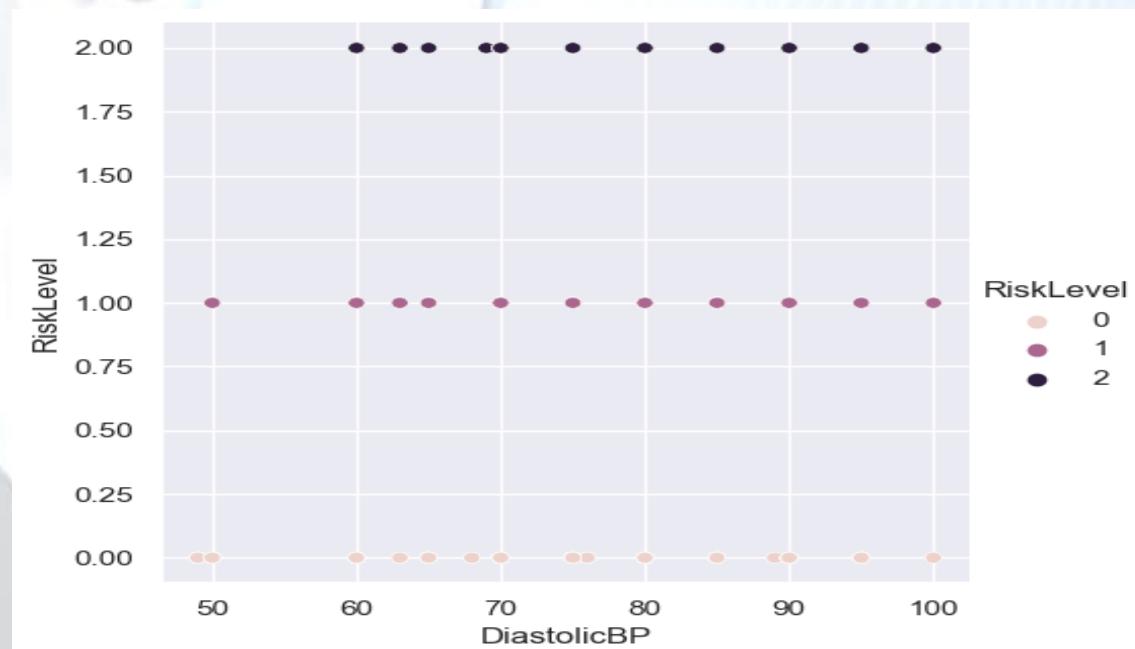
- The figure shows the Pie chart to show the percentage of each value of risk level column



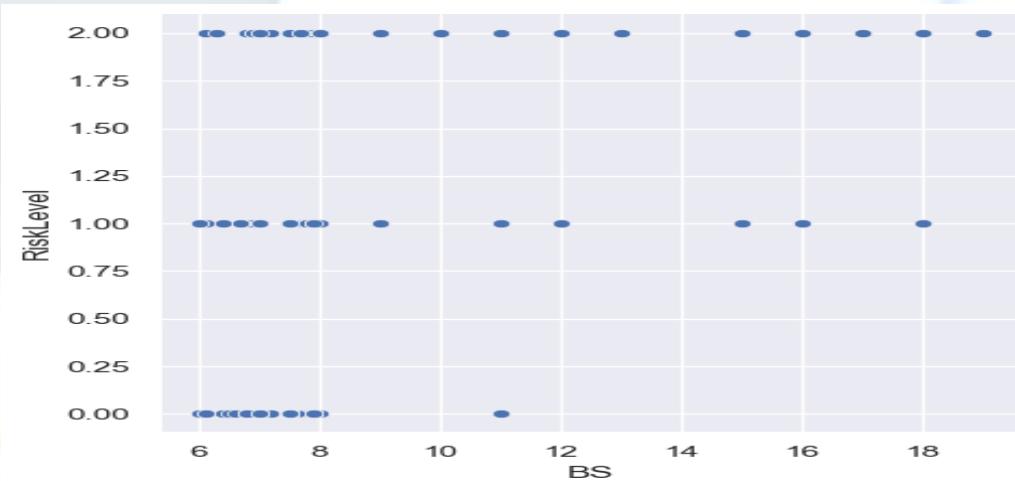
- The figure shows box plot to displays the five-number summary of a set of data.
- The lozenge symbol “◆” represents the outliers values of each measure



- The figure shows the Relational plot of diastolic-BP and risk level



- The figure shows the Relational plot of Blood Sugar and risk level

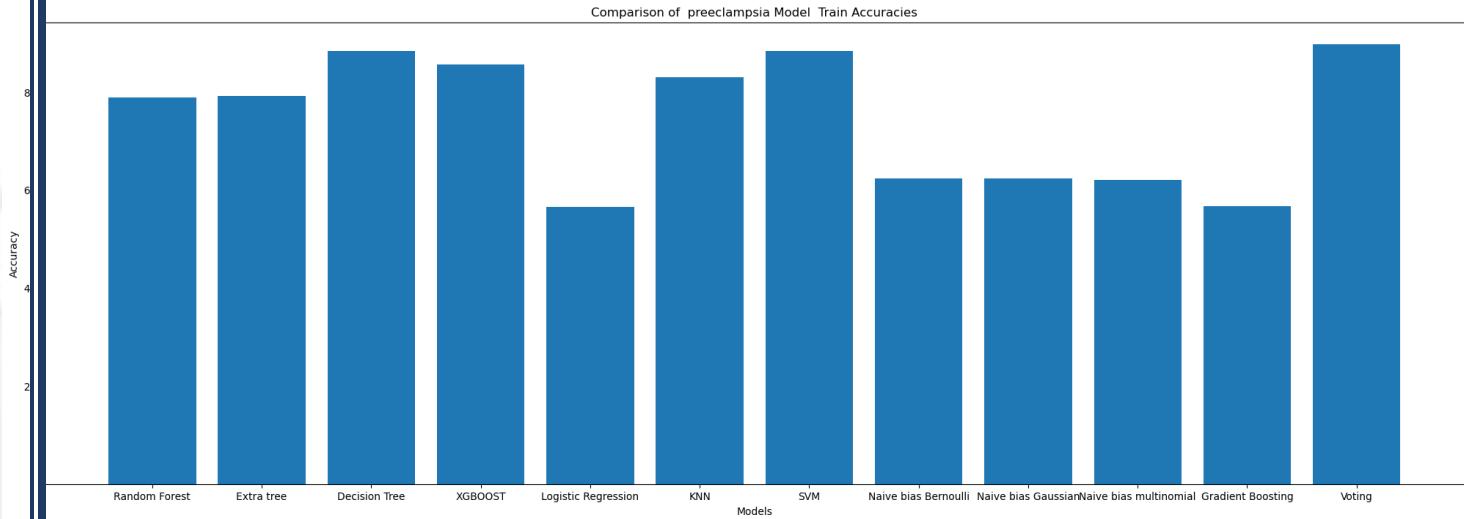


- The figure shows the value table to illustrate number of each value in the risk-level column

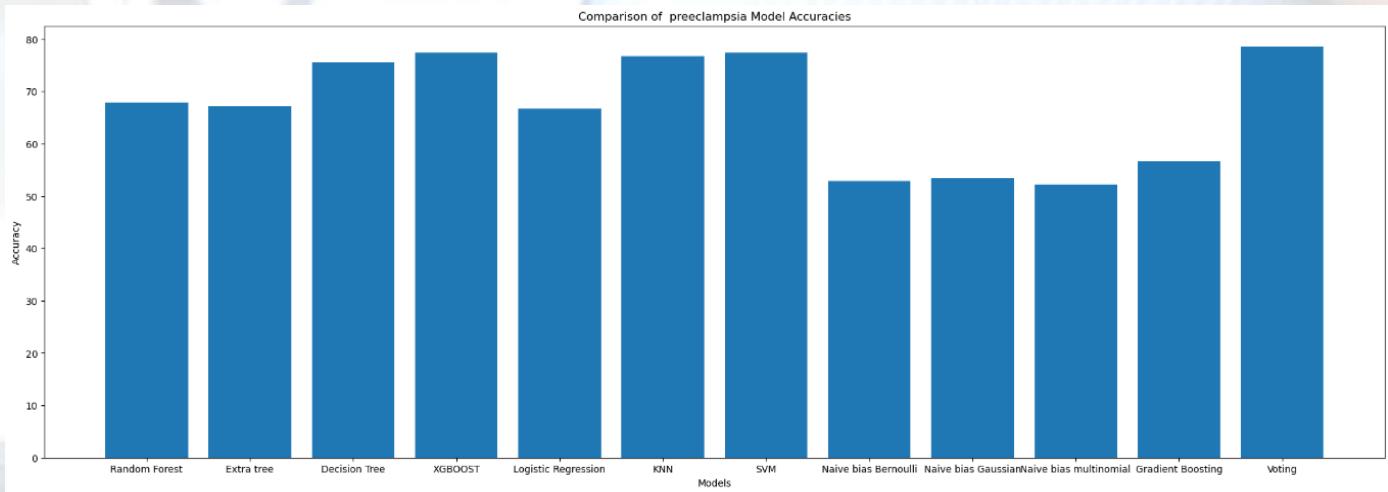
Value	Count	Frequency (%)
low risk	406	40.0%
mid risk	336	33.1%
high risk	272	26.8%

Preeclampsia visualization

- The figure shows the comparison of preeclampsia model accuracies

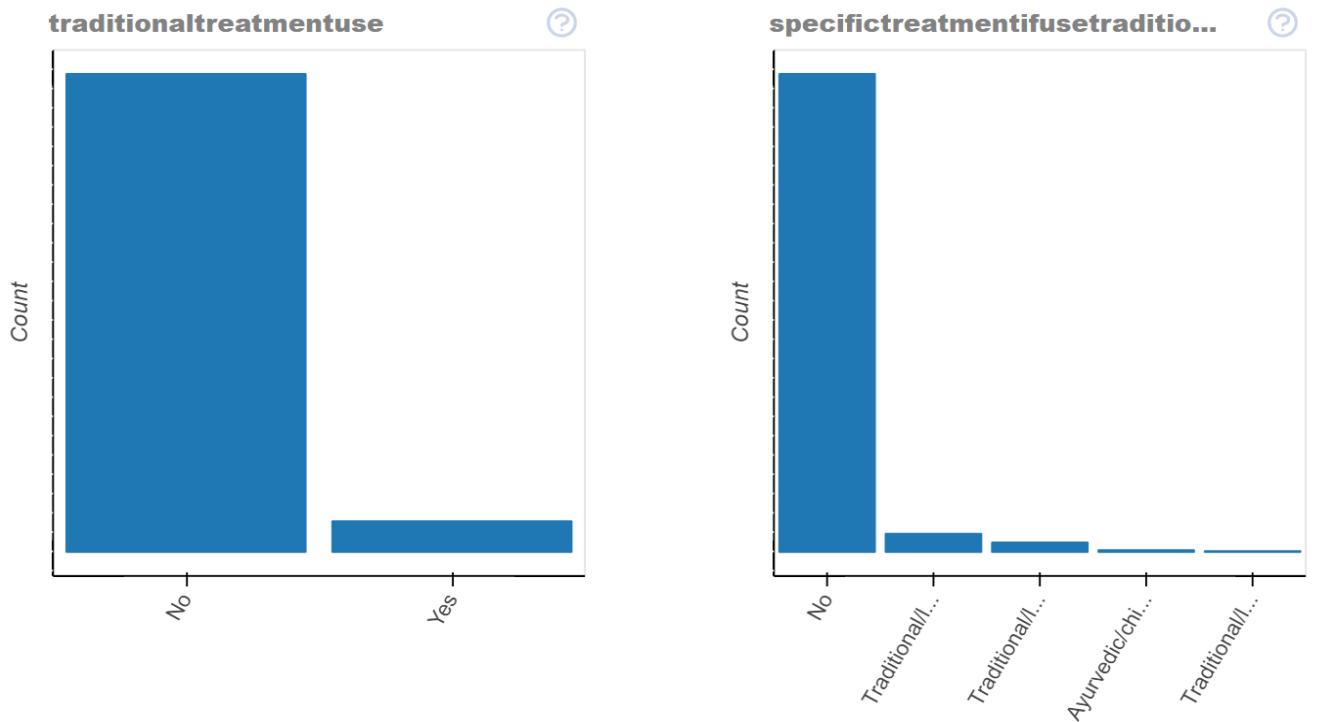


- The figure shows the comparison of preeclampsia-train model accuracies

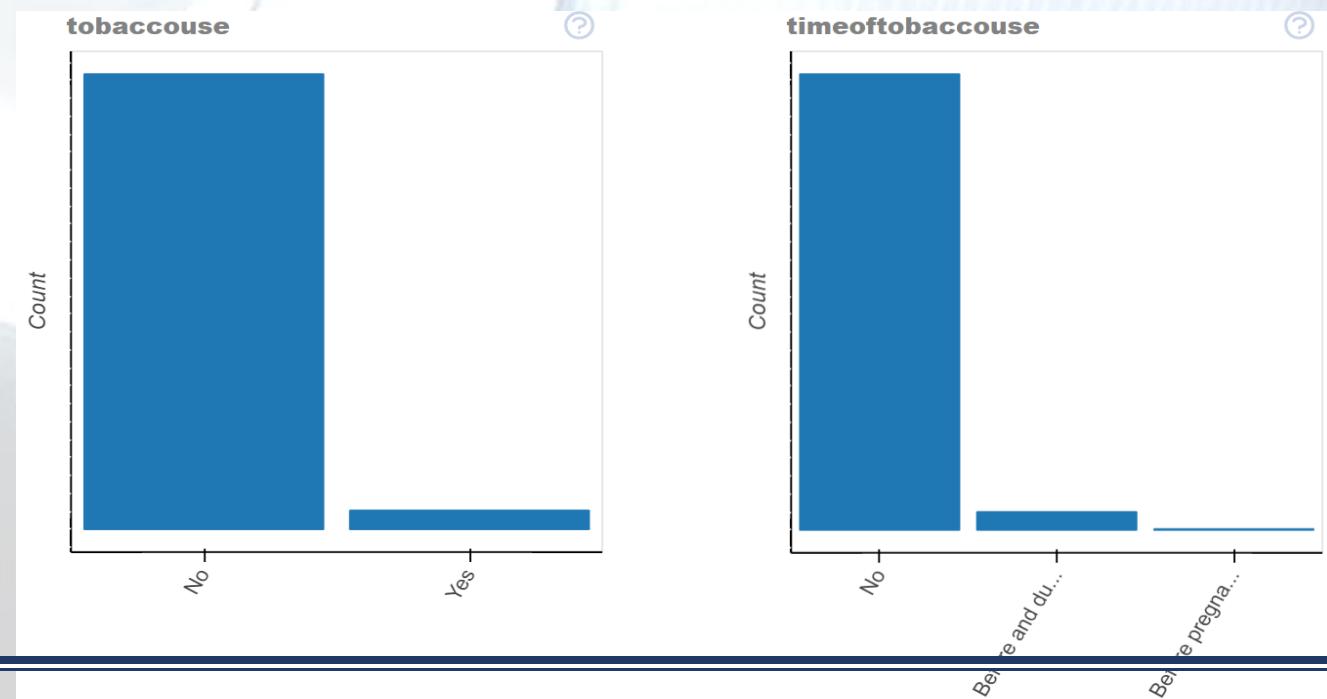


❖ Pre-column-viz

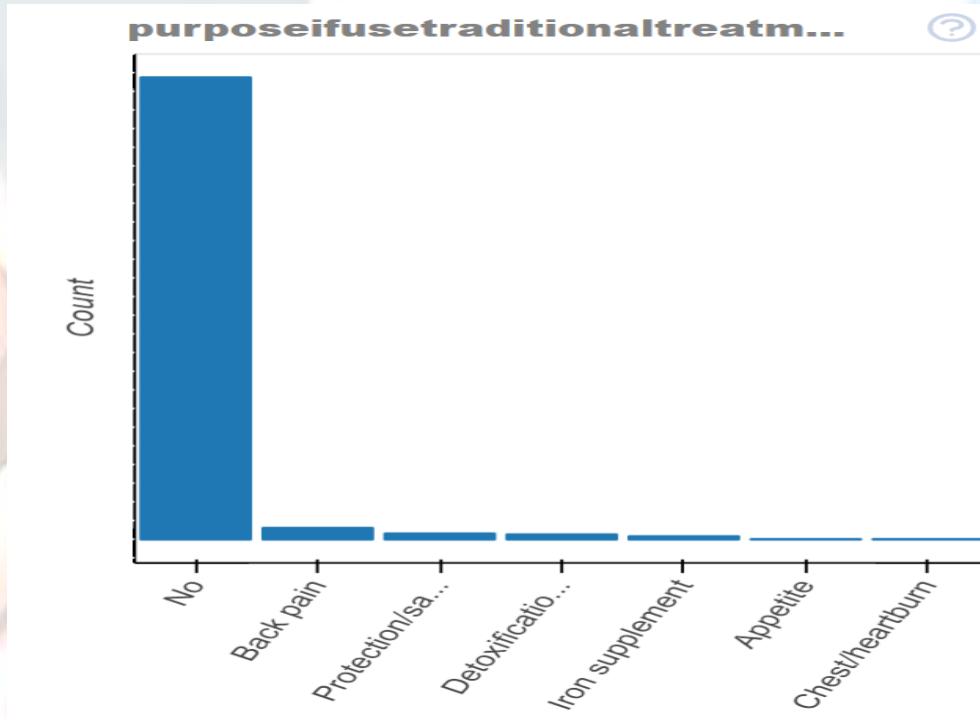
- *The figure shows The treatment use and The specific treatment if use traditional treatment values in the data*



- *The figure shows the tobacco use and time of use values in the data*



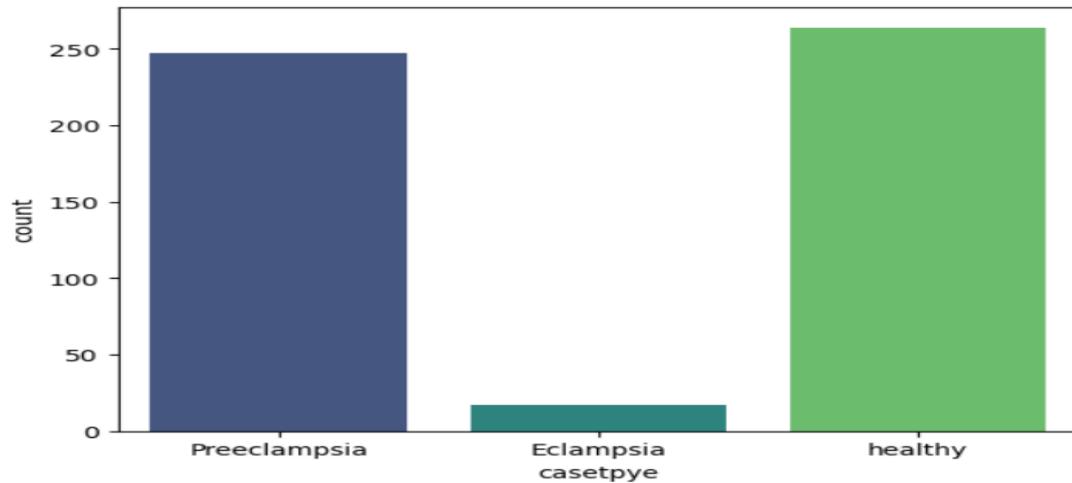
- The figure shows The purpose of treatment use values in the data



- The figure shows the value table to illustrate number of each value in case-control Column

Value	Count	Frequency (%)
Case	264	50.0%
Control	264	50.0%

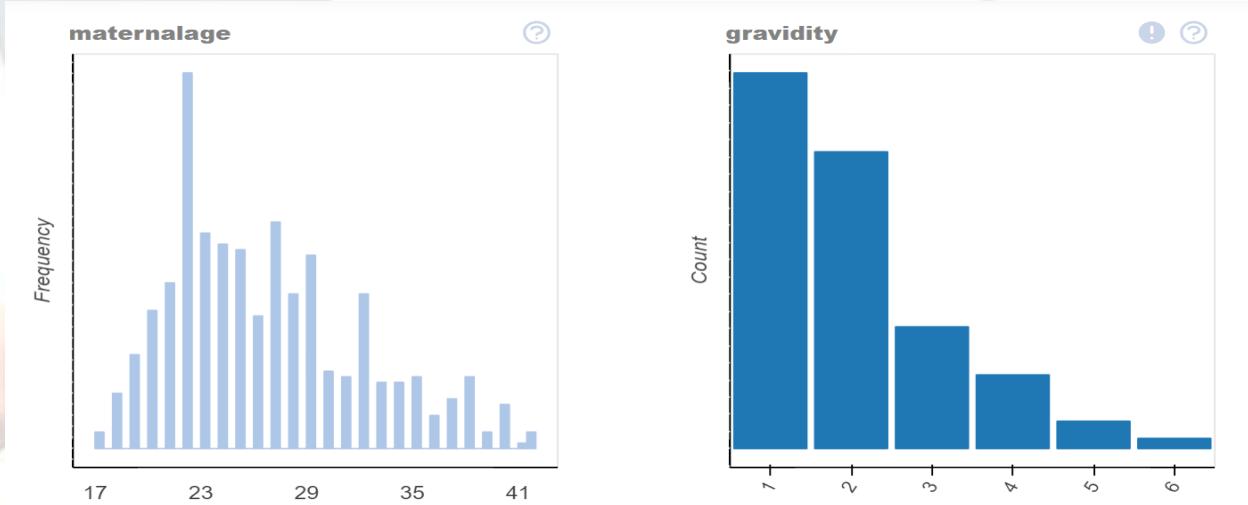
- The figure shows the value table to illustrate number of each value in the case type Column



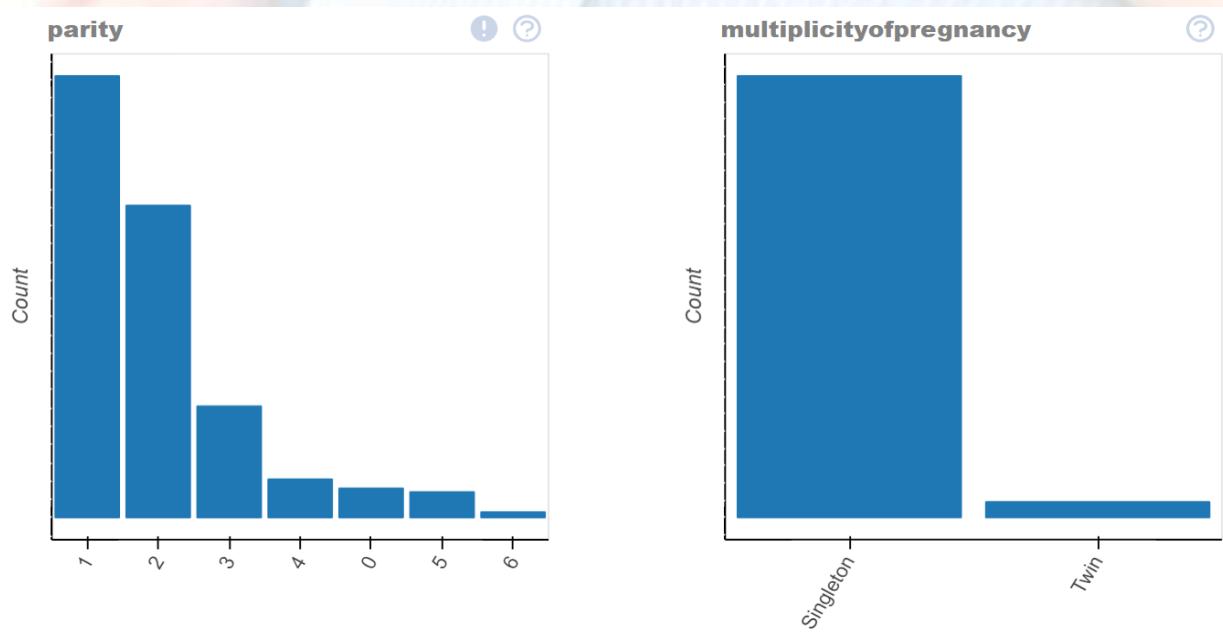
- The figure shows the value table to illustrate number of each value in the case-type Colum

Value	Count	Frequency (%)
healthy	264	50.0%
Preeclampsia	247	46.8%
Eclampsia	17	3.2%

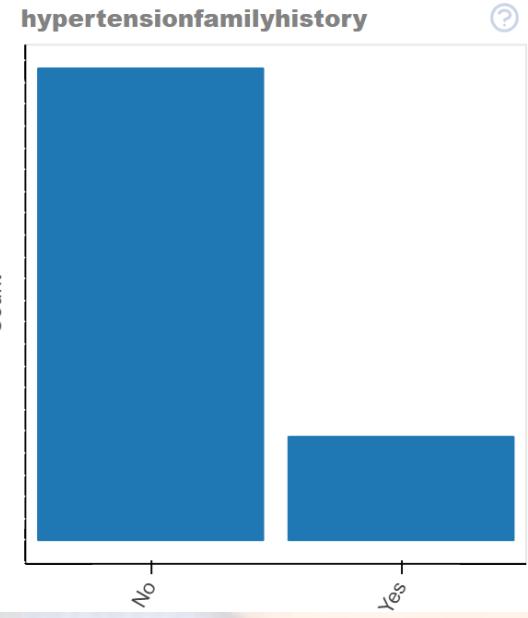
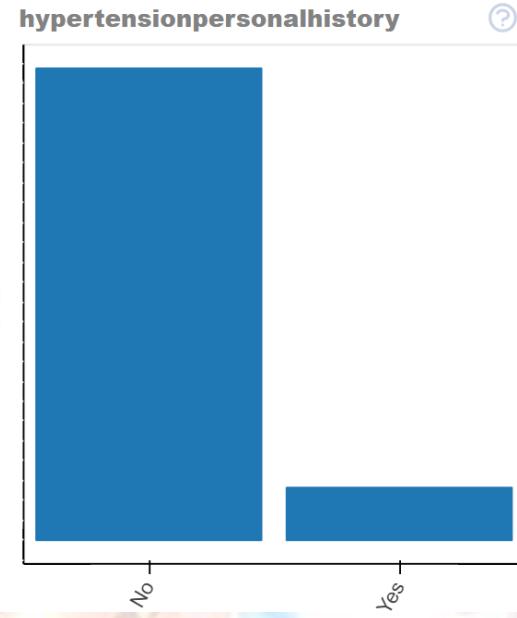
- The figure shows The age values in the data
- The figure shows gravidity values in the data



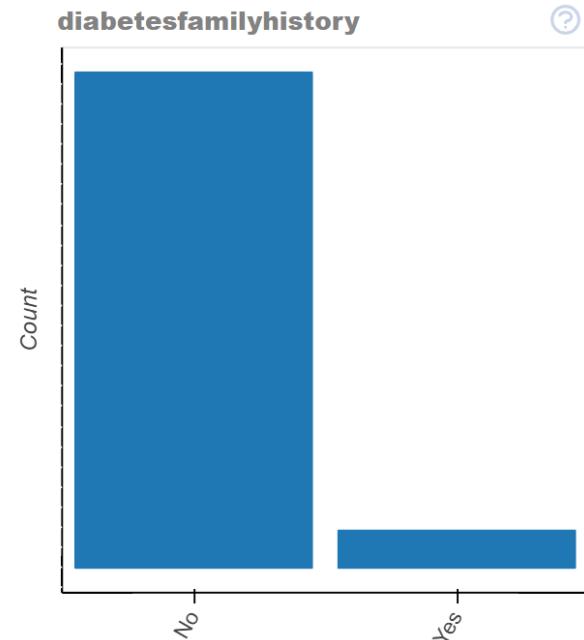
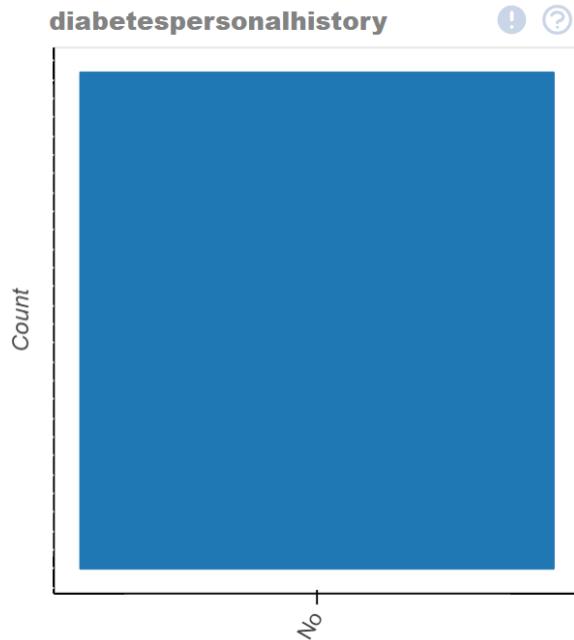
- The figure shows The parity values in the data
- The figure shows The multiplicity values in the data



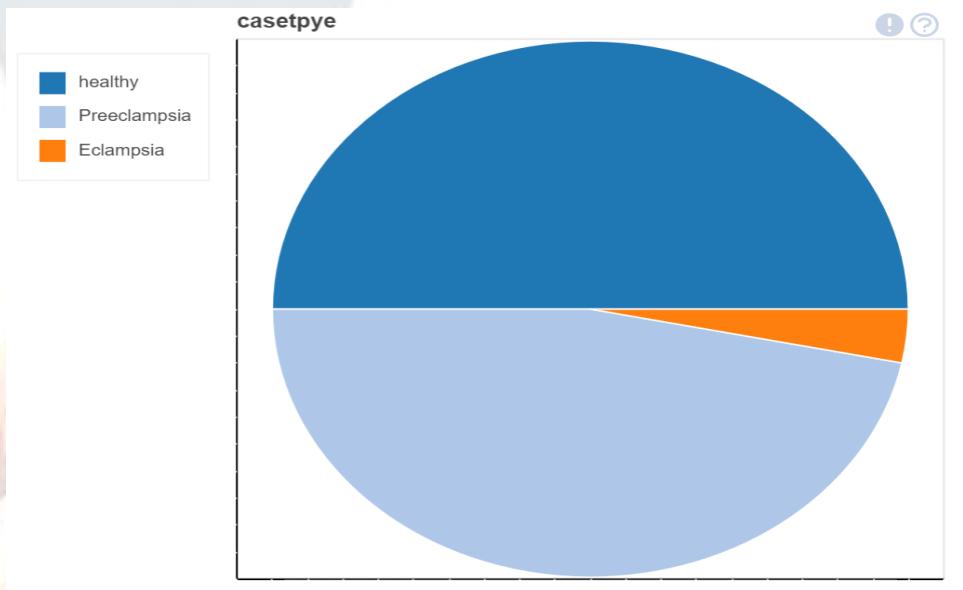
- The figure shows The hypertension values in the data



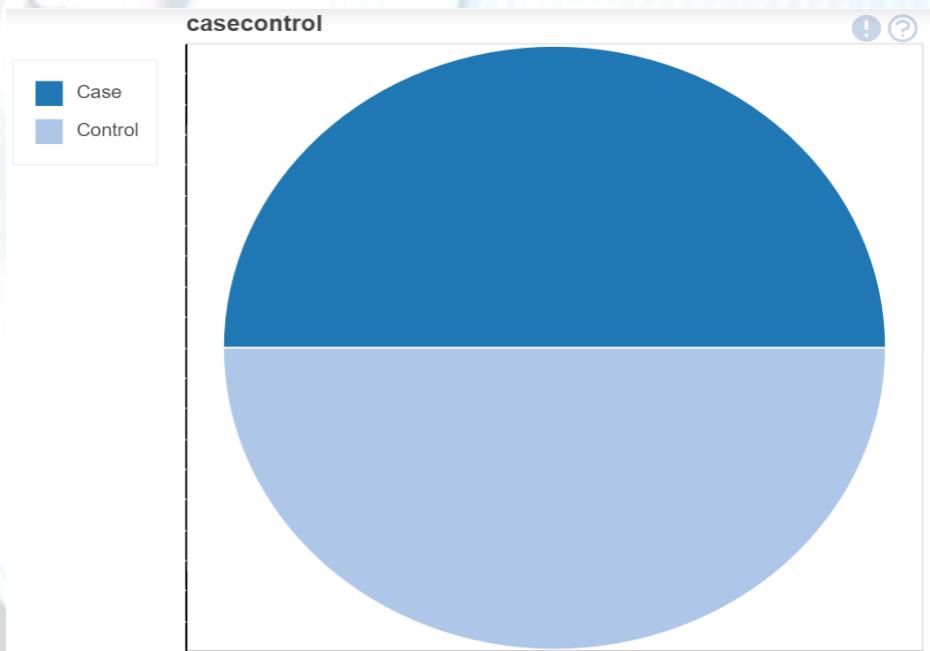
- The figure shows The diabetes values in the data



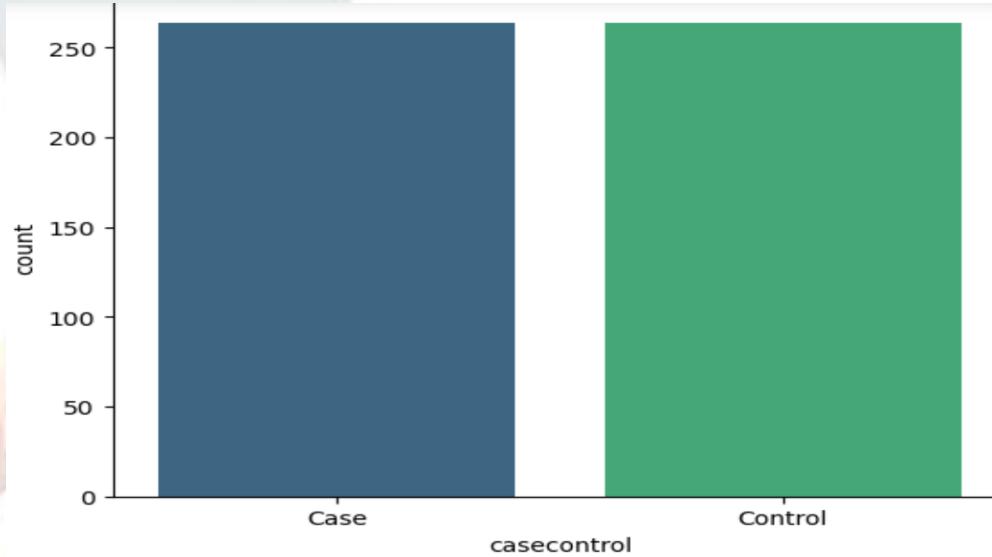
- The figure shows the Pie chart to show the percentage of each value of case type column



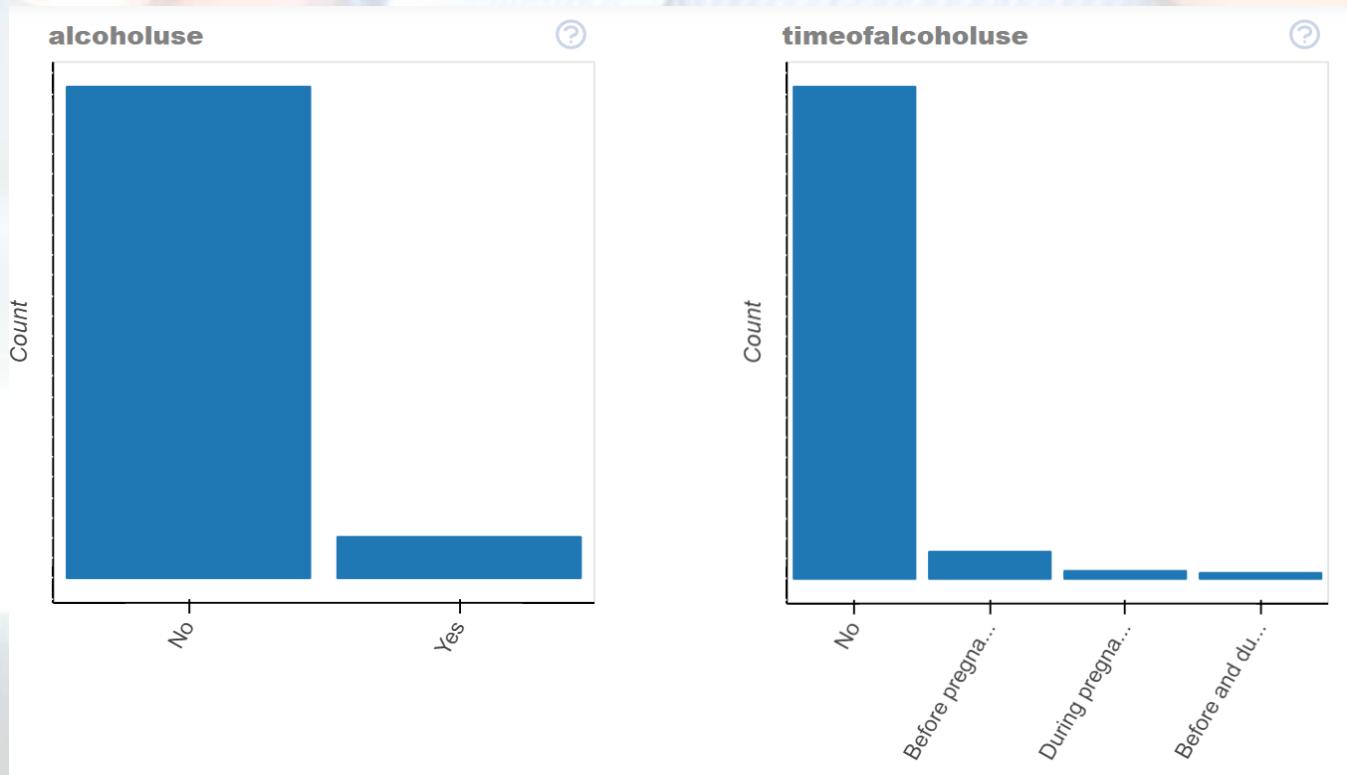
The figure shows the Pie chart to show the percentage of each value of case-control column



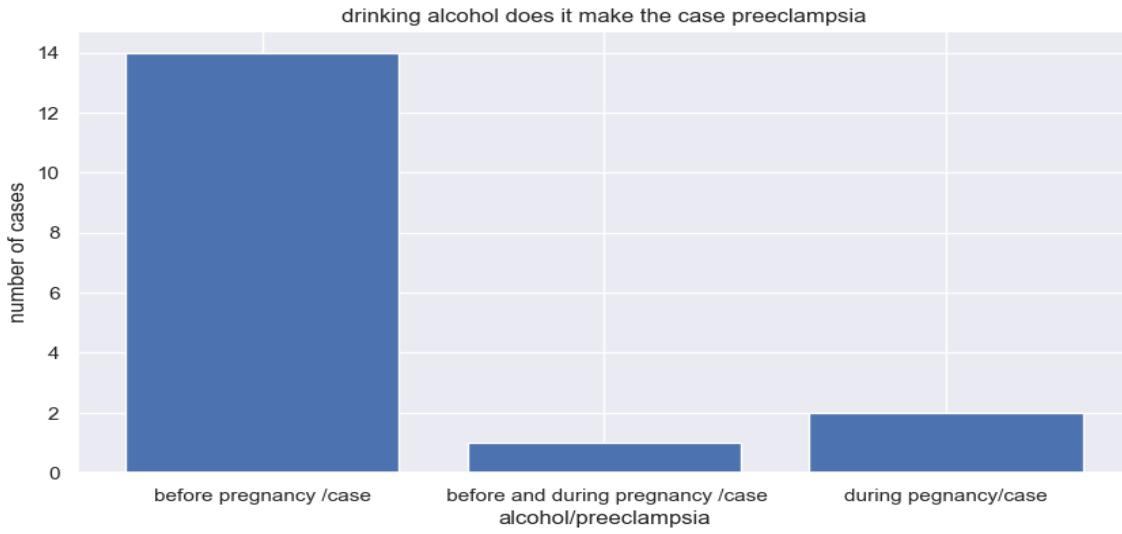
- The figure shows The par chart which shows the number of case control different values in the data



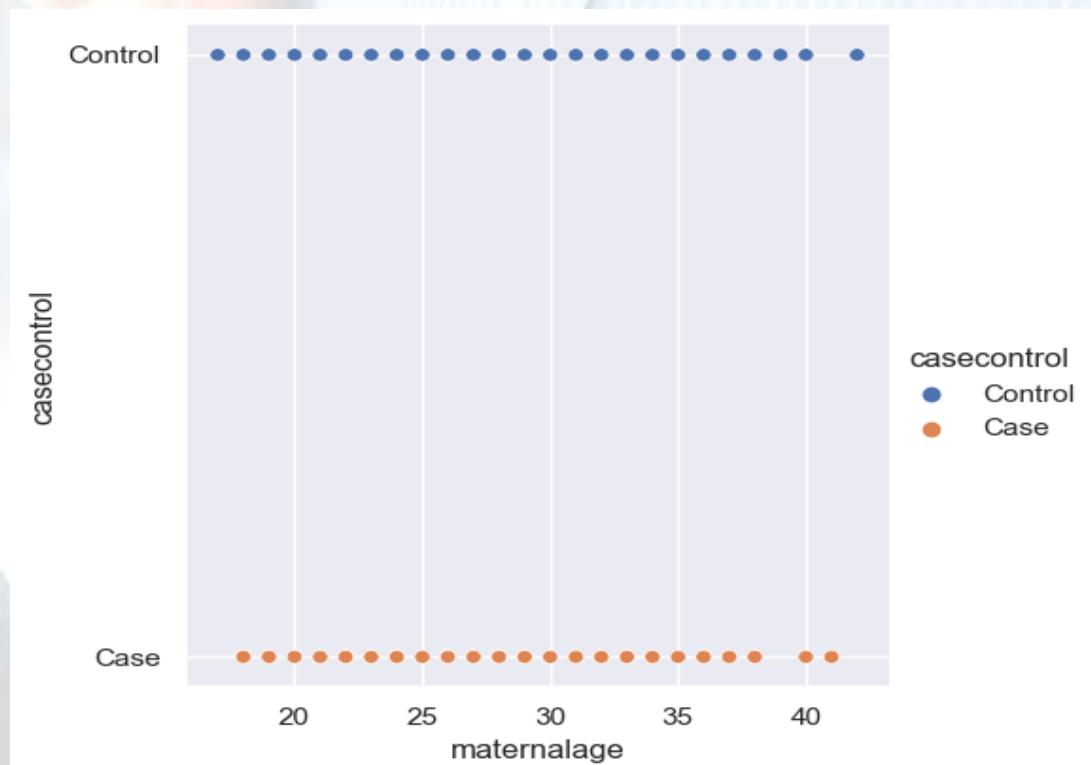
- The figure shows The alcohol use values in the data



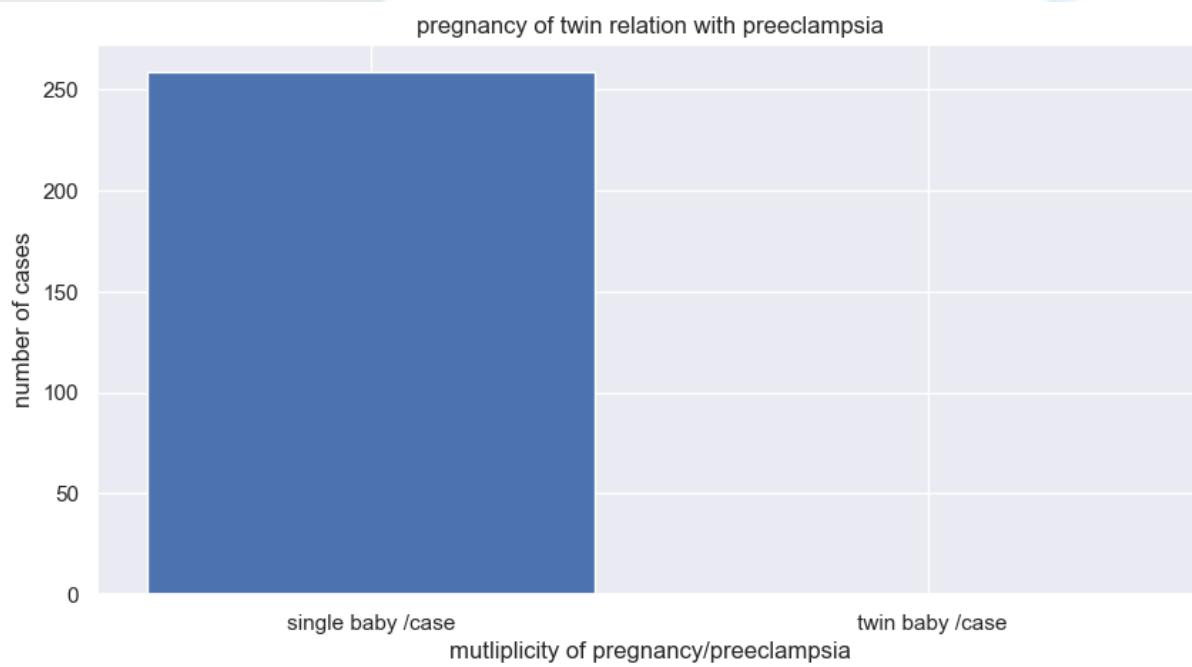
The figure shows the effect of alcohol for the risk of preeclampsia on mothers health



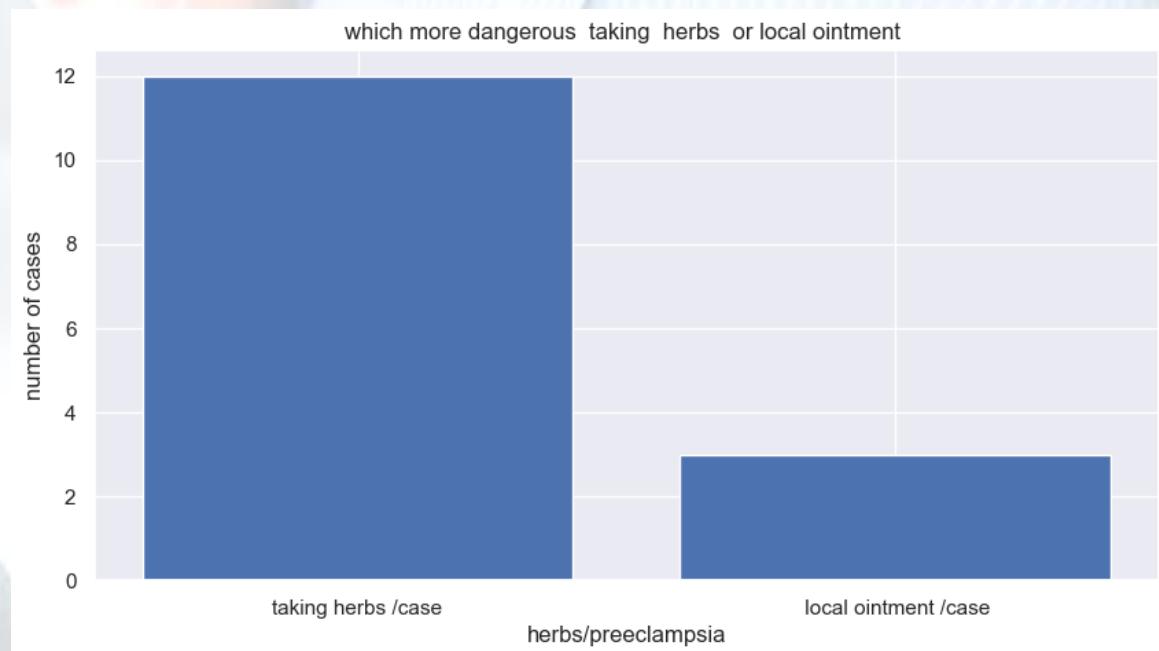
The figure shows the relational plot of maternal age and case control columns



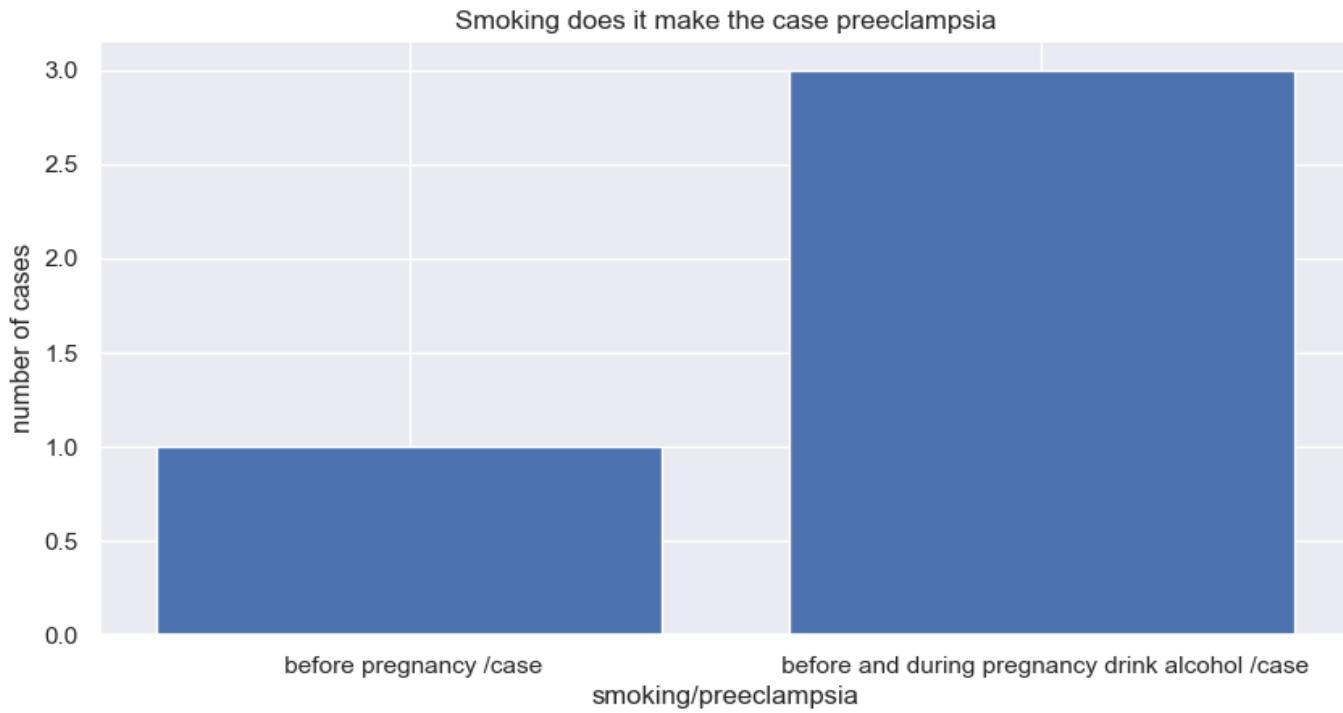
- The figure shows the risk of multiplicity for the mother's health



- The figure shows the risk of treatments types for the mother's health



- *The figure shows the risk of smoking for the mother's health*



Chapter 5: Testing

➤ **Unit Testing**

Main fragment:

- If the user is a new user, the home will be empty
- Through the home, the user will enter the sign up fragment
- If the user is a current user of the application, you will enter her home page
- As soon as you sign up, the application will alert the alarm to send her some general medical advice regarding her health condition.

```
if (viewModel.getName() != "") {  
    findNavController().navigate(R.id.action_mainFragment_to_homeFragment)  
} else {  
    findNavController().navigate(R.id.action_mainFragment_to_signupFragment)  
}  
}
```

Sign up:

- It requires a set of data such as (date of birth, city, country, etc.)
- The date of birth is required to calculate the age of the mother
- It requires the rest of the other data in order to put it in its profile
- If the mother does not enter one of the data, the application refuses to perform the signup process
- After entering the data, the application puts it in the view model and then sends it to the form fragment

```
binding.signupBtn.setOnClickListener { it: View!  
    if (binding.userName.text.toString().isBlank()  
        || binding.dateOfBirth.text.toString() == "Date of birth" || binding.City.text.toString()  
            .isBlank() || binding.country.text.toString().isBlank()  
    ) {  
        Toast.makeText(context, text: "Signed Up Failed! ALL fields are required", Toast.LENGTH_SHORT).show()  
  
    } else {  
        viewModel.setName(binding.userName.text.toString())  
        viewModel.setDateOfBirth(binding.dateOfBirth.text.toString())  
        viewModel.setCity(binding.City.text.toString())  
        viewModel.setCountry(binding.country.text.toString())  
        Toast.makeText(context, text: "Successfully Signed Up", Toast.LENGTH_SHORT).show()  
        findNavController().navigate(R.id.action_signupFragment_to_formFragment)  
    }  
}
```

The form

- To create her health record
- The form contains: weight, height, parity, Gravidity, health history, and family history
- Then it sends this data to the view model
- After completing the form data, the mother becomes a current user of the application

```
binding.submit.setOnClickListener { it: View!
    if (binding.weight.text.toString().isBlank() || binding.height.text.toString()
        .isBlank() || binding.parity.text.toString().isBlank()
        || binding.gravidity.text.toString().isBlank() || binding.lmp.text.toString() == "Last missed period"
    ) {
        Toast.makeText(context, text: "Please enter all fields", Toast.LENGTH_SHORT).show()
    } else {
        viewModel.setWeight(binding.weight.text.toString())
        viewModel.setHeight(binding.height.text.toString())
        viewModel.setParity(binding.parity.text.toString())
        viewModel.setGravidity(binding.gravidity.text.toString())
        if (binding.Fdiabetes.isChecked) { viewModel.setFDiabetes(1) }
        else { viewModel.setFDiabetes(0) }
        if (binding.diabetes.isChecked) { viewModel.setDiabetes(1) }
        else { viewModel.setDiabetes(0) }
        if (binding.FHypertension.isChecked) { viewModel.setFHypertension(1) }
        else { viewModel.setFHypertension(0) }
        if (binding.Hypertension.isChecked) { viewModel.setHypertension(1) }
        else { viewModel.setHypertension(0) }
        findNavController().navigate(R.id.action_formFragment_to_homeFragment)
    }
    sendNotification()
}
```

Notifications:

- Function sends "sending notifications" to the alert manager so that he can start sending her notifications every 6 hours that include some important health tips

```
private fun sendNotification() {  
    val calendar = Calendar.getInstance()  
    val manager: AlarmManager = context?.getSystemService(Context.ALARM_SERVICE) as AlarmManager  
    val intent = Intent(context, NotificationReceiver::class.java)  
    val pendingIntent: PendingIntent = PendingIntent.getBroadcast(  
        context,  
        MainFragment.REQUEST_CODE,  
        intent,  
        PendingIntent.FLAG_IMMUTABLE  
    )  
    MainFragment.REQUEST_CODE++  
    manager.setRepeating(  
        AlarmManager.RTC_WAKEUP,  
        calendar.getTimeInMillis(),  
        intervalMillis: 1000 * 60 * 60 * 6 ,  
        pendingIntent  
    );  
}
```

Profile

- "ON TIME CLICK FUNCTION"
- A dialog box appears for the mother
- You can modify its own data
- However, it is not allowed to modify some data such as: age, current week of pregnancy, and trimester

```
private fun DisplayDialog(fieldName:String, edtName:String){  
    val builder = AlertDialog.Builder(context)  
    builder.setMessage("Enter your ${fieldName}")  
    builder.setTitle("Please !")  
    val customLayout: View = layoutInflater.inflate(R.layout.custom_layout, root: null)  
    builder.setView(customLayout)  
    var editText:EditText = customLayout.findViewById(R.id.editText)  
    var no:Int=PersonalList.indexOf(EdtText(fieldName,edtName))  
  
    builder.setCancelable(false)  
    builder.setPositiveButton( text: "Yes" ) {  
  
        dialog, which -> PersonalList.set(no,EdtText(fieldName,editText.text.toString()))  
        when(fieldName){  
            "name" -> viewModel.setName(editText.text.toString())  
            "country" ->viewModel.setCountry(editText.text.toString())  
            "city" -> viewModel.setCity(editText.text.toString())  
            "weight" -> viewModel.setWeight(editText.text.toString())  
            "height" -> viewModel.setHeight(editText.text.toString())  
  
        }  
        PersonalRecyclerView.setList(PersonalList)  
    }  
    builder.setNegativeButton( text: "No" ) { dialog, which -> dialog.cancel() }  
    val alertDialog = builder.create()  
  
    alertDialog.show()  
}
```

Baby development:

- Every week he displays a picture of what the baby looks like in the week he is in
- It also contains an explanation and details about the current week

```
init {  
    for (i in 1 .. 41) {  
        week = "Week" + i  
        itemList.add(Weeks(week, image[i - 1], description[i - 1]))  
    }  
}
```

On item clicked week:

- It displays detailed information for the current week

```
override fun onItemClick(weeks: Weeks) {  
    val action = BabyFragmentDirections.actionBabyFragmentToWeeksDataFragment(weeks.weekNum)  
    findNavController().navigate(action)  
}
```

Risk:

- It takes blood pressure, blood sugar, age, and body temperature and sends them to the machine learning model

```
binding.Submit.setOnClickListener { it: View!
    if (binding.SystolicBP.text.toString().isBlank()
        && binding.DiastolicBP.text.toString().isBlank() && binding.BS.text.toString()
            .isBlank() && binding.BodyTemp.text.toString().isBlank()
        && binding.HeartRate.text.toString().isBlank())
    ) {
        Toast.makeText(context, text: "Enter all fields", Toast.LENGTH_SHORT).show()
    } else {
        val obj = pyobj.callAttr(
            key: "main",
            viewModel.getAge(),
            binding.SystolicBP.text.toString(),
            binding.DiastolicBP.text.toString(),
            binding.BS.text.toString(),
            binding.BodyTemp.text.toString(),
            binding.HeartRate.text.toString()
        )
        binding.Result.setText(obj.toString())
        viewModel.setRisk(obj.toString())
    }
}
```

ML-risk:

```
Age=int(Age)
SystolicBP=int(SystolicBP)
DiastolicBP=int(DiastolicBP)
BloodSugar=float(BloodSugar)
BodyTemp=int(BodyTemp)
HeartRate=int(HeartRate)
filename = join(dirname(__file__), "MaternalHealthRiskDataSet.csv")
data=pd.read_csv(filename)
x = data.drop(["RiskLevel"], axis = 1)
y=data["RiskLevel"].values
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.25,random_state=6)
extra_tree_forest = ExtraTreesClassifier(random_state=1,n_estimators=100)
random_forest = RandomForestClassifier(random_state=17,n_estimators=100,criterion='entropy')
model = XGBClassifier(max_depth=5)
voting_hard = VotingClassifier(estimators=[('ExtraTree', extra_tree_forest), ('XGboost',model), ('RandomForest', random_forest)], voting='hard',weights=[2,1,1])
voting_hard.fit(x_train, y_train)

for clf in (model,extra_tree_forest,random_forest, voting_hard):
    clf.fit(x_train, y_train)
patient = []
patient.append(Age)
patient.append(SystolicBP)
patient.append(DiastolicBP)
patient.append(BloodSugar)
patient.append(BodyTemp)
patient.append(HeartRate)
mat = np.array([patient])
vote=voting_hard.predict(mat)
predict=prediction(vote)
return predict
```

```
val obj = pyobj.callAttr(  
    key: "main", viewModel.getAge(),  
viewModel.getGravidity(),  
viewModel.getParity(),  
multiplicityofpregnancy,  
tobaccouse,  
timeoftobaccouse,  
alcoholuse,  
timeofalcoholuse,  
viewModel.getDiabetes(),  
viewModel.getFDiabetes(),  
viewModel.getHypertension(),  
viewModel.getFHypertension(),  
traditionaltreatmentuse,  
specifictreatmentifusetraditiona,  
purposeifusetraditionaltreatment  
)  
binding.Result1.setText(obj.toString())  
viewModel.setPreeclampsia(obj.toString())  
}  
}  
}
```

ML-Pre-eclampsia:

```

filename = join(dirname(__file__), "cleaned_preeclampsia.csv")
data=pd.read_csv(filename)
x = data.drop(["casecontrol", "casetye"], axis = 1)
y=data["casecontrol"].values
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.3, random_state=6)
model = XGBClassifier(max_depth=10)
svclassifier = SVC(kernel='rbf', C = 10 , gamma = 1)
knn = KNeighborsClassifier(1, algorithm="brute", metric='cosine')
voting_hard = VotingClassifier(estimators=[('SVC',svclassifier), ('KNN',knn), ('XGBOOST', model)],voting='hard')
voting_hard.fit(x_train, y_train)
for clf in (knn, svclassifier, model, voting_hard):
    clf.fit(x_train, y_train)
y_pred = clf.predict(x_test)

```

Daily-symptoms:

- focuses on the trimester she is in
- Shows the changes made to it
- When you click on any symptom, a detailed description of it will appear

```

(viewModel = ViewModelProvider(requireActivity()).get(LocalDataViewModel::class.java)
when(viewModel.getTrimester()){
    "First Trimester"->trimesterNum="first"
    "Second Trimester"->trimesterNum="second"
    "Third Trimester"->trimesterNum="third"
}
val minput = InputStreamReader(requireContext().assets.open(fileName: trimesterNum+".csv"))
val reader = BufferedReader(minput)
binding.list.adapter=questionRecyclerView
binding.list.setLayoutManager(GridLayoutManager(context, spanCount: 1))
var line : String?
while (reader.readLine().also { line = it } != null){

    val row : List<String> = line!!.split( ...delimiters: ", ")
    QuestionsList.add(Questions(count, row[0]))
    answers.add(row[1])
    add.add(row[2])
    questionRecyclerView.setList(QuestionsList)
    count++
}

questionRecyclerView.onListItemClick=this
}

```

Video:

- Show baby development

```
fun Display(path:String){  
    val uri: Uri = Uri.parse(path)  
    binding.videoView.setMediaController(mediaController)  
    binding.videoView.setVideoURI(uri)  
    binding.videoView.requestFocus()  
    binding.videoView.start()  
}  
}
```

Common Qs:

When you click on the question, the answer will appear

```
val minput = InputStreamReader(requireContext().assets.open(fileName: "commonQ.csv"))  
val reader = BufferedReader(minput)  
binding.Qlist.adapter = questionRecyclerView  
binding.Qlist.setLayoutManager(GridLayoutManager(context, spanCount: 1))  
var line: String?  
while (reader.readLine().also { line = it } != null) {  
    val row: List<String> = line!!.split(...delimiters: ",")  
    QuestionsList.add(Questions(count, row[0]))  
    answers.add(row[1])  
    questionRecyclerView.setList(QuestionsList)  
    count++  
}  
questionRecyclerView.onListItemClick = this
```

Common questions and answers:

- The questions are the most popular questions that revolve in the mind of every pregnant woman
- The answers to these questions include some important medical information and advice

```
override fun onItemClick(question: Questions) {  
    val builder = AlertDialog.Builder(context)  
    builder.setTitle("Answer")  
    builder.setMessage(answers.get(question.id))  
    builder.setPositiveButton("Done") {  
        dialog, which ->  
        dialog.cancel()  
    }  
    val alertDialog = builder.create()  
    alertDialog.show()  
}  
}
```

Save Kicks:

- Record the number of kicks made by the fetus throughout the day

```
binding.save.setOnClickListener { it: View!  
    if (count != 0) {  
        viewModel.addData(Kicks(id: 0, current, count))  
        getAllItems()  
        current = LocalDateTime.now().format(formatter)  
        count = 0  
        binding.counter.setText("number of kicks" + count)  
  
    } else {  
        Toast.makeText(context, text: "Kicks = 0 ", Toast.LENGTH_SHORT).show()  
    }  
  
}  
  
kickRecyclerView.onListItemClick = this  
viewModel.KicksLiveData.observe(viewLifecycleOwner,  
    Observer { it: List<Kicks>!  
        if (!it.isNullOrEmpty()) {  
            kickRecyclerView.setList(it)  
        } else {  
            kickRecyclerView.setList(emptyList())  
        }  
    })  
}
```

Delete Kicks:

- The mother can delete the number of old fetal kicks recorded to create a new one

```
override fun onItemClick(kicks: Kicks) {  
  
    val builder = AlertDialog.Builder(context)  
    viewModel = ViewModelProvider(requireActivity())[KicksViewModel::class.java]  
    builder.setTitle("Warning!!!")  
    builder.setMessage("Are you sure you want to delete this item?")  
    builder.setPositiveButton( text: "Yes") {  
        dialog, which ->  
        viewModel.deleteData(kicks)  
        getallitems()  
    }  
    builder.setNegativeButton( text: "No") {  
  
        dialog, which ->  
        dialog.cancel()  
    }  
  
    val alertDialog = builder.create()  
    alertDialog.show()  
  
}
```

Add Notes:

- Function determines the time and date that you will add to notes
- the Broadcast send notification to the mother in the time of note

```
binding.add.setOnClickListener { it:View!  
    if (binding.Date.text.toString() != "Date" && binding.Time.text.toString() != "Time" && !binding.Note.text.toString()  
        .isBlank())  
    ) { var date = binding.Date.text.toString()  
        var time = binding.Time.text.toString()  
        var note = binding.Note.text.toString()  
        viewModel.addNote(Note( id: 0, date, time, note))  
        val manager: AlarmManager = requireActivity().getSystemService(ALARM_SERVICE) as AlarmManager  
        val intent = Intent(requireActivity(), MyReceiver::class.java)  
        intent.putExtra( name: "Data",note)  
        val pendingIntent: PendingIntent = PendingIntent.getBroadcast(requireActivity(), REQUEST_CODE, intent, PendingIntent.FLAG_IMMUTABLE)  
        REQUEST_CODE++  
        c.set(years, months, days, Hours, Minutes, second: 0)  
        manager.setExact(AlarmManager.RTC_WAKEUP, c.timeInMillis, pendingIntent)  
        binding.Date.setText("Date")  
        binding.Time.setText("Time")  
        binding.Note.setText(" ")  
        getAllNote()  
    } else { Toast.makeText(context, text: "Enter all fields to add note", Toast.LENGTH_SHORT).show() }  
}  
  
NoteRecyclerView.onListItemClick = this  
viewModel.noteLiveData.observe(viewLifecycleOwner, Observer { it:List<Note>!  
    if(!it.isNullOrEmpty()) {  
        binding.progressBar3.visibility = View.VISIBLE  
        NoteRecyclerView.setList(it)  
        binding.progressBar3.visibility = View.GONE  
    }else{ NoteRecyclerView.setList(emptyList()) }  
})  
}
```

Delete Note:

- The mother can erase the notes that she recorded

```
override fun onItemClick(note: Note) {
    val manager: AlarmManager = requireActivity().getSystemService(ALARM_SERVICE) as AlarmManager
    val intent = Intent(requireActivity(), MyReceiver::class.java)
    val pendingIntent: PendingIntent = PendingIntent.getBroadcast(
        requireActivity(),
        note.REQUEST_CODE,
        intent,
        PendingIntent.FLAG_IMMUTABLE
    )
    val builder = AlertDialog.Builder(context)
    builder.setTitle("Warning!!!")
    builder.setMessage("Are you sure you want to delete this note?")
    builder.setPositiveButton( text: "Yes") {
        dialog, which ->viewModel.deleteNote(note)
        manager.cancel(pendingIntent)
        getallNote()
    }
    builder.setNegativeButton( text: "No") {
        dialog, which ->
        dialog.cancel()
    }

    val alertDialog = builder.create()

    alertDialog.show()
}
```

Kicks View Model:

- This function is important because it takes the data from the database to display it on the view
- It also takes the data from the view to store it in the data base

```
class KicksViewModel(application: Application) : AndroidViewModel(application) {  
    private var LocalRepoImp: localRepoImp  
    private var kicksMutableLiveData = MutableLiveData<List<Kicks>>()  
    val KicksliveData: LiveData<List<Kicks>> get() = kicksMutableLiveData  
  
    init {  
        var db = UserDatabase.getInstance(application)  
        LocalRepoImp = localRepoImp(db)  
    }  
    fun getData() = viewModelScope.launch { this: CoroutineScope  
        kicksMutableLiveData.postValue(LocalRepoImp.getItems())  
    }  
    fun addData(kicks: Kicks) {  
        viewModelScope.launch(Dispatchers.IO) { this: CoroutineScope  
            LocalRepoImp.addAndUpdateItem(kicks)  
        }  
    }  
    fun deleteData(kicks: Kicks){  
        viewModelScope.launch { this: CoroutineScope  
            LocalRepoImp.deleteItem(kicks)  
        }  
    }  
    fun deleteAllItems(){  
        viewModelScope.launch { this: CoroutineScope  
            LocalRepoImp.deleteAllitems()  
        }  
    }  
}
```

Notes View Model:

- This function is very important because it can take the notes from the data base and display them on the view.

```
class NotesViewModel(application: Application) : AndroidViewModel(application) {  
    private var LocalRepoImp: localRepoImp  
    private var noteMutableLiveData = MutableLiveData<List<Note>>()  
    val noteLiveData: LiveData<List<Note>> get() = noteMutableLiveData  
    init {  
        var db = UserDatabase.getInstance(application)  
        LocalRepoImp = localRepoImp(db)  
    }  
    fun getNotes() = viewModelScope.launch { this: CoroutineScope  
        noteMutableLiveData.postValue(LocalRepoImp.getNotes())  
    }  
  
    fun addNote(note: Note) {  
        viewModelScope.launch(Dispatchers.IO) { this: CoroutineScope  
            LocalRepoImp.addAndUpdateNote(note)  
        }  
    }  
    fun deleteNote(note: Note){  
        viewModelScope.launch { this: CoroutineScope  
            LocalRepoImp.deleteNote(note)  
        }  
    }  
    fun deleteAllNote(){  
        viewModelScope.launch { this: CoroutineScope  
            LocalRepoImp.deleteAllNotes()  
        }  
    }  
}
```

Test case ID	Test case objective	Test case description	Expected result
1	Check the interface link between the sign-up and home page	Enter all data and credentials and click on the sign-up button	To be directed to the home page
2	Check the interface link between the form and view model	Enter all in the form and click on the submit button	To be directed to send notifications
3	Check the interface link between the alarm manager and notifications	Enter all in the form and click on the submit button and wait	To be directed to send notifications Every 6 h
4	Check the link between the profile and the dialog box	Try to change the data in the form and click on the save button	To be directed to change the data
5	Check the link between the baby's development and the database	Try to change the week and click on the save button	To be directed to change the data to the new current week
6	Check the link between the risk factors and the ml model	Enter high blood pressure into the form and click on the save button	Predict the maternal health risk
7	Check the link between the pre-eclampsia risk factors and the ml model	Enter some of the symptoms of the pre-eclampsia into the form and click on the save button	To be directed to predict the pre-eclampsia

Test case ID	Test case objective	Test case description	Expected result
8	Check the interface link between the Qs and the database	click on the question	To be directed to display the answer
9	Check the interface link between the notes view model and database	Enter to add the note and click on the save button	To be directed to save the note
10	Check the interface link between the notes view model and the database	Enter to delete the note and click on the save button	To be directed to delete the note
11	Check the link between the baby's development and the database	Try to change the week and click on the save button	To be directed to change the data to the new current week
12	Check the interface link between the kicks view model and the database	click on the kick button	To be directed to add kicks and increase the number of kicks
13	Check the interface link between the kicks view model and the database	Try to delete the record of old kicks	To be directed to delete kicks
14	Check the interface link between the notes view model and notifications	Enter the date and the time of taking notes	The application should send a notification to make the user add notes

Chapter 6: Results and Discussion

➤ **Expected result**

✓ **Support Pregnancy**

- The mother creates a new account containing all information about her health, and her medical history to store them in the private medical record.
- The application saves all patient data so that the doctor can always check on his patient's past data.
- Will also work on the anonymous collection of data and the creation of reliable datasets.
- Pregnancy follow-up is a supported Pregnancy app for busy moms dealing with some serious pregnancy brain.
- Available for Android

Accurate diagnosis

- The application must predict preeclampsia and other diseases based on the patient's medical history.
- The application must predict the risk to the mother, Based on the daily/weekly symptoms, her medical history taken by the doctor, and her current health state.

Guide Pregnancy

- The application has an excellent reputation for its medical accuracy and up-to-date facts about pregnancy.
- In addition to the daily and weekly guides, tracking ability, and health information, you also get some pretty amazing images of the baby's development.
- The application provides a simple medical Library containing articles, videos & images, and Common questions asked by pregnant women, and answered by Gynecologists. , General dos and don'ts of pregnancy, General topics, and Books about child upbringing.
- Help the pregnant woman stay organized and educated about all of the developments and changes happening in her body.
- Provide the possibility of permanent translation of some medical terms when clicking on the word to help the mother understand these terms by providing her with a medical dictionary present in the library and providing quick definitions of highlighted words.

Improved efficiency and speed

- The application can enhance healthcare delivery with more efficiency, as it can handle multiple queries and requirements at a time.

Reduction in healthcare costs

- The cost associated with the healthcare consultation is reduced significantly with the usage of apps as the maintenance cost is less.
- The application will help her reduce her hospital visit costs, the mother needs to go to the hospital more than the number of visits allocated to her, in order to suspect any symptoms she has, so she would like to know that she is fine, as this is considered an extra cost to her.

Easy to use and convenient

- Monitor vital stats such as blood pressure, heart rate, glucose levels, stress management, sleep quality, nutrition tracking, and several other important activities.
- Record her fetus' movement during the day.
- The mother checks the symptoms she feels daily from a list of symptoms.
- The application predicts the risk to the mother, Based on the daily/weekly symptoms, her medical history taken by the doctor, and her current health state.
- Similarly, telemedicine is improving the accessibility of healthcare information to remote areas.

Save time

- The patients can easily connect with the healthcare provider for consultation.
- The doctor may write virtual prescriptions to help the mother in a remote way
- It saves traveling time between home and the healthcare center and also requires fewer visits as compared to the traditional approach.
- The application saves the mother time and, she can ask the application at any time about her symptoms and make sure of her health at any time by interacting with the doctors present in the application.
- It helps to reduce overcrowding in hospitals and to allow time for the doctor to assist in emergency cases only.
- The doctor shall make Easy communication with the mother by using chat and online calls.

Seamless exchange of data

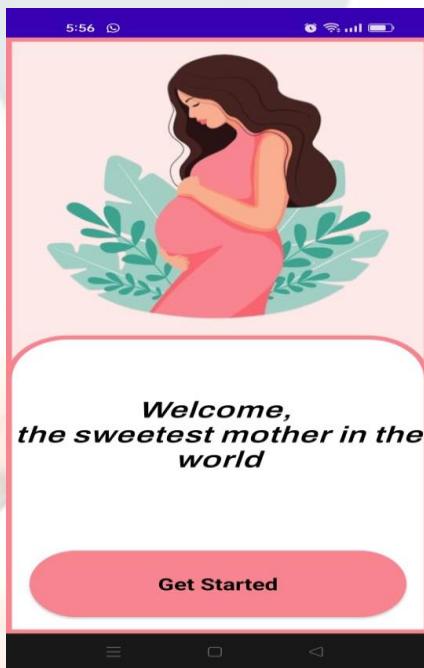
- Come with an inbuilt option to share and transfer health data across the healthcare system.
- The app provides an option for secure and hassle-free process payment options with different gateways for medical bills and subscriptions. If the pregnant woman forgets to pay the bills, these apps send notifications as a reminder

Support Comprehensive services

- Provide one location to keep all of her baby bump information.
- The app is packed full of useful tips on every pregnancy topic you can imagine.
- The pregnant woman logs on to find out info about where you are in her pregnancy or watch videos about how her body is going to change over the course of nine months..
- The application must provide notifications for Reminders for symptom entry, Upcoming appointments, Library notifications, Ability to decide which notifications are allowed.
- The application should provide a calendar to manage the time of medicine to be taken with doses and time during the day, and a Pregnancy timeline.

✓ Actual results

- Main:



- Sign-up:

The image shows the first step of a sign-up form. The title "Enter your data" is at the top. There are four input fields: "Your name", "Date of birth", "Country", and "City". Below the fields is a red "SUBMIT" button. At the bottom of the screen is a decorative illustration of a pregnant woman holding a baby, with a heart icon above them. The background of the slide features a soft, out-of-focus image of a pregnant woman's belly.

The image shows the second step of the sign-up form, where the user has entered data into the fields. The "Your name" field contains "Hana", the "Date of birth" field contains "1/7/1987", the "Country" field contains "Egypt", and the "City" field contains "Cairo". Below the fields is a red "SUBMIT" button. At the bottom of the screen is a decorative illustration of a pregnant woman holding a baby, with a heart icon above them. The background of the slide features a soft, out-of-focus image of a pregnant woman's belly.

- **The form:**

Create your account

weight in Kg
height in cm
Number of babies who reached 24 w
Number of times you were pregnant
Last missed period

Your history Family history

Diabetes Diabetes
 Hypertension Hypertension

SUBMIT

2023
Mon, May 29

< May 2023 >
S M T W T F S
1 2 3 4 5 6
7 8 9 10 11 12 13
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28 29 30 31

CANCEL OK

- **Home:**

Home

Week20
20 Weeks to Go

Your Result
pregnancy risk : No Result

Home

20 Weeks to Go

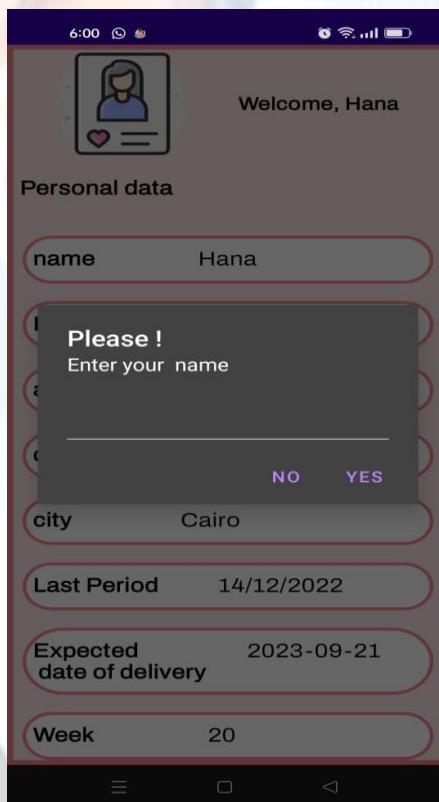
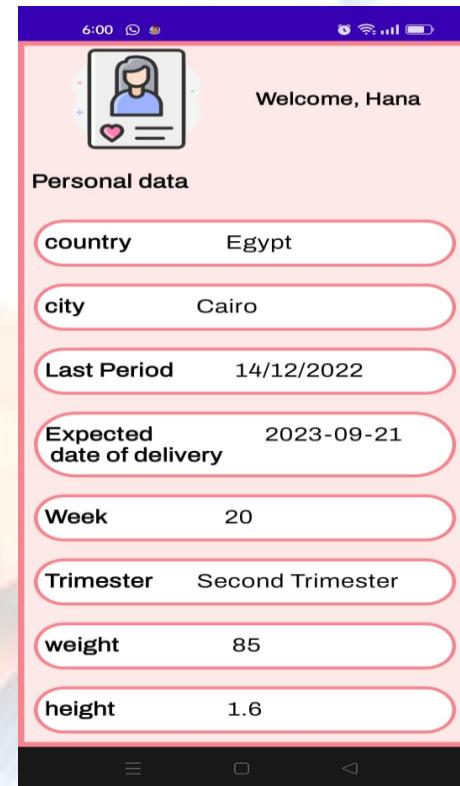
Your Result
pregnancy risk : No Result
Preeclampsia :No Result
Follow up your pregnancy Every Day
Your routine for healthy pregnancy

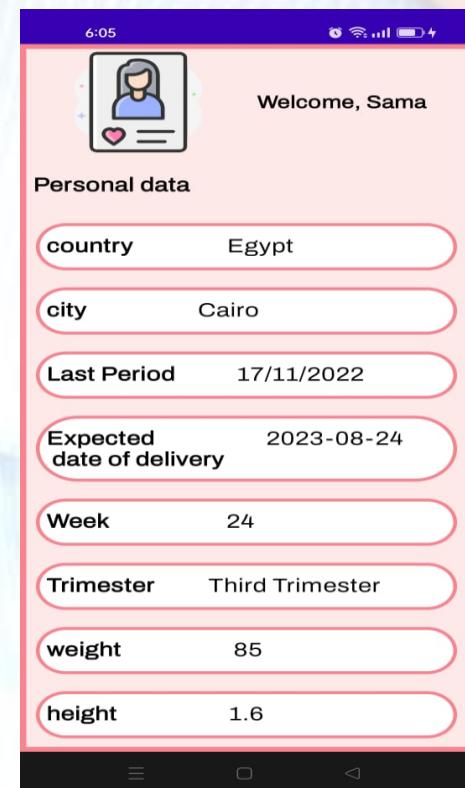
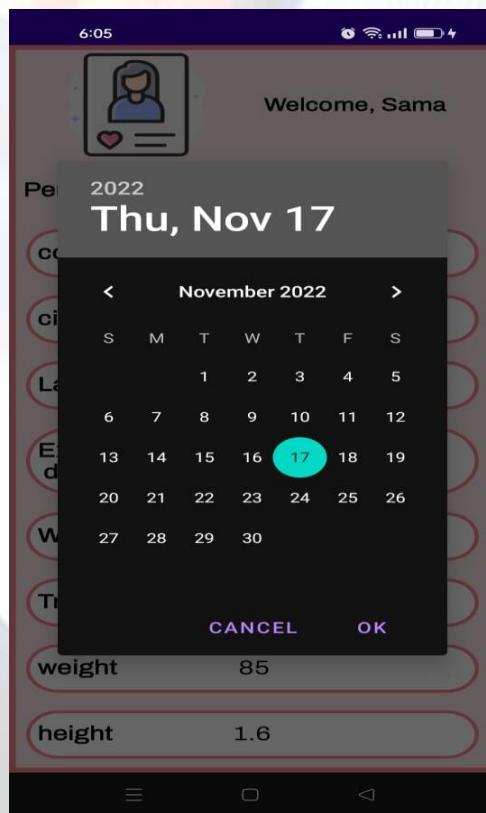
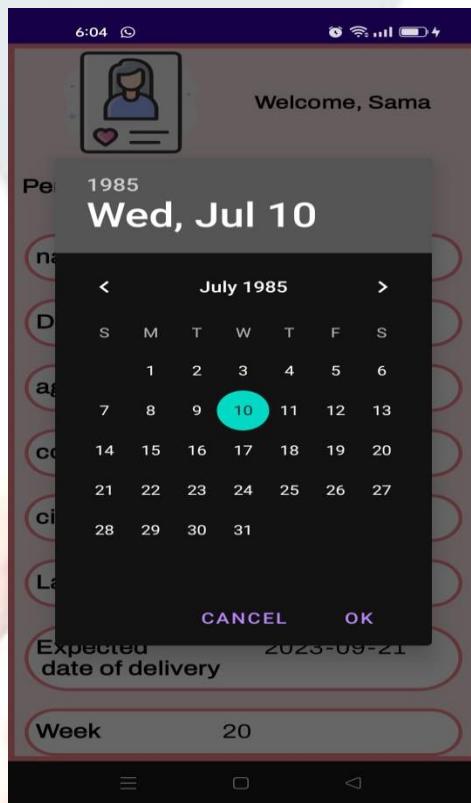
Home

20 Weeks to Go

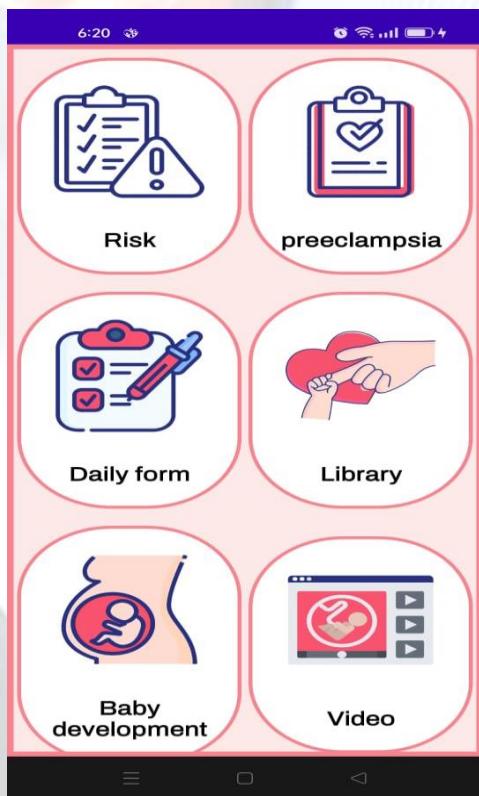
Your Result
pregnancy risk : No Result
Warning!!!
Your Data will be deleted
NO YES

- **Profile:**

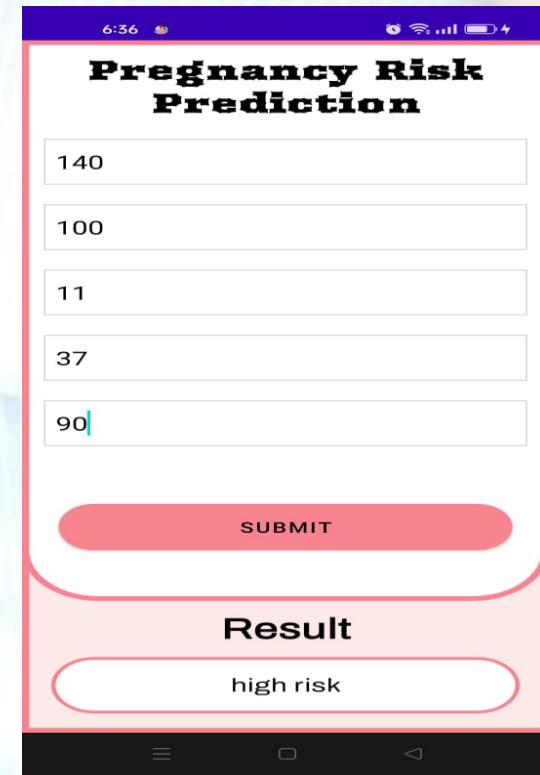
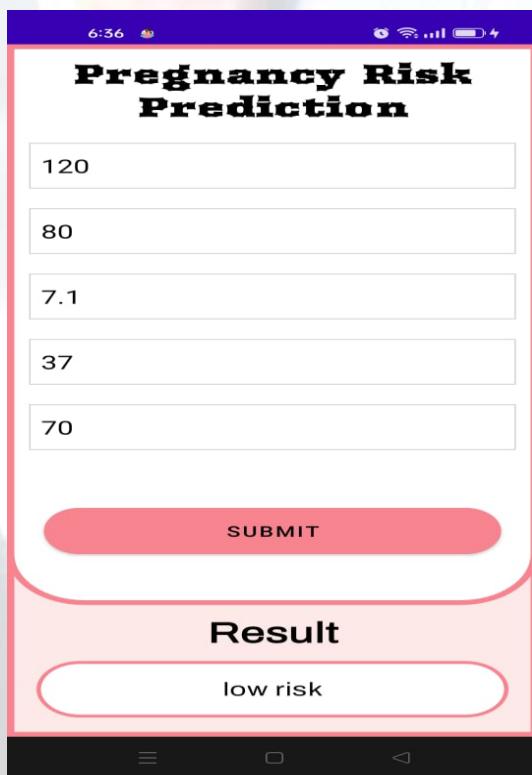
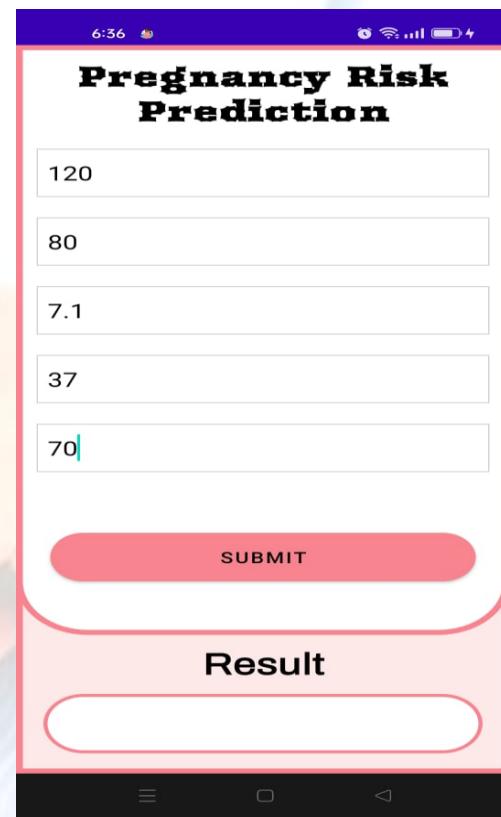
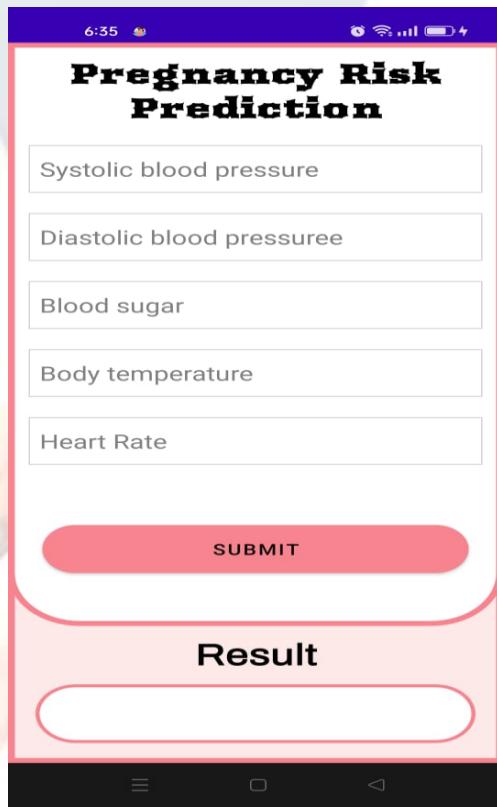




- **Main feature**



Risk:



- **Preeclampsia:**

6:37

preeclampsia

pregnant with twins

alcoholuse use?

No use

use before pregnancy

use during pregnancy

tobaccouse use?

No use

use before pregnancy

use during pregnancy

treatment use?

No use

SUBMIT

Result

≡ ◻ ◄

6:38

preeclampsia

pregnant with twins

alcoholuse use?

No use

use before pregnancy

use during pregnancy

tobaccouse use?

No use

use before pregnancy

use during pregnancy

treatment use?

No use

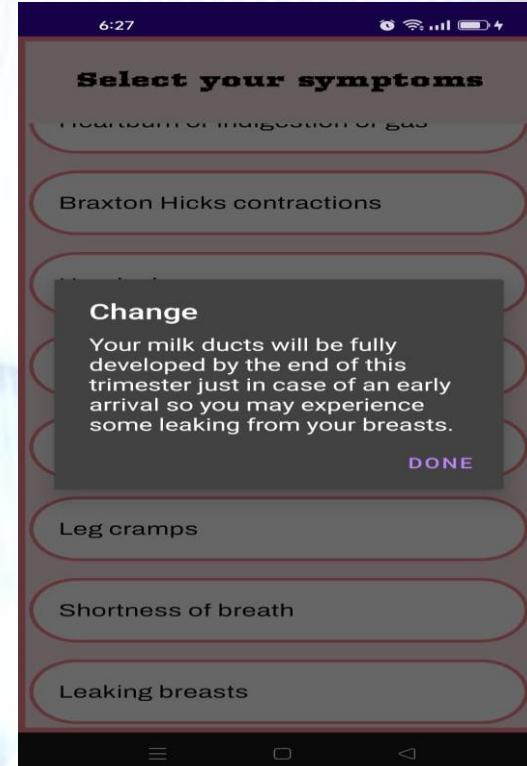
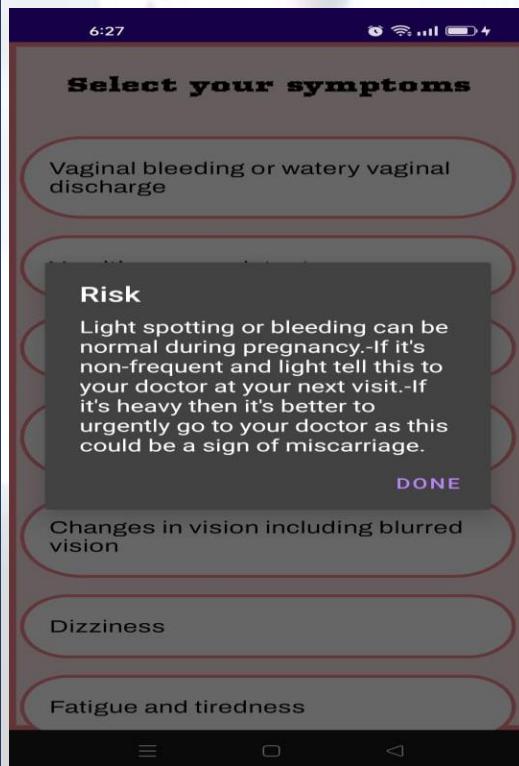
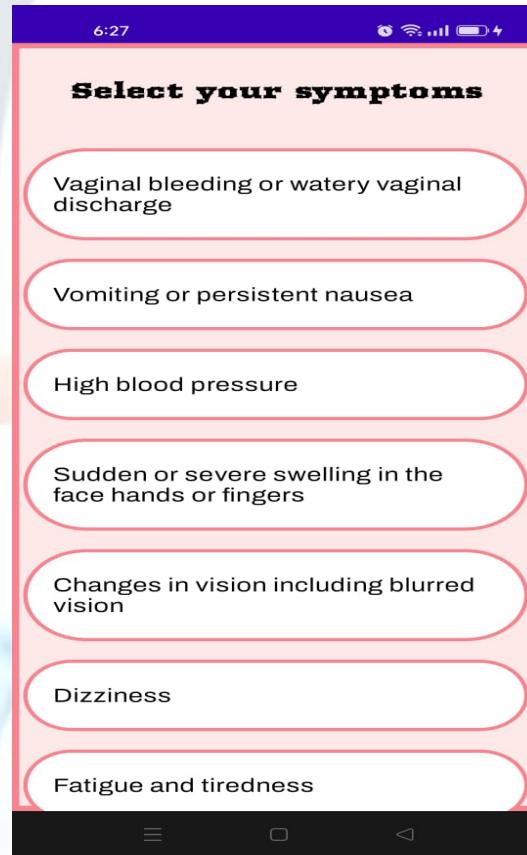
SUBMIT

Result

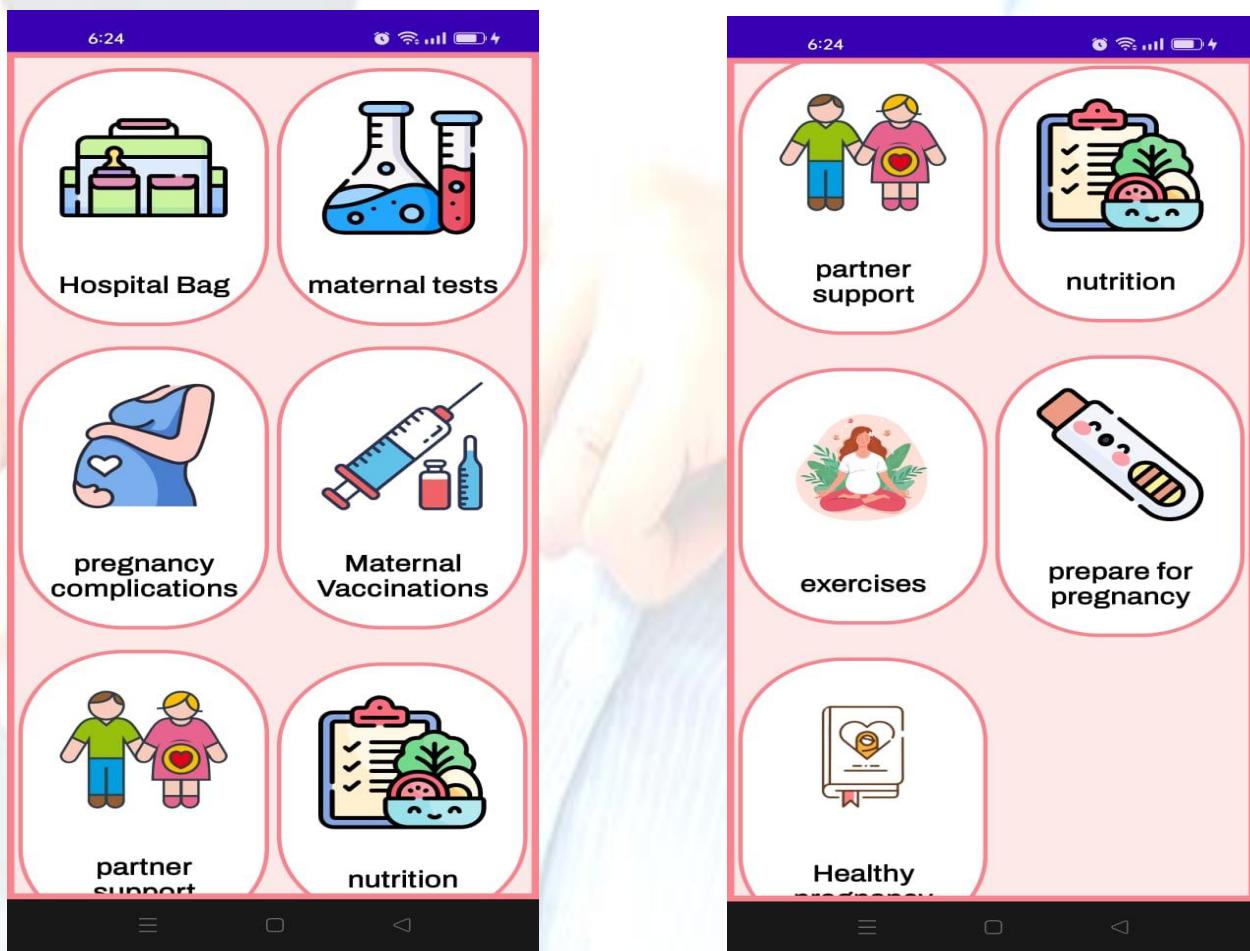
Preeclampsia

≡ ◻ ◄

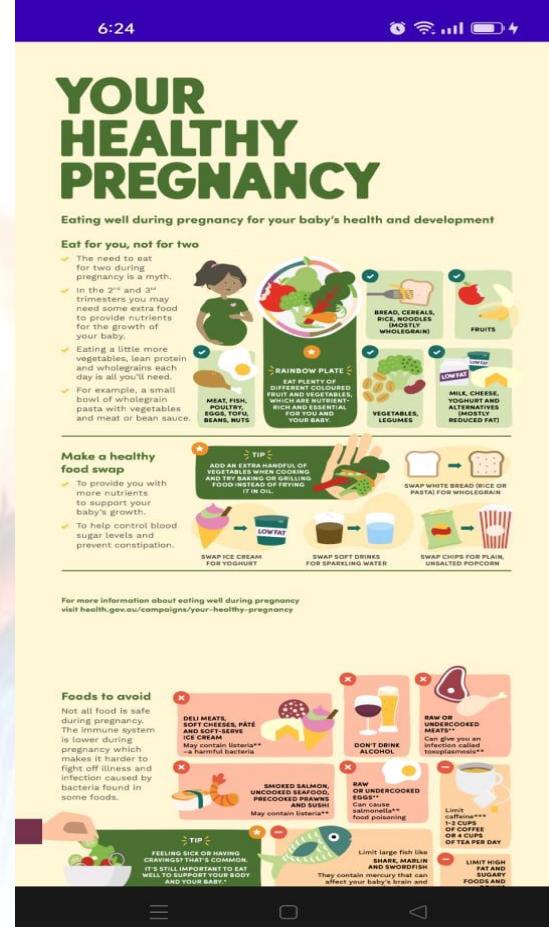
- **Daily symptoms:**



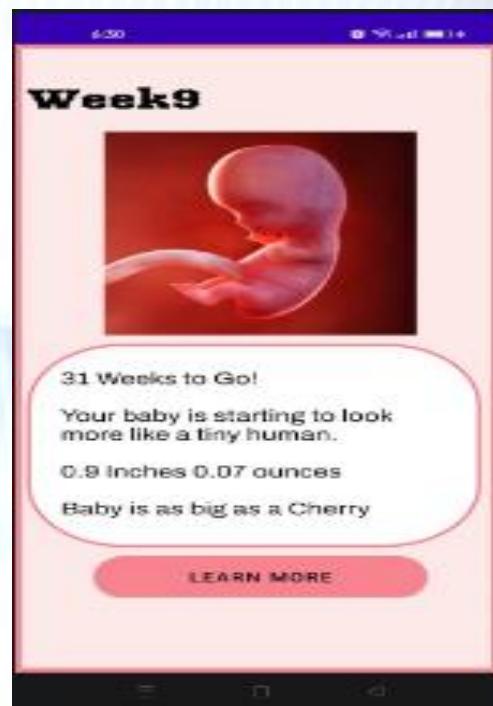
• **Library:**



• Libraries



- **Baby development**



• Learn more about baby development

Week 20

The fetus is around 21 cm in length. The ears are fully formed and can hear muffled sounds from the outside world. The fingers have prints. The genitals can now be distinguished with an ultrasound scan.

Baby development

Belly hiccups

If you notice some baby movements that feel like subtle, rhythmic jolting, don't worry—baby hiccups in the womb are totally normal. Many expecting moms start to feel baby hiccups around the same time they feel other fetal movements, typically between 16 and 22 weeks.

How baby can taste

Many of your baby's taste buds can now transmit taste signals to their brain, and your baby is swallowing molecules of the food you eat that have passed through your blood into your amniotic fluid. Researchers aren't positive whether babies can taste these molecules, but some research indicates that what you eat during pregnancy can influence the foods your baby prefers later.

Symptoms

Fingernail discharge

You can expect the **discharge** to keep increasing until delivery, a direct result of heightened hormone levels. But let your doctor know if the discharge is yellow, green or foul smelling.

Leg cramps

Do stretches regularly, and drink plenty of water to prevent your legs from **cramping**.

Heartburn and/or indigestion

As baby starts to crowd your digestive system, it might not work exactly as it did pre-pregnancy. Watch what you're eating! If you've got heartburn or an upset stomach—acidic and spicy foods can cause tummy troubles.

Week 25

Baby development

Gaining baby fat

Your baby will soon exchange that long, lean look for some baby fat. Wrinkled skin will begin to smooth out, and they'll start to look more and more like a **baby**.

Your baby's hair

Your baby is **growing more hair**—and if you could see it, you'd be able to discern its color and texture.

Sleeping like a baby

Your baby spends most of their time sleeping, and cycles between rapid eye movement (REM) sleep and non-REM sleep every 20 to 40 minutes.

Symptoms

Trouble sleeping

Maybe you can't **sleep** because you're getting nervous about delivery, or maybe it's your **hormone** hormones—or just you're **getting** in the way. Experiment with different **solutions** for getting some sleep. One idea is to drink extra water early in the day, so you can start peeing off your intake as you get closer to bedtime. That way, you might need fewer bathroom breaks during the night.

Frequent urination

Now that baby is **crowding your bladder**, you've got to pee. A lot.

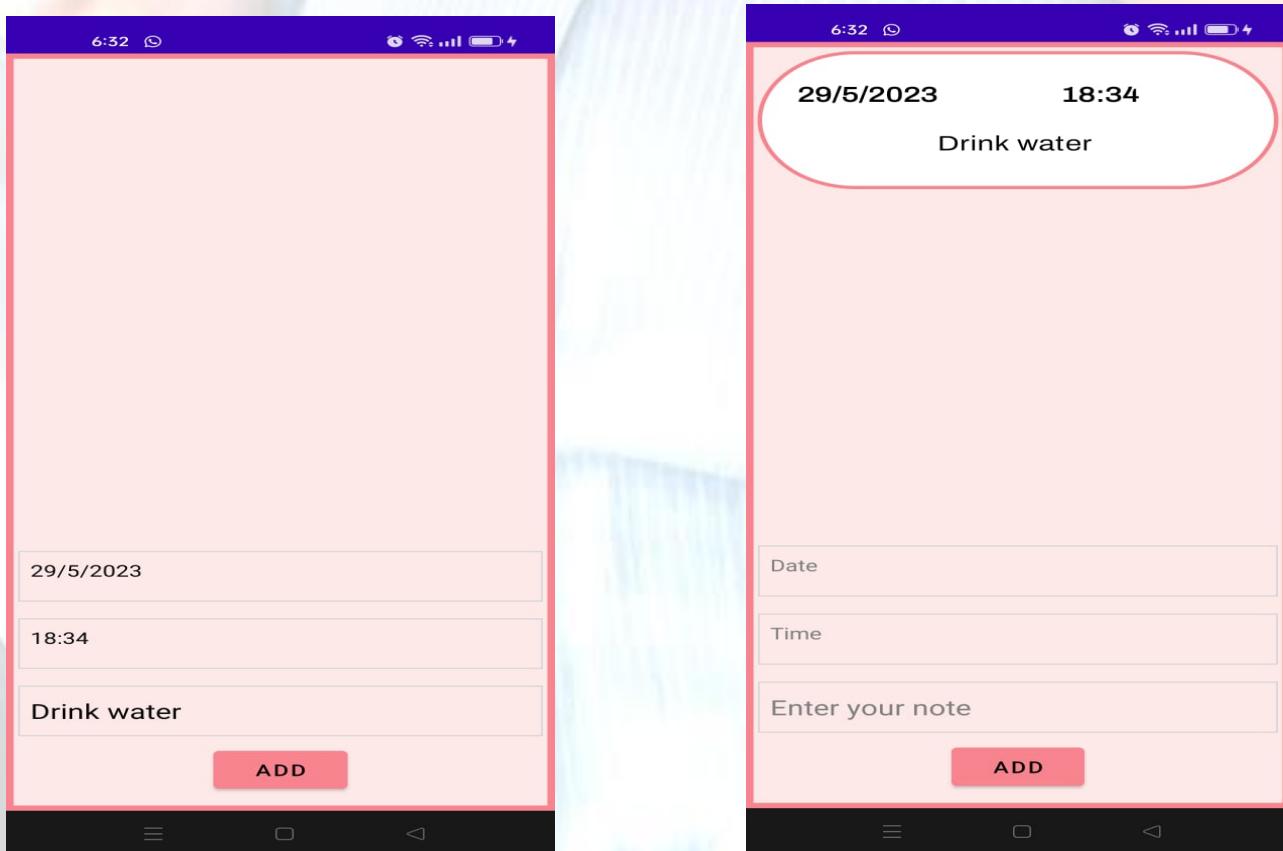
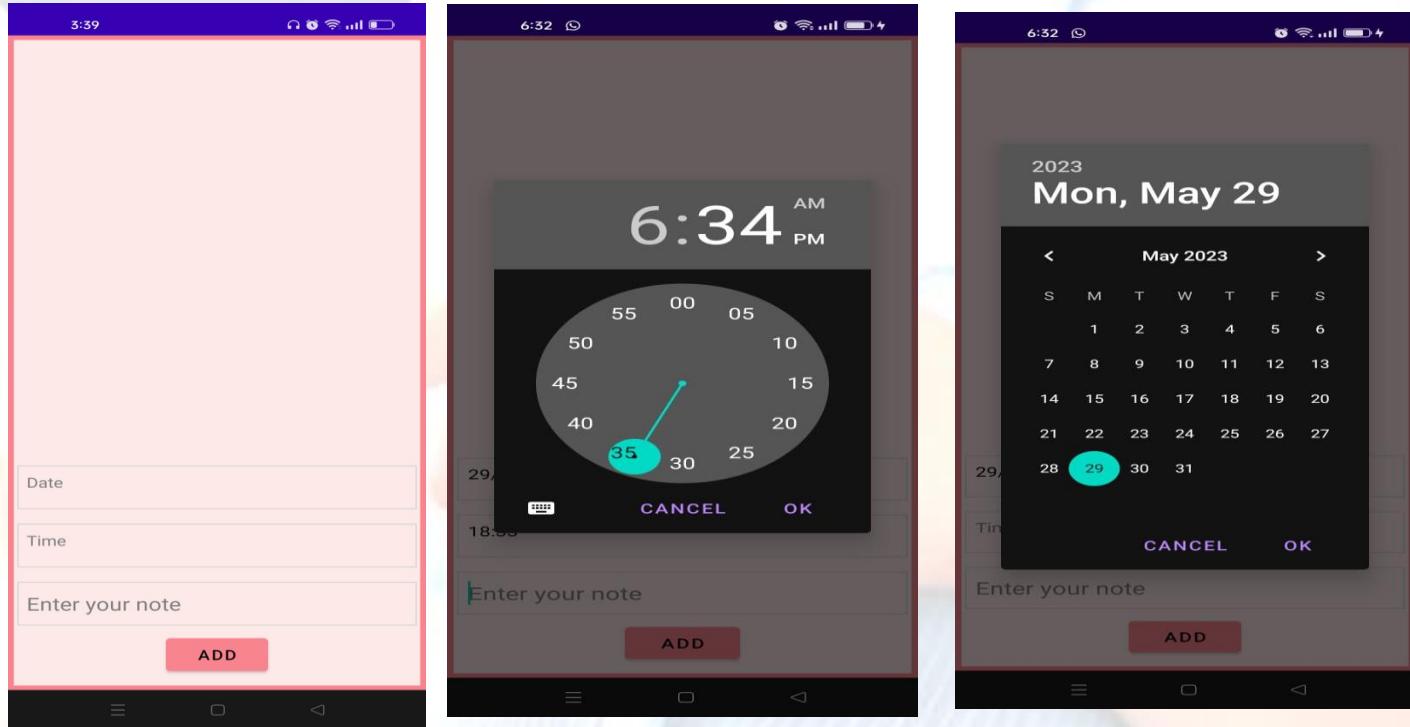
Constipation

Eating (it's as simple as taking regular walks), drinking lots of water and eating plenty of fiber-rich foods can help you **stay regular**.

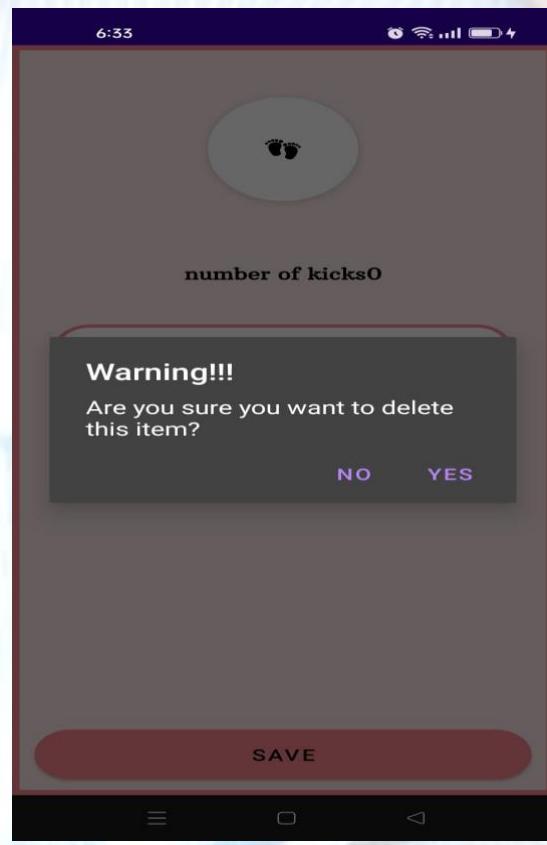
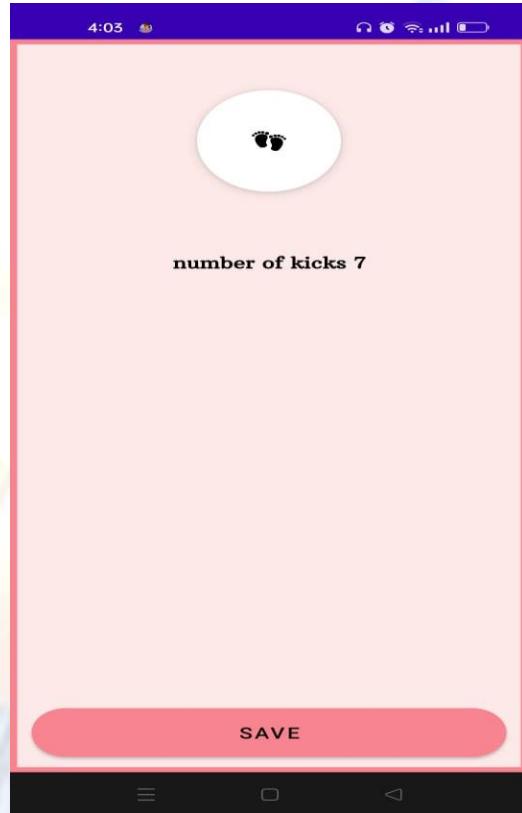
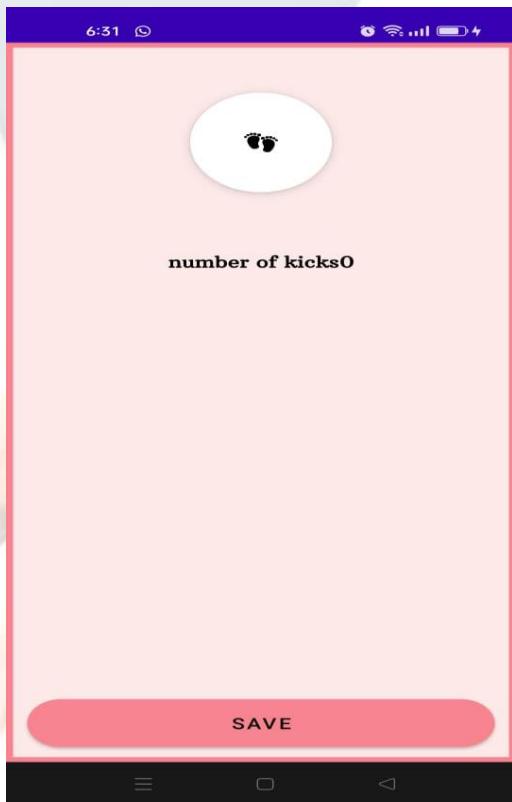
Video:



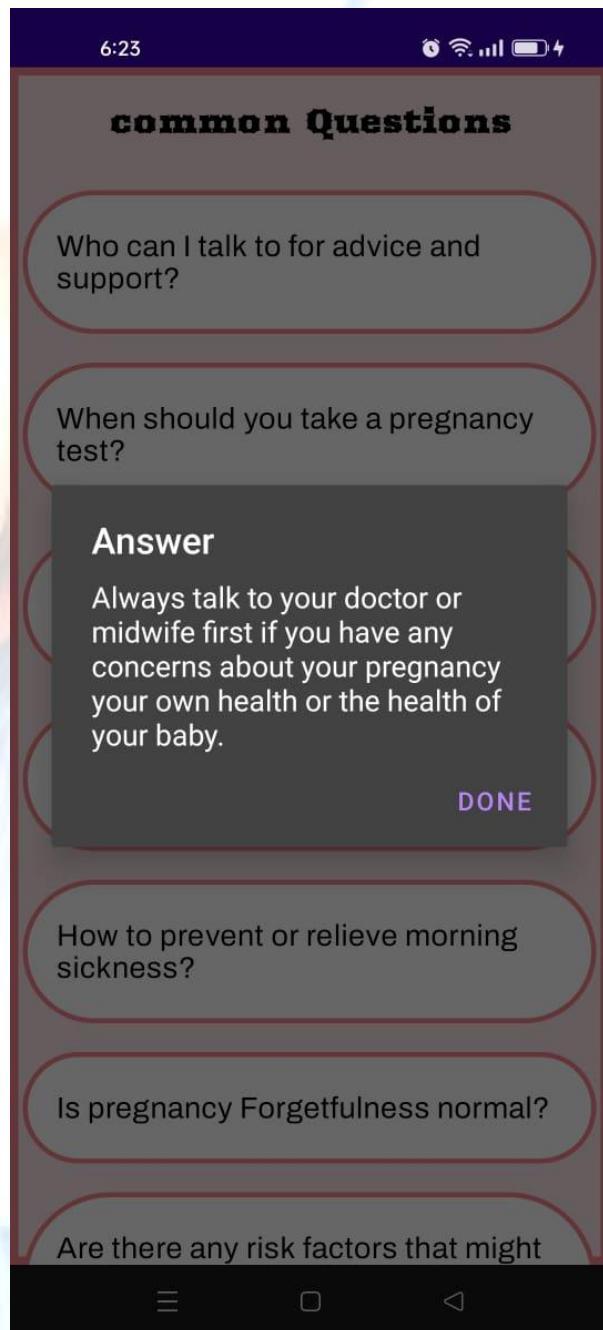
Notes:



Kicks:



Questions:



Chapter 7: Conclusion

The pregnancy follow-up program is one of the most important programs that a pregnant woman needs in all months of her pregnancy. It is a special doctor for her and her health condition available to her at anytime and anywhere. A pregnant woman can make it an assistant in all aspects of her life during the months of pregnancy, because the program serves her as follows:

- It is an ml model that responds to her symptoms in form for a risk form for her pregnancy ,and predict if she will have preeclampsia or not according to her condition
- The mother can create her own account on the program, and her data and medical history are recorded, and they are saved in her own medical record.
- This app also works with anonymous collection of data and creation of reliable datasets.
- The application saves all patient data.
- Allows the mother to record the movement of her fetus during the day.
- Makes the mother check the symptoms she feels daily from a list symptoms.
- The app predicts risks based on that daily symptoms/medical history current state of health.
- The application predicts symptoms based on the patient's condition Medical history.
- The application displays symptoms based on the patient's trimester.
- The application provides a simple medical library containing articles, videos & images like hospital bag, maternal tests, pregnancy complications, maternal vaccinations, partner support, nutrition, exercises, preparing for pregnancy and healthy pregnancy.
- The application provides baby development videos and articles, a kick counter and common questions asked by pregnant women answered by gynecologists.
- The app provides notifications to remind you of symptoms entry, upcoming appointments, library notifications, ability to decide allowed notifications.

- The application provides a notes feature for managing the doctor's office appointments, medications to be taken during the day, and the table for pregnancy.
- The application displays a daily routine she should follow to have a healthy pregnancy.

We have recommendations how to enhance the project if you are given the right resources:

- The app function as a social network for healthcare workers, allowing them to share information, ask and answer questions, and communicate as a group.
- The application will help her reduce her hospital visit costs, the mother needs to go to the hospital more than the number of visits allocated to her, in order to suspect any symptoms she has, so she would like to know that she is fine, as this is considered an extra cost to her.
- The app provides an option for secure and hassle-free process payment options with different gateways for medical bills and subscriptions. If the pregnant woman forgets to pay the bills, these apps send notifications as a reminder.
- the application will provide some medical terms when pressing on the word mother understand these terms by providing them with an existing medical dictionary provides quick definitions of highlighted words.
- The patients can easily connect with the healthcare provider for consultation.
- The application saves the mother time and, she can ask the application at any time about her symptoms and make sure of her health at any time by interacting with the doctors present in the application.
- It helps to reduce overcrowding in hospitals and to allow time for the doctor to assist in emergency cases only..

Chapter 8: Future work

Support Pregnancy

- The application saves and backs up all patient data so that the doctor can always check on his patient's past data.
- Will also work on the anonymous collection of data and the creation of reliable datasets.
- Pregnancy follow-up is a supported Pregnancy app for busy moms dealing with some serious pregnancy brain.
- Available for Android, the Support app also comes with the ability to capture belly photos and pair them with your ultrasounds to create a digital record.
- Can also use the support app to log appointment reminders, questions for her doctor, and milestones she reaches along the way.
- The mother should upload the lab results and radiographs and the application must store them in her medical record.

Guide Pregnancy

- Help the pregnant woman stay organized and educated about all of the developments and changes happening in her body.
- Provide the possibility of permanent translation of some medical terms when clicking on the word to help the mother understand these terms by providing her with a medical dictionary present in the library and providing quick definitions of highlighted words.

Improved efficiency and speed

- The application can enhance healthcare delivery with more efficiency, as it can handle multiple queries and requirements at a time.

Reduction in healthcare costs

- The cost associated with the healthcare consultation is reduced significantly with the usage of apps as the maintenance cost is less.
- The application will help her reduce her hospital visit costs, the mother needs to go to the hospital more than the number of visits allocated to her, in order to suspect any symptoms she has, so she would like to know that she is fine, as this is considered an extra cost to her.

Save time

- The patients can easily connect with the healthcare provider for consultation.
- The doctor may write virtual prescriptions to help the mother in a remote way
- It saves traveling time between home and the healthcare center and also requires fewer visits as compared to the traditional approach.
- The application saves the mother time and, she can ask the application at any time about her symptoms and make sure of her health at any time by interacting with the doctors present in the application.
- It helps to reduce overcrowding in hospitals and to allow time for the doctor to assist in emergency cases only.
- The doctor shall make Easy communication with the mother by using chat and online calls.

Seamless exchange of data

- Come with an inbuilt option to share and transfer health data across the healthcare system.
- The app provides an option for secure and hassle-free process payment options with different gateways for medical bills and subscriptions. If the pregnant woman forgets to pay the bills, these apps send notifications as a reminder.

Support Comprehensive services

- Provide one location to keep all of her baby bump information.
- The app is packed full of useful tips on every pregnancy topic you can imagine. .
- The mother must click on the Alarm button for emergency situations that require going to the hospital by calling emergency contacts, calling the nearest emergency room for an ambulance.
- The application must allow accessing the location of users, and give access to users of Veezeta/Google maps/Online pharmacies to aid the pregnant woman.
- The application should provide a calendar to manage doctor's appointments, Medicine to be taken with doses and time during the day, and a Pregnancy timeline.

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- <https://www.statology.org/>
- <https://www.tableau.com/>
- <https://seaborn.pydata.org/index.html>
- <https://scikit-learn.org/stable/index.html>
- <https://pusher.com/tutorials/>
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