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POSTPARTUM DEPRESSION PREDICTION USING MACHINE LEARNING

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ABSTRACT
After giving birth, postpartum depression is a serious mental health problem that affects moms. Symptoms may include trouble bonding with the child, difficulty sleeping, loss of appetite, and extreme irritability. Among 50 % of the mothers experience major changes in their mental health and approximately 1 in 10 women will seek help.The typical duration of postpartum depression is 3 to 6 months, however this might vary depending on a number of factors. The Edinburgh Postnatal Depression Scale (EPDS) data set, which is gathered after a week from the mothers who gave birth to their children, is used in this study to train the model using Random forest algorithm.This model has two phases, where the first phase predicts the status of the mother in any one of the four ranges (Depressed, Most Likely Depressed, Likely Depressed, No Depression) based on the trained data. Where the second phase predicts the level of depression(0-4 none, 5-9 mild, 10-14 Moderate, 15-19 moderately severe, 20-27 severe.) based on the PHQ-9 Questionnaire, and it is suggested to take post-6 weeks of delivery. The results of phase one and two will be sent to the user via mail when they take the assessments in week one and week 6 respectively. The key benefit of this model is that there is no need for a third party because user and model evaluations take place directly between them. Since postpartum depression is not properly understood, many mothers do not receive treatment for their sickness, which can result in terrible circumstances and can be avoided by following this approach.

INTRODUCTION
Artificial intelligence (AI) has a subfield called machine learning that focuses on creating algorithms and models that let computers learn and make predictions or decisions without having to be explicitly programmed. To find patterns, predict outcomes, or take action, it involves the study of statistical models and algorithms that can analyze and interpret vast amounts of data. Postpartum depression (PPD) is a form of depression that occurs in women following childbirth. It is characterized by intense sadness, anxiety, and exhaustion, which can hinder a new mother's ability to care for herself and her baby. PPD typically emerges within the first few weeks after delivery but can arise up to a year later. Hormonal changes, personal or family history of depression, and stressful life events are among the factors that contribute to PPD. This condition can have a profound impact on both the mother and the baby, affecting their emotional well-being and the bonding process. Fortunately, postpartum depression is treatable through therapy, medication, and support networks, allowing women to recover and enjoy their motherhood journey. Seeking help from healthcare professionals is crucial for diagnosis and the implementation of appropriate interventions. To help in this situation, we have used Machine learning to implement postpartum depression prediction model. In this project, there are 2 phases. The first phase is an EPDS quiz that defines if the user has depression or not. This quiz must be taken post 1 week of

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delivery. The second phase is a PHQ9 quiz which defines the level of depression out of 27 points. The reports of both the surveys are sent to the user's registered mail for further analysis. The data of the users who have taken the survey is saved in an excel file for the service provider's information. Our model aims to help the mothers suffering from postpartum depression because, this condition can be or cannot be detected. If it is not detected and cured in time, it can lead to problems such as suicide attempt or baby harming. This project uses latest ML technology to help the women cure their depression and make them feel safe.

LITERATURE SURVEY

505 postpartum women in Jining City: Psychological and Physiological Characteristics and Contributing Factors

AUTHORS: Bin Zhuang, Xiu-Hui Liu, Shu-Ling Wang, Hong-Mei Song, and Ben-Fu-Yang

This approach investigates the Self-designed questionnaires about general states, Self-Rating Anxiety Scale (SAS), and Self-Rating Depression Scale (SDS), which were given to all postpartum women hospitalised to three hospitals in the Jining central district between March 15 and April 15, 2006. Results 26.5 percent of the 505 individuals experienced depression, while 18.8 percent had anxiety.

Education level, social support, and occupation were found to be protective among the characteristics examined, and it is crucial to enhance the availability of medical care and psychological counselling for women throughout the perinatal period. A study of postpartum depression in a fast developing country: prevalence and related factors

Abdulbari Bener and colleagues, Int J Psychiatry Med.

The Edinburgh Postnatal Depression Scale (EPDS) score was used in the study to estimate the prevalence and identify risk factors for postpartum depression. The period covered by this study lasted from January 2010 to May 2011. 1379 moms who had given birth during the previous six months were selected from a sample of 1669 mothers, and they participated in the study. Face-to-face interviews and a questionnaire served as the basis for this study. This covers a patient's sociodemographic traits, medical history, family history, and other factors. This questionnaire was examined, and the resultant score—which indicates the risk cases—was computed.

Visually Analysing the Postpartum Depression Domain Using a Combination of MDS and SOM

AUTHORS: Xi Meng, Ruifang Shen, Jianqiang Li, and Jijiang Yang

In order to visually expose study themes in the postpartum depression research area from a bibliographic point of view, this model was introduced in 2015 and focuses on a combination method that incorporated MDS and SOM. In this study, 391 materials that fell within the postpartumdepression category were used for analysis. We selected the two visualisation techniques since MDS and SOM each have drawbacks when it comes to dimension reduction strategies. To divide documents based on their topics, the self-organizing map and nonmetric MDS approach (Sammon's mapping) were used. A cluster analysis was then performed. The study's findings demonstrated the effectiveness of Sammon's mapping in combination with self-organizing map approaches for improved visualisation of the postpartum depression domain.

Improved Data Mining Techniques in a Community-Based Study for Postpartum Depression Early Detection

Siddhartha Baruah and Priyanka Mazumder are the authors.

By surveying 96 people in 2021, this study attempted to predict the most likely circumstances under which women would have postpartum depression. The goal of the study was to create a predictive model that could aid in predicting postpartum depression in females. The J48, Random Tree, Random Forest, and Reduce Error Pruning (REP) Tree data mining algorithms are used to construct predictive models.

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Additionally working together with these four algorithms are Adaptive Boosting and Bagging. The Edinburgh Postpartum Depression Scale was used in the dataset's class model building and it helped to validate the precise observation of Postpartum Depression sufferers. WEKA application tool is used during the model development process.

EXISTING SYSTEM

The birth of a child can cause intense feelings such as excitement, joy, anxiety, and others. However, it can occasionally result in unanticipated outcomes like sadness. Most new mothers have postpartum "baby blues" after giving birth, which commonly include mood swings, crying spells, anxiety, and difficulties sleeping. The newborn blues normally begin two to three days after delivery and can last for up to two weeks.

On the other hand, postpartum depression is a more severe and persistent kind of depression that some new mothers experience. It is frequently referred to as peripartum depression because it can start during pregnancy and continue after childbirth. After giving delivery, 10% to 15% of women worldwide have postpartum psychosis or postpartum depression (PPD), which is particularly prevalent in developing countries. Inadequate mother-baby bonding, newborn physical and cognitive development, language development, infant behaviours, and sleep quality have all been associated to PPD symptoms. Women are much more vulnerable to mental illness as a result of childbirth, with postpartum depression issues being the most common cause of postpartum haemorrhage. There are several methods for predicting the signs of depression. The existing methodologies used with a single questionnaire, such as the PHQ-9, the Centre for Epidemiological Studies Depression (CESD), the BDI, and primarily self-declaration statements. Logistic Regression (LR), Support Vector Machine (SVM), and other classification techniques were used to analyse the data that was obtained.

PROBLEM DEFINITION

After giving birth, postpartum depression is a serious mental health problem that affects moms. It may negatively impact the mother's health as well as the dynamics of the entire family. The challenge lies in accurately identifying and diagnosing postpartum depression to ensure appropriate treatment and support. There might be a chance of noticing the symptoms after a prolonged time period, so it takes much time to recover, eventually leading to severe consequences. So it is suggestible to monitor and take the assessments to keep the problems at bay. The objective is to develop an effective screening or diagnostic tool that can detect the presence and level of postpartum depression. This tool should consider various factors such as maternal demographics(age) and psychological well-being to provide an assessment.

PROPOSED SYSTEM

Postpartum depression is neither a sign of personal weakness nor a lack of virtue. It can occasionally be a side effect of childbirth. You should get postpartum depression treatment as soon as you can to manage your symptoms and improve your bond with your infant. A woman's life shouldn't be impacted by having a child. If a timely forecast is available, they can overcome it. Therefore, we suggest a solution to the question of whether the mother in this model will most likely experience postpartum depression or not within a week. This includes the physiological questionnaire. Data from delivered women were collected for one week on the Edinburgh Postnatal Depression Scale (EPDS), and the score was assessed by medical professionals to make predictions. The post-natal dataset is used in the Random Forest Algorithm for prediction.

The Patient Health Questionnaire-9 (PHQ-9) was collected for the above-predicted subjects up to six weeks later as part of the multistage progress and shouldn’t be neglected. The Report is sent to the user’s mail after every survey.

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Systems Architecture

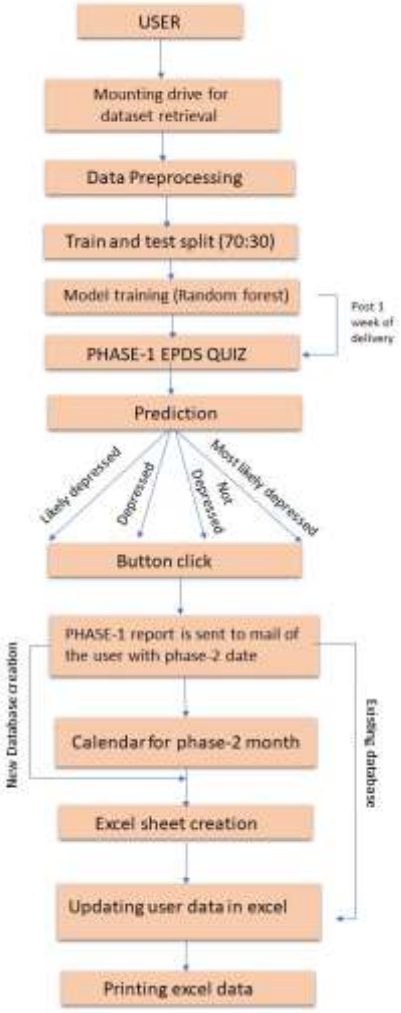

Fig.1. Phase-1 System architecture

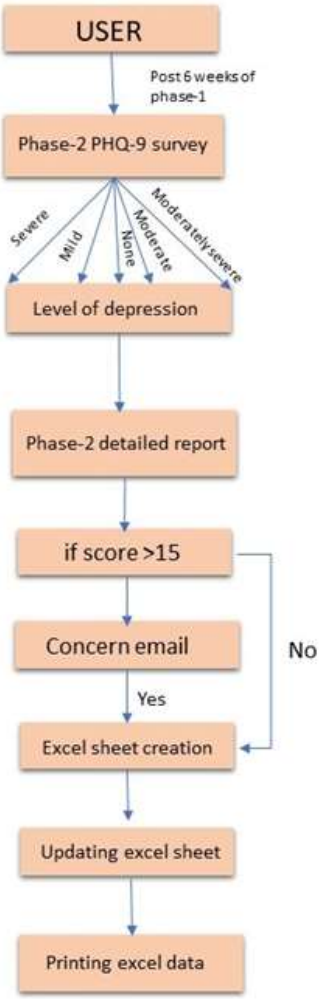

Fig.2. Phase-2 System architecture

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FLOW CHARTS

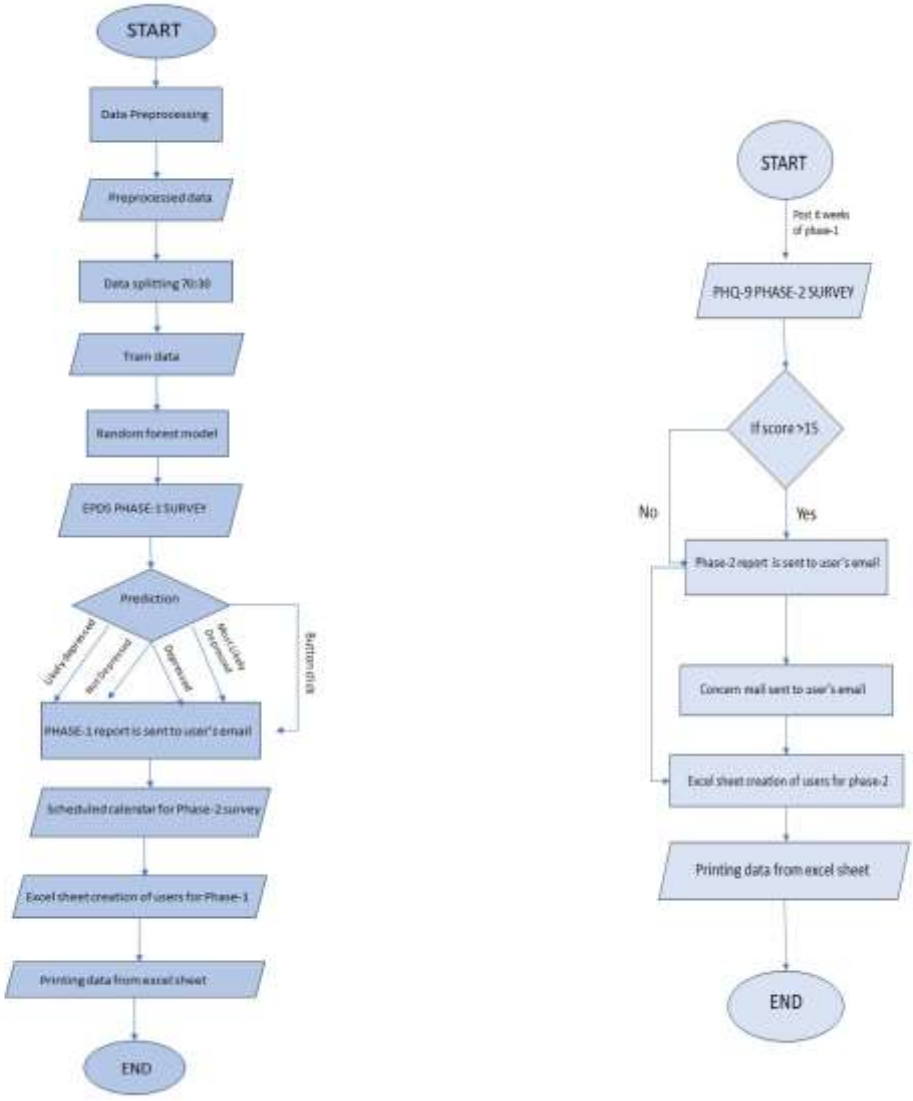

Figure.3. Phase-1 flow diagram

IMPLEMENTATION

LIBRARIES

Pandas is a Python library used for working with data sets, and its name is pandas. It offers tools for data exploration, cleaning, analysis, and manipulation. Working with "relational" or "labelled" data can be simple and intuitive thanks to the Python module pandas, which offers quick, adaptable, and expressive data structures. It seeks to serve as the essential, high-level building block for using Python for actual, useful data analysis.

In Python, the term "datetime" refers to the fusion of dates and times. This class's characteristics are comparable to those of the date and distinct classes. Day, month, year, minute, second, microsecond, hour, and tzinfo are some of these characteristics.

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pytz - The pytz module allows for date-time conversion and timezone calculations so that your Python applications can keep track of dates and times, while staying accurate to the timezone of a particular location

The random-random function produces random floating-point values between 0.1 and 1.0. It has no input parameters and outputs values that are evenly spaced between 0 and 1. The random module serves a variety of purposes, such as: Random() in Python

timezone - The timezone, in general, is used to display the conversion of date and time between timezones, which means it is used to display the timezone it is using to print the time and date.

Messages are sent across a network using sockets and the socket API. They offer an inter-process communication (IPC) method. The network may be physically connected to an external network and have its own links to other networks, or it may be a logical network that is local to the computer.

timedeltas - Timedeltas are intervals of time that are stated as intervals of days, hours, minutes, and seconds. They come in both good and bad forms. Datetime has a subclass called timedelta.

ipywidgets- A Python library of interactive HTML widgets for Jupyter notebooks is called IPyWidgets. Each UI component in the library has the ability to react to events by calling particular event handler routines. They improve the Jupyter notebook application's interactive capabilities.

emailmessage - The fundamental functionality for establishing and requesting header fields, gaining access to message bodies, and constructing or changing structured messages is provided by EmailMessage. Headers and the payload, usually referred to as the content, make up an email message.

sll- To leverage Secure Sockets Layer (SSL) and Transport Layer Security (TLS) to secure communication on both the client and server sides, the Python SLL module offers functions and classes.

smtplib - To send email to any internet-connected device with an SMTP or ESMTP listener daemon, the smtplib module specifies an SMTP client session object.

imghdr - A file's or byte stream's image type is identified by the imghdr module. tests the image data in the file specified by file and produces a string indicating the kind of the image. The file argument is disregarded if optional parameter h is given, and it is presumed that h contains the byte stream to test.

calendar - Python's Calendar module is used to show calendars and has helpful built-in functions for showing the week, weekday, month, year-round month, and other things. These calendars automatically start the week on Monday and end it on Sunday.

openpyxl - A Python module called Openpyxl is used to read from or write to Excel files. For data analysis, data copying, data mining, creating charts, styling sheets, adding formulas, and other tasks, data scientists utilise Openpyxl. Workbook: In openpyxl, a spreadsheet is referred to as a workbook.

ALGORITHM

Random Forest Classifier

Leo Breiman and Adele Cutler are the creators of the widely used machine learning technique known as random forest, which mixes the output of various decision trees to produce a single outcome. Its widespread use is motivated by its adaptability and usability because it can solve classification and regression issues.

For a more precise forecast, Random Forest produces numerous decision trees that are then combined. The Random Forest model is based on the idea that several uncorrelated models (the various decision trees) work significantly better together than they do separately.

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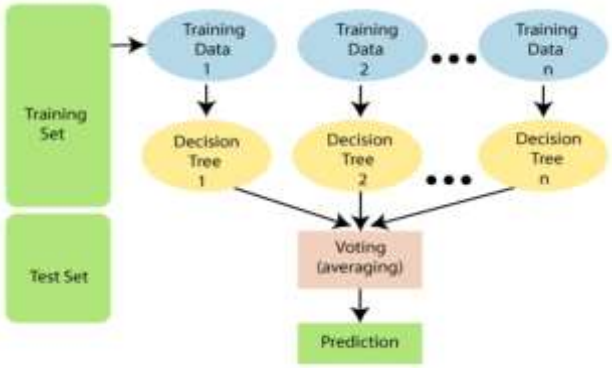

Figure.5. Random forest algorithm

TESTING TABLES

S.NO	Test Scenario	Test Steps	Test Data	Expected Result	Success/ Failure
1	Check whether the user is having mostlikely depression, likely depression, depression, or no depression	Test withdatas et	Figure 1	Successfulin displaying the result	Success
2	Check whether the email is sent or not	Test with program	Figure 2	Successful in displaying the result	Success
3	Check whether the user's data is stored or not	Test with program	Figure 3	Successful in displaying the result	Success

Table.1. Phase-1 Testing table

S.NO	Test Scenario	Test Steps	Test Data	Expected Result	Success/ Failure
1	Check whether the user's PHQ-9 result is shown or not	Test with quiz	Figure 4	Successful in displaying the result	Success
2	Check whether the concern email is sent or not	Test with program	Figure 5	Successful in displaying the result	Success
3	Check whether the concern email is sent or not, if the level of depression is severe	Test with program	Figure 6	Successful in displaying the result	Success

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4	Check whether the user's data is stored or not	Test with program	Figure 7	Successful in displaying the result	Success

Table.2. Phase-2 Testing table

RESULTS

Figure.6. Pre-processed Dataset

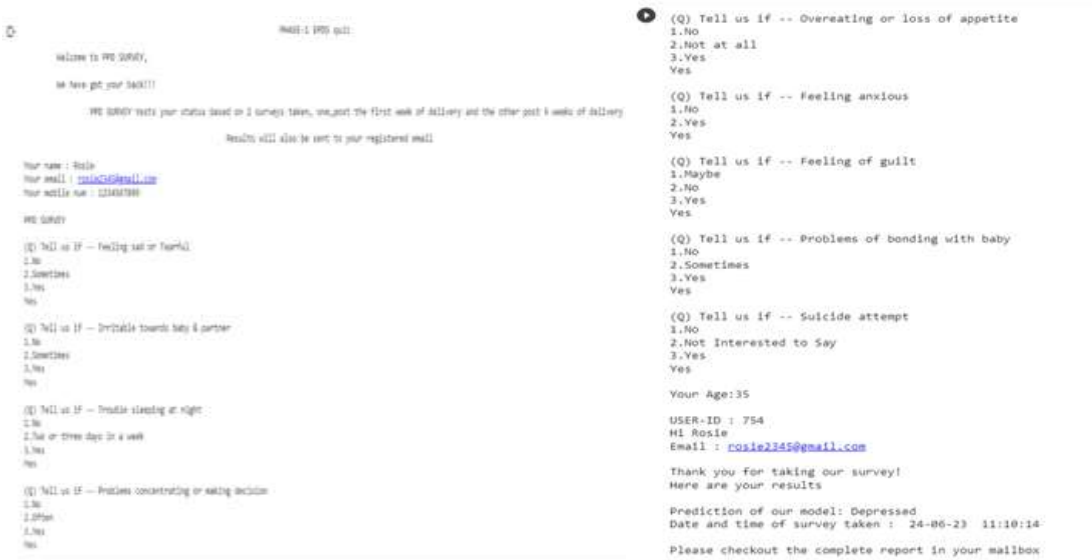

Figure.7. PHASE-1 Assessment

Figure.8. PHASE-1 Mail Snippet

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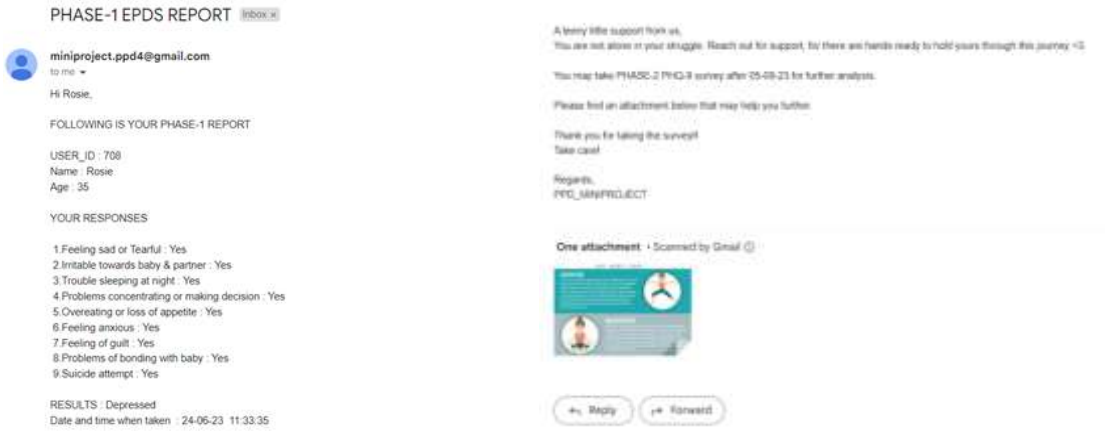


Figure.9. PHASE-1 Mail

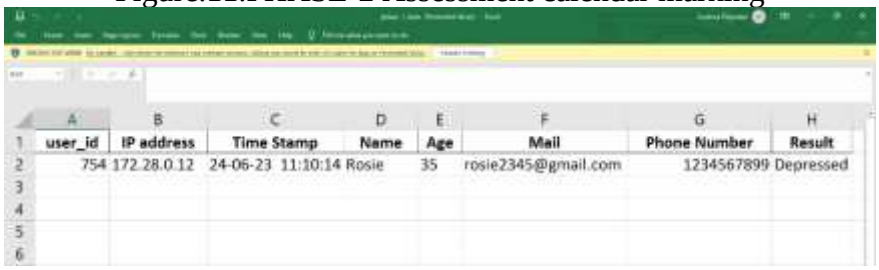
ACCURACY OF THE MODEL

```
[21] from sklearn.metrics import accuracy_score

     accuracy = accuracy_score(y_test,y_pred)
     print("Accuracy of model : ",accuracy*100,"%")

     Accuracy of model :  97.09821428571429 %
```

Figure.10. Accuracy of the model

```
PHASE-2 QUIZ WEEK MARKING

      August 23
Mo Tu We Th Fr Sa Su
    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
```

Figure.11.PHASE-2 Assessment calendar marking



	A	B	C	D	E	F	G	H
1	user_id	IP address	Time Stamp	Name	Age	Mail	Phone Number	Result
2	754	172.28.0.12	24-06-23 11:10:14	Rosie	35	rosie2345@gmail.com	1234567899	Depressed
3								
4								
5								
6								

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```
import openpyxl

def print_xlsx_content(file_path):
    workbook = openpyxl.load_workbook(file_path)
    sheet = workbook.active
    for row in sheet.iter_rows(values_only=True):
        for cell in row:
            print(cell, end='\t')
        print()

    workbook.close()

xlsx_file_path = '/content/phase_1_data.xlsx'

print_xlsx_content(xlsx_file_path)
```

```
user_id IP address      Time Stamp      Name    Age     Mail    Phone Number    Result
754     172.28.0.12     24-06-23  11:10:14      Rosie   35      rosie2345@gmail.com     1234567899      Depressed
```

Figure.12. PHASE-1 Data storage and retrieval

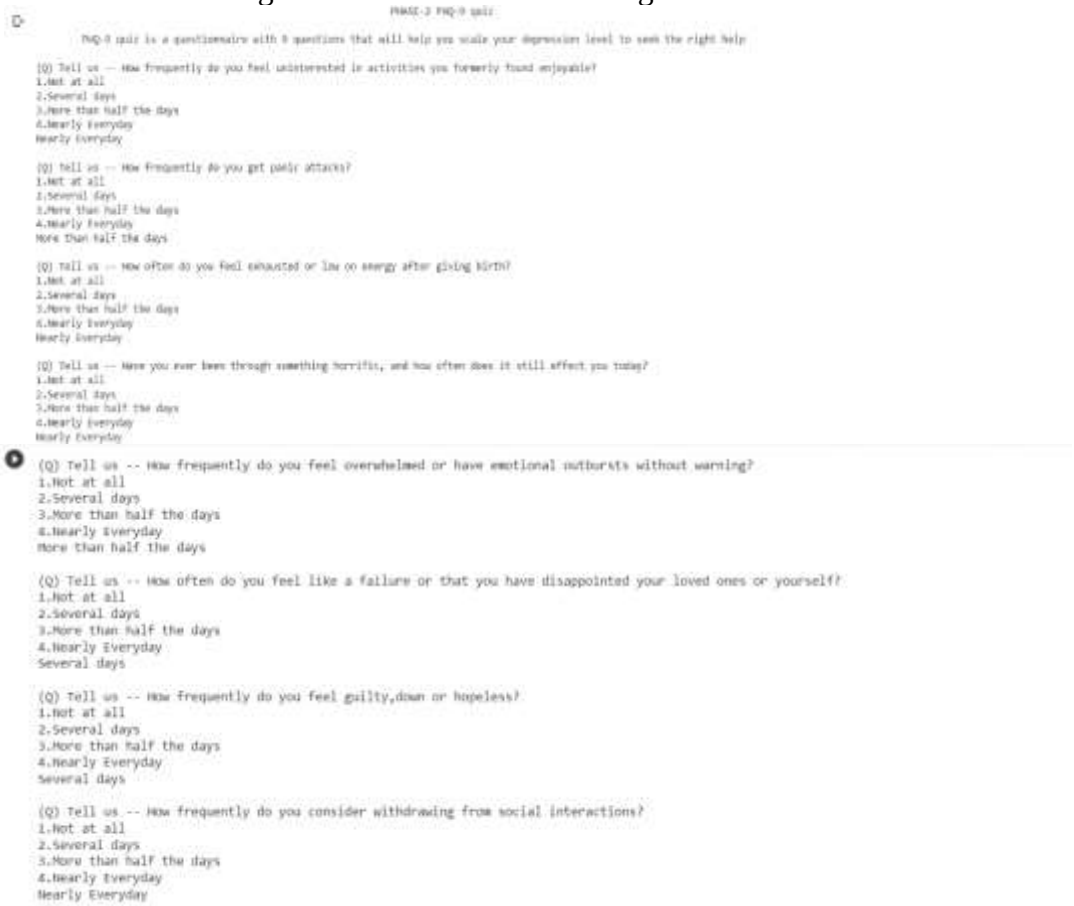

Figure.13. PHASE-2 Assessment

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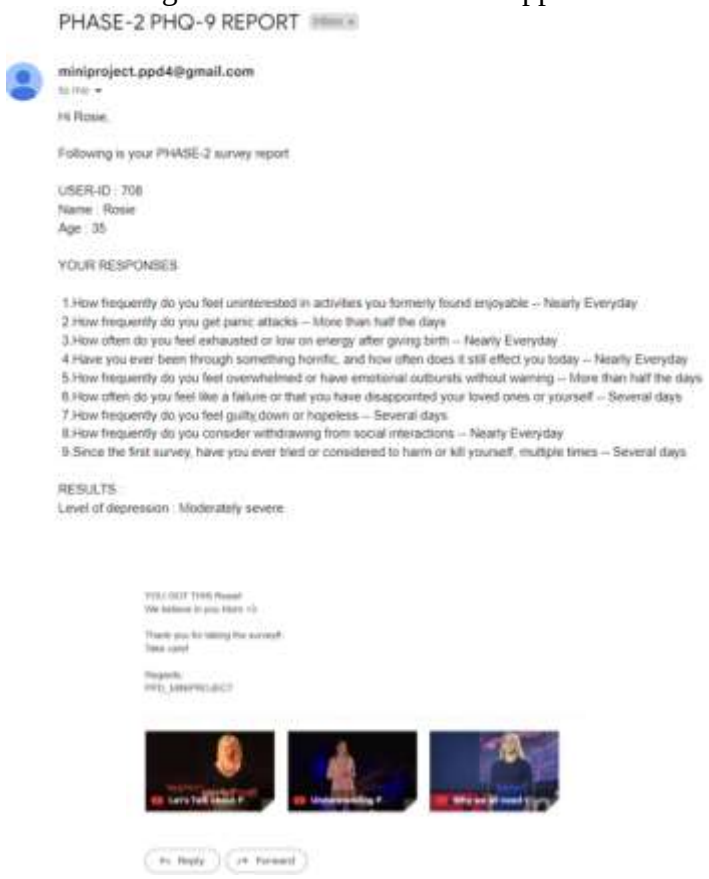
```
em = EmailMessage()
em['From'] = sender
em['To'] = receiver
em['subject'] = subject
em.set_content(body)

context = ssl.create_default_context()


with smtplib.SMTP_SSL('smtp.gmail.com',465,context = context) as smtp:
  smtp.login(sender,password)
  smtp.sendmail(sender,receiver,em.as_string())

print("PHASE-2 REPORT EMAIL SENT ")

button = widgets.Button(description="Send Mail-2")
button.on_click(button_click_event)
display(button)
```

Figure.14. PHASE-2 Mail Snippet



PHASE-2 PHQ-9 REPORT

miniproject.ppd4@gmail.com

Hi Rosie,

Following is your PHASE-2 survey report

USER-ID : 708
Name : Rosie
Age : 35

YOUR RESPONSES

1.How frequently do you feel uninterested in activities you formerly found enjoyable -- Nearly Everyday
2.How frequently do you get panic attacks -- More than half the days
3.How often do you feel exhausted or low on energy after giving birth -- Nearly Everyday
4.Have you ever been through something horrific, and how often does it still effect you today -- Nearly Everyday
5.How frequently do you feel overwhelmed or have emotional outbursts without warning -- More than half the days
6.How often do you feel like a failure or that you have disappointed your loved ones or yourself -- Several days
7.How frequently do you feel guilty,down or hopeless -- Several days
8.How frequently do you consider withdrawing from social interactions -- Nearly Everyday
9.Since the first survey, have you ever tried or considered to harm or kill yourself, multiple times -- Several days

RESULTS
Level of depression : Moderately severe

Reply Forward

Figure.15. PHASE-2 Email

```
    em = EmailMessage()
    em['From'] = sender
    em['To'] = receiver
    em['subject'] = subject
    em.set_content(body)

    context = ssl.create_default_context()

    with smtplib.SMTP_SSL('smtp.gmail.com',465,context = context) as smtp:
      smtp.login(sender,password)
      smtp.sendmail(sender,receiver,em.as_string())

    print("CONCERN EMAIL SENT ")
  else:
    print("Concern email not required")

button = widgets.Button(description="Send Concern mail")
button.on_click(button_click_event)
display(button)
```

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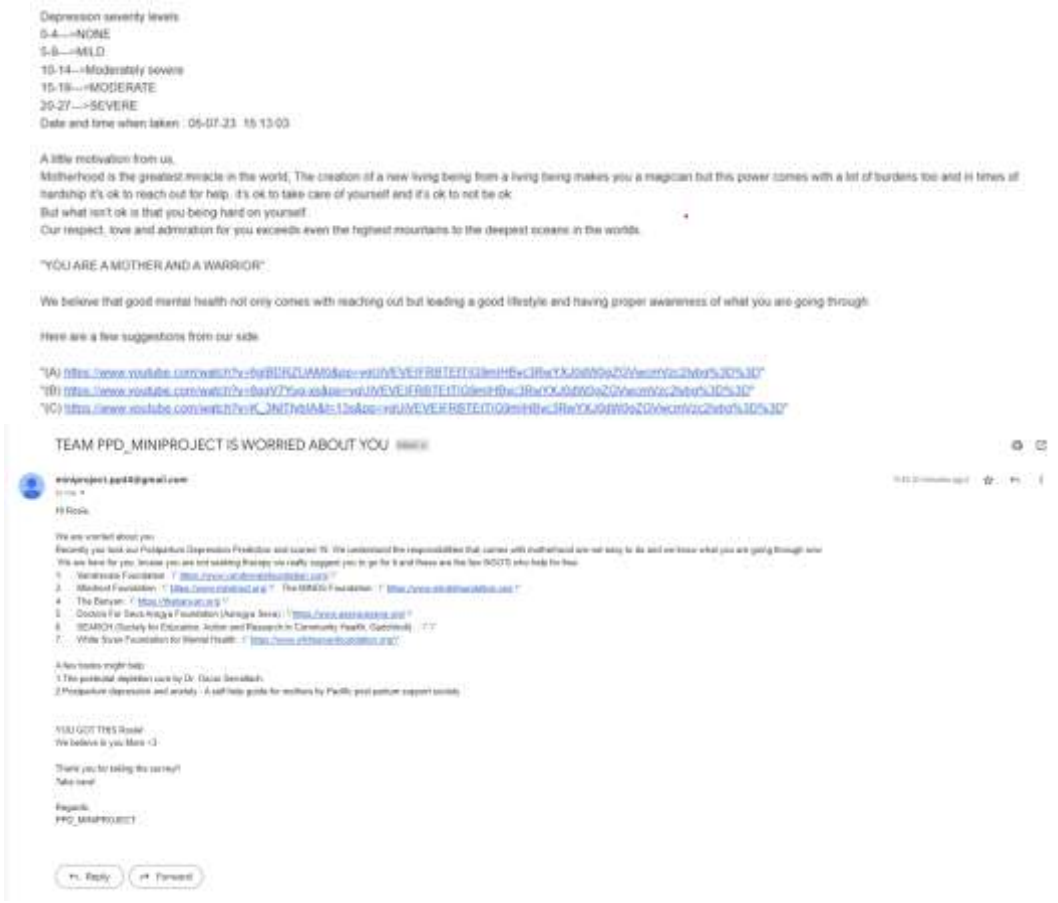

Figure.16. Concern mail

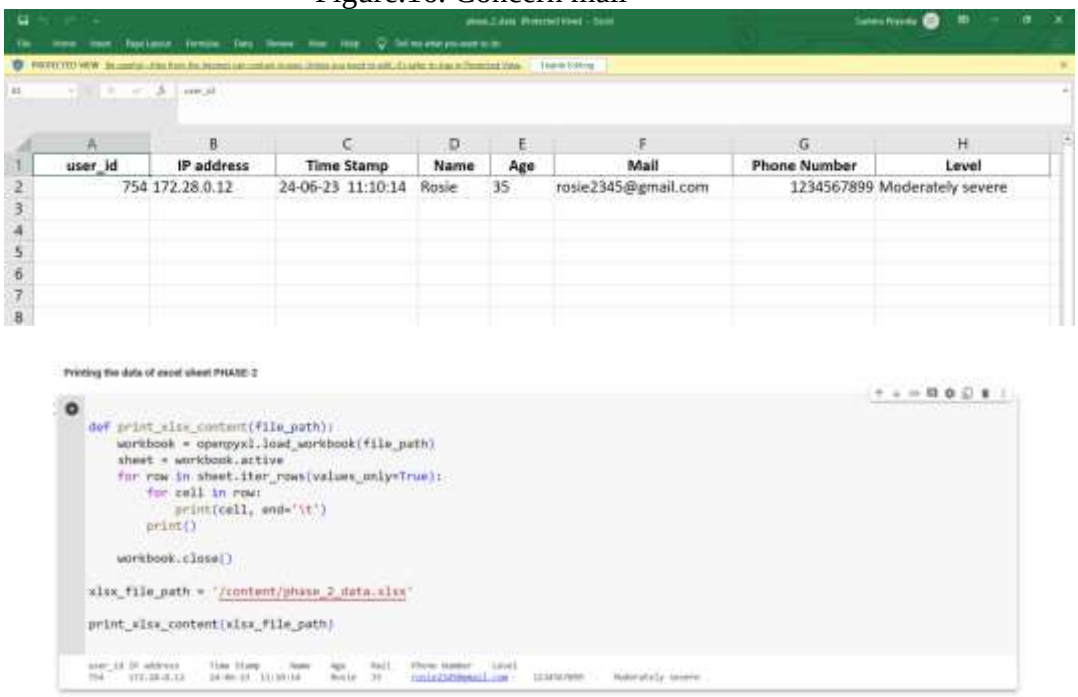

Figure.17. PHASE-2 Data storage and retrieval

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CONCLUSION

The model aims to predict the Postpartum Depression in two phases i.e post week 1 and week 6 respectively. In Phase 1, Edinburgh Postnatal Depression Scale (EPDS) dataset is used which consists of one week data after delivery of the mother. The dataset is pre-processed and trained with the Random Forest Algorithm. The results can provide whether the user has Depression or Most likely Depression or Likely Depression or No Depression. The report is sent to the user's registered mail with preventions as attachment and saved in the data storage as .xlsx format. The remainder is set to the user for phase 2 assessment. In Phase 2, the level of depression is predicted based on the PHQ-9 questionnaire. If level of depression is predicted Severe, then the mail is sent to user with NGO's recommendations to help people to fight depression, top recommended books for new mother's as CONCERNED mail. And the report is sent to user's registered email with you tube links included.

FUTURE SCOPE

To create a Graphical User Interface for a user-friendly environment.
Remind the user to take therapy or survey through SMS and Whats App.
To suggest the best nutritionist who wants to improve their diet to make the user healthy and happy
To recommend the therapist session for users, if they want to improve their lifestyle and mood by collaborating with the hospital.

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