Predictive Data Analytics Framework based on Maternal and Child HealthCare System (MCHS) using Machine Learning

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Abstract - Because it affects both mother and child health, maternal health research has become a top priority in public health. There aren't many synthetic review papers in this field despite the rising amount of empirical investigations, particularly from developing nations. To inform readers of the state of the subject and suggest areas for future study, an attempt at a synthesis of research in this field appears pertinent. Predictive analytics has grown in importance as an aid for child welfare services and safeguards for kids in an era of ever-rising data availability. This cutting-edge technology helps child welfare agencies make better judgments regarding the way to best assist their clientele by forecasting future patterns and outcomes using data gathered from past occurrences. Predictive analytics needs to be used properly, though, just like any other data-driven technology, to ensure efficient and moral business practices. As AI-Artificial Intelligence and ML-Machine Learning become more popular, healthcare forecasting has grown in significance in recent years. Forecasting in the healthcare industry can also help doctors make diagnoses more quickly and accurately. Medical personnel may identify and treat patients more swiftly and precisely by anticipating probable medical occurrences. Better patient outcomes and even financial savings may arise from this. By simulating human cognition, these systems offer tremendous therapeutic aid and may even make medical diagnoses. The studies included in this study concentrate on utilising machine learning algorithms to forecast child healthcare. We put the system into practise using a decision tree for CHS, MySQL for reminders about immunizations, and the K-means Elbow technique for maternal registration and notification.

Keywords- Maternal health, Child health, Machine Learning, Decision Tree, MySQL, K-means algorithm,

1. INTRODUCTION-

The medical treatment given to mothers and children is known as Maternal & Child Health (MCH) care. The women between age of 25 to 50 who are in their reproductive years, as well as kids, and teenagers (upto age 12), are the MCH's target demographics. Maternal and child healthcare(MCH) is a subject i.e. receiving extra courtesy and concern universally, predominantly in poorer nations. After the World Summit for Children in 1991, which provided significant thought and specified important subjects needing tackled when the execution of Maternal and Child HealthCare services, this dedication to MCH care has grown even stronger.

The following are some key factors and justifications:

• More than two thirds of the population consists of mothers and children. Women of reproductive age (15–49) make up 21%, pregnant women 4.5%, children under the age of five 47%, children under the age of five 18%, children under the age of three 12%, and babies 4%. (The aforementioned baseline estimate is crucial in project development and implementation in underdeveloped nations.)

- A bad result of numerous pregnancies is maternal death. Concluded 40% of pregnancies in underdeveloped nations end in problems, diseases, or lifelong impairment for either mother or baby due to miscarriage, forced abortions, and other circumstances. Maternal and Child Health Care fatalities resulting from pregnancy account for almost 80% of all maternal deaths. They are caused "by complications associated with the maternal stage (pregnancy, and puerperium), by assistance, mistakes, inappropriate treatment, or by a series of events brought on by any of the foregoing."
- The majority of expectant mothers in the underdeveloped countries receive only limited prenatal care and give birth without assistance from medical professionals who are properly educated. Maternal health issues and their poor care are thought to be the cause of over 7 million neonatal deaths.
- The prevalence of these illnesses is very high, and a large proportion of women suffer from chronic medical conditions that can be made worse by maternity and mother's impaired immune system.
- Pregnant women are more likely than non-pregnant women to contract infectious disorders like malaria (most frequently in the first trimester). Human immunodeficiency virus tests are also coming up positive in an increasing percentage of pregnant women.
- Due to early marriage, early motherhood, and high fertility, many women experience pregnancy-related

impairments including uterine prolapse for a long time after giving birth.

- Pregnant women experience significant nutritional issues, and it is believed that between 60 and 70% of pregnant women from underdeveloped nations are anaemic. Low birth weight babies tend to be delivered by women in poor nutritional condition.

The capacity of healthcare forecasting to create forecasts about upcoming medical occurrences based on intricate data correlations is what gives it its predictive strength. These data come from a range of sources, including clinical information, patient records, pictures, and more. Then, procedures for identifying and forecasting illnesses are developed using ML-Machine Learning and DL-Deep Learning algorithms. These procedures make it easier for medical personnel to correctly and swiftly assess and treat a patient's condition[1].

Forecasting in the healthcare industry can also help doctors make diagnoses more quickly and accurately. Medical personnel may identify and treat patients more swiftly and precisely by anticipating probable medical occurrences. Better patient outcomes and even financial savings may arise from this. Forecasting for the healthcare industry can also lessen the likelihood of medical mistakes. Healthcare providers can take action to avoid probable medical problems by foreseeing them. This may contribute to fewer medical mistakes occurring, improving patient care[2].

Predictive analytics' main purpose is to find patterns in existing data and then utilise those patterns to forecast what will happen in the future. Predictive analytics may be used to find systemic problems that might be affecting child protection measures in the context of child welfare services. It may be used, for instance, to identify racial discrepancies in how the system handles certain families. Child welfare agencies may take action to eliminate these gaps by utilising predictive analytics to identify them and guarantee all families receive assistance impartially and equitably[4].

Predictive analytics may also be used to find parents that might be at danger of abuse or neglect and to step in before things get out of hand. Child welfare organisation can more accurately predict which families may be at danger and focus individuals with extra resources and assistance by reviewing data from prior instances. This can guarantee that those who need them most receive the proper assistance, as well as the child protective system is working to its full potential[5].

Since illnesses are a global issue, researchers and doctors are doing everything they can to reduce disease-related mortality. The expanding volume of health information originating from many disparate and mismatched sources has made predictive analytics models more and more crucial in the medical industry in recent years. However, handling, storing, and analysing the massive volumes of historical data and ongoing streaming data input created by healthcare institutions using normal database storage has become an unprecedented challenge[10]. Healthcare is the collective effort of society to supply, fund, and support health. The 20th century saw a significant shift in attitudes towards health and the prevention of sickness and disability. Structured institutional or personal efforts are necessary for the delivery of medical assistance in order to aid individuals in regaining their health and preventing illness and impairment [11][2]. Healthcare may be viewed as established criteria that support evaluating actions or situations that affect judgement [13][14].

Today, childhood vaccination is essential for preventing any viruses or bacterial illness. This strategy aims to let parents know how long the vaccination effort will last. The suggested strategy focuses on using the vaccination notification system to pinpoint new-borns and their safety precautions[33].

This study introduces a machine learning-based predictive data analytics system centred upon the Maternal and Child Health Care System (MCHS). The research examines the possibility for utilising ML algorithms to find trends and patterns in health information to increase the precision of diagnosis and prognosis for infant and prenatal care. The article presents the idea of analytical prediction and outlines how the MCHS might take use of it. The study then investigates the usage of each ML algorithm and covers the many ML algorithms that may be utilised for predictive data analytics. The pre-processing processes required to get the data ready for analysis are also included in the study. The report then offers a conclusion after discussing possible uses for analytical prediction in the MCHS.

Overall, this study offers a thorough review of the possibility of automated prediction to increase the precision of diagnosis and prognosis in maternal and child health. The different machine learning methods and data pre-processing procedures required to get the data ready for analysis are covered in depth. Additionally, the report discusses possible uses of analytics for prediction in the MCHS and makes suggestions for further study. Those who are interested in investigating the possibilities of analytics for prediction in the MCHS will find this study to be a useful resource.

2. LITERATURE SURVEY –

The use of machine learning in the prediction of data for CHS has been the subject of several research investigations. In one study, a machine learning system was used to forecast the likelihood that children in the

CHS would end up in the hospital. According to the study's findings, the algorithm did manage to correctly forecast the likelihood that a kid would need to be hospitalised. The study also discovered that the algorithm could more precisely forecast the likelihood that a kid will be hospitalised if they had specific risk indicators, like age, gender, and ethnicity. A machine learning technique was utilised in a different study to forecast the possibility of medical mistakes in the CHS. The study's findings demonstrated that the algorithm was capable of correctly estimating the probability of medical mistakes in the CHS. Researchers also discovered that for several risk variables, such age, gender, and race, the algorithm managed to forecast the possibility of medical mistakes with greater accuracy.

Researchers employed a framework, comprising Logistic Regression, SVM, KNN, and RF, in [18] to create and assess ML classification models for diabetes patient predictions. The ML method was tested using the Pima Indian Diabetes Database (PIDD), which has 9 columns and 768 rows. The actual forecast's accuracy is 83%. The results of executing the strategy demonstrate that Logistic Regression outperformed other ML algorithms. The results revealed that unstructured data were ignored and that solely an organised database was analysed. The model should also be used to forecast other conditions such as heart disease, COVID-19, and hereditary backgrounds of diabetes, as well as other variables including smoking, physical inactivity, and other healthcare domains.

In order to predict diabetes using two separate methods, the authors of [19] developed an evaluation method utilising 4 prediction algorithm frameworks (RF, NB, SVM, and DT). The SVM technique's accuracy was 83.1%. It may be more effective to use a DL approach to forecast diabetes, and the model should also be tested for other medical conditions such as heart disease and COVID-19 prediction. This work still requires some improvements in several areas.

The contributors of [20] introduced the unsupervised ML technique K-means clustering to the UCI heart disease dataset in order to detect heart disease in its earliest stages. Through PCA, dimensionality reduction is achieved. According to the methodology's outcomes, early heart disease could be predicted with an accuracy rate of 94.06%. The authors should employ the proposed strategy, employing numerous datasets and algorithms.

The contributors of [21] created a model of forecasting for the categorization of diabetes data using the logistic regression(LR) classification technique. The dataset's sample data is made up of 459 patients, while the testing data is made up of 128 occurrences. The prediction accuracy of the LR technique was 92%. Because these researchers failed to assess the model against existing diabetes prediction algorithms, this study's main flaw was that their model can't be validated.

By[23], who uses IoT to study COVID patient health. A person that has been quarantined inside has to have someone watch over him or her. Measurements of body temperature, sweat production, oxygen saturation, respiration, heart rate, and other variables are needed to design a ventilation system for those individuals or persons. The pulmonary sensor monitors breathing, the cardiopulmonary sensor searches for heart attacks or discomfort in the chest, O_2 sensor gauges the body's O_2 saturation levels, and the body's temperature sensor searches for fever. The recommended approach keeps track of breathing rate, body temperature, pulse rate, and saturating O_2 levels. Received information is electronically sent to a COVID hospital or facility nearby.

The goal of [24] was to explore the benefits of various DM approaches and verified models for predicting survival from cardiac disease. The authors' observations led them to theorise that although LR and NB perform better on large-dimensional samples such as the Cleveland hospital dataset, DT and RF function best on smaller-dimensional datasets. RF outperforms the DT classifier because it employs an improved learning methodology. Using programmes like Map-Reduce, HBase, and other distributed computing technologies, the model might be built. As the author said that this study might be expanded to include further ML techniques.

The authors of [25] developed a DL methodology that employs CR-chest radiography images to differentiate between people with mild, pneumonia-like, and COVID-19 illnesses, providing a trustworthy method for COVID-19 diagnosis. The proposed approach enhanced the chest X-ray image and reduced noise using image-enhancing algorithms. This article presents two novel DL methods for COVID-19 identification utilising chest X-ray images that leverage a similar ResNet-50 to mitigate over fitting and enhance the overall functioning of the suggested DL systems. According to the authors, a substantial and difficult dataset with a number of COVID-19 occurrences must be used to assess the usefulness of the suggested strategy.

The authors of [26] developed ML procedure using the PIDD and NIDDK. The participants in PID are only female and older than 21. PID has 768 occurrences total, of which 268 included specimens that had diabetes and 500 did not. The eight main variables that improved diabetes forecasting. Functional classifiers with an accuracy rate of 90 to 98% include ANN, NB, DT, and DL. On the PIMA dataset, DL showed the greatest results for diabetes onset among the four, with a success rate of 98.07%. The technique was inefficient in early illness

detection, but it produces precise predictions regarding the disease through a variety of classifiers.

3. MACHINE LEARNING(ML)-

It is a form of AI-Artificial Intelligence that enables machines to gain insight from (collected) information and anticipate outcomes. It is an area of artificial intelligence that concerns with creating programmes that can gain knowledge from data and get better on their own despite needing explicitly programmed. Numerous applications of machine learning (ML) techniques exist, including stock price forecasting, the diagnosis of diseases, and object recognition in images[3].

Creating algorithms that can take input data and utilise statistical techniques to anticipate the outcome within a reasonable range is at the heart of machine learning. As more data is provided, the technique iteratively trains from the data, improving the accuracy of its predictions. Supervised learning is the most used kind of machine learning algorithm. In order to learn how to create the right output for fresh data, this type of algorithm is first fed labelled data (with the proper output values). For instance, by exposing a supervised learning algorithm to several images of cats and dogs together with their accompanying labels, the system may be trained to discriminate between the two. After training, the programme could be presented with a fresh image and accurately determine whether it represented a cat or a dog[11].

Unsupervised learning, reinforcement learning, and deep learning are other categories of machine learning algorithms. Unsupervised learning algorithms must identify patterns and correlations in the data given only the input data[12].

With applicability in several industries, machine learning is increasing in popularity in the past decade. Virtual assistants are also created using machine learning. Machine learning has countless applications, and it will probably continue to spread throughout society in years to come. Machines may now be taught to perform practically any task with the correct data and algorithms[14].

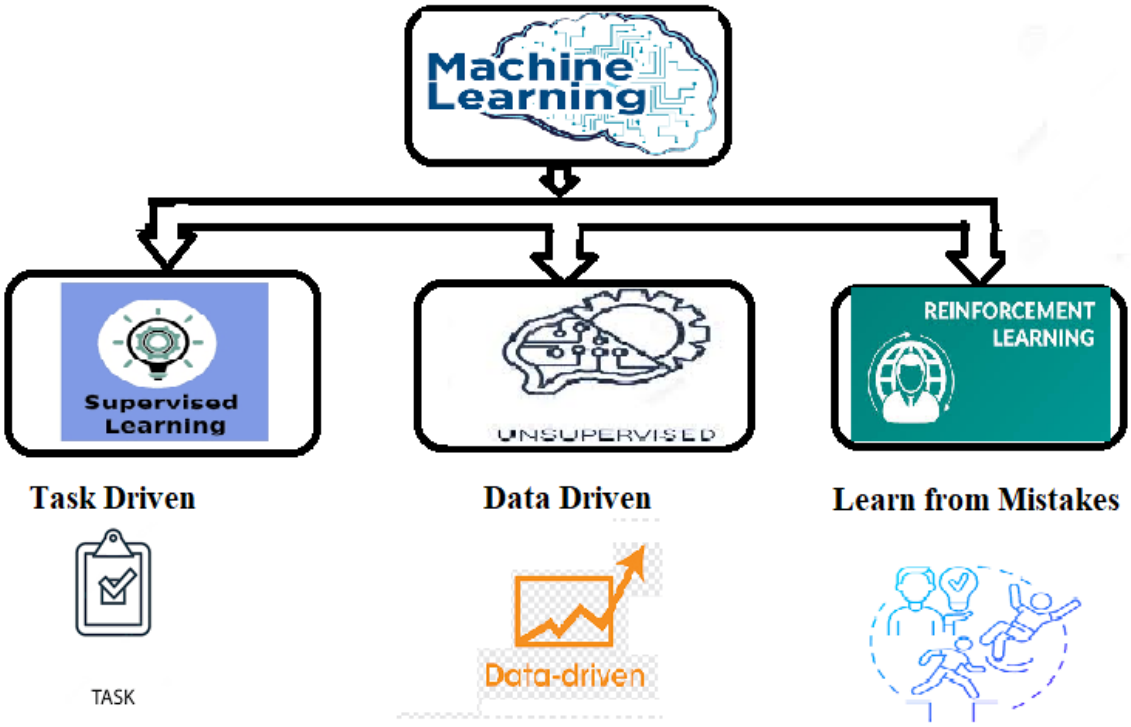

Figure 1- Machine Learning Types

4. DECISION TREES:-

Among the most popular machine learning algorithms is this one. They are utilised to decide depending on a variety of inputs. Decision trees are employed in data classification, prediction, and relationship discovery. A decision tree is a diagram that shows how decisions are made. It can be applied to a group of selections or judgements. In a decision tree, each node represents a decision point, and every link from this node represents several options or outcomes. Illustration 2, the decision tree comes about by data analysis and decision-making utilising an array of rules. Supervised learning approach called decision tree learning is used to produce predictions based on a collection of input data. The algorithm is trained on a collection of labelled data to produce the decision tree[15]. The algorithm learns the decision tree's structure from the labelled data and determines the relationships between the various variables.

Till decision point is reached, the decision tree is traversed in order to make predictions. The algorithm will decide the result based on the information it has learnt after a decision point has been reached. This is accomplished by examining the outcomes of the parameters connected to the decision point. An effective ML approach that may be employed to make judgements based on a collection of input data is decision trees. They are employed in a variety of processes, including as feature selection, regression, and classification. It's critical to comprehend the fundamentals of decision tree learning if you're interested in employing decision trees within any machine learning endeavours.

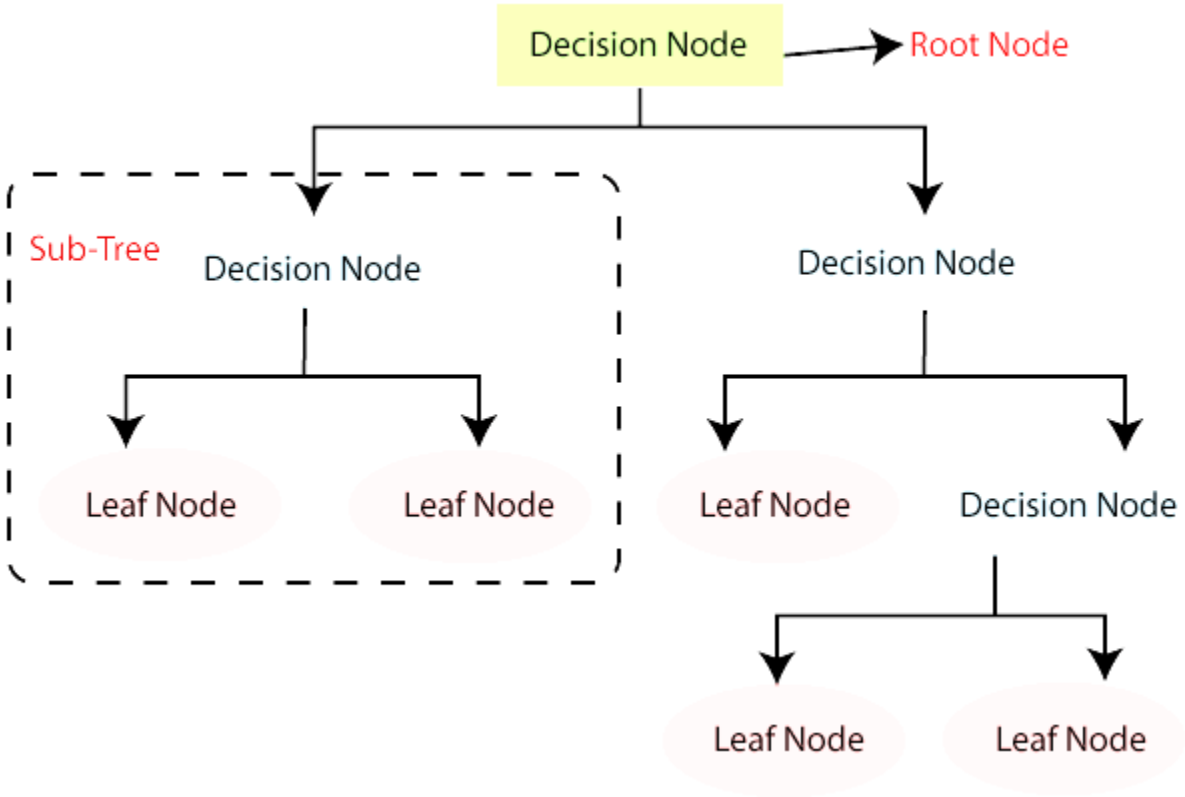

Figure 2- Decision Tree

5. K-MEANS ELBOW METHOD-

A crucial step in any unsupervised approach is determining the optimal number of clusters to split the data into. Since there is no predetermined number of clusters in unsupervised learning. We typically use a method that lets us pick the right number of clusters. To obtain the ideal number of clusters for K-Means clustering, we use the Elbow Method. The elbow technique is used to decide how many centroids(k) to use in a k-means clustering process. This method allows us to obtain the k-value by repeatedly going from k=1 to k=n (in which n - hyperparameter we choose depending on our needs). We determine the within-cluster sum of squares (WCSS) value for each value of k. The square sum of the distances between the centroids and each point is known as the WCSS. Using k-means clustering technique, obtaining the ideal K value graphically is called the elbow approach. With respect to the various K values (on the x-axis), the elbow graph displays WCSS values on the y-axis. The point where the graph creates an elbow is the ideal K value.

6. MySQL-

A popular relational data management system (RDBMS) is MySQL. MySQL is open-source and free. Both big and small applications may benefit from MySQL. Instead of placing everything information in one huge warehouse, a relational database keeps the data in individual tables. The physical files used to organise the database structure are designed for speed. The logical data model provides a versatile programming environment with objects including data tables, views, rows, and columns. A multithreaded SQL server that supports many back ends, a number of different client programmes and libraries, administrative tools, and a broad variety of application-programming interfaces (APIs) make up the client/server system known as MySQL Database. Additionally, we provide MySQL as an integrated multithreaded library

which you can connect into your programme to create a standalone solution that is more manageable, quicker, and smaller.

7. METHODOLOGY-

Young children who are under five are more prone to contract diseases than older ones. in 5.9 billion Thousands of children die each year, and greater than 50% of these deaths could have been avoided or treated sooner. This report presents the results of our investigation on the risks to children's health. In accordance with these results, we developed and implemented a completely new health risk strategy for children under five. This system's goal is to automate procedures requiring medical diagnosis for children under the age of five. The internet portal system will highlight potential health risks and suggest safety measures. the development and installation of a new online health risk assessment tool for children under five. Parents can post information about their children. The programme is able to assess current growth and development status, identify harmful behaviours, foresee probable chronic diseases, report health-related data (such as vaccination rates, coverage), and ultimately deliver tailored findings in order to minimise health risks as soon as feasible. The aim of our study is to:

• To ascertain the state of the kid by looking at child's symptoms and to thoroughly inform parents regarding the child's illness.

• To provide the groundwork for the vaccine message programme for kids.

• To develop a framework for providing pregnant women with monthly care instructions.

We construct the system utilising Decision Trees to determine the sickness of the kid from the child's symptoms and send the doctor information about the condition for the parent of the kid in question. We use MySQL to create a framework for immunising children, and our system will send the parents a message. MySQL is utilised to do this. The suggested strategy for prediction in paediatric healthcare is depicted in Figure 3 below.

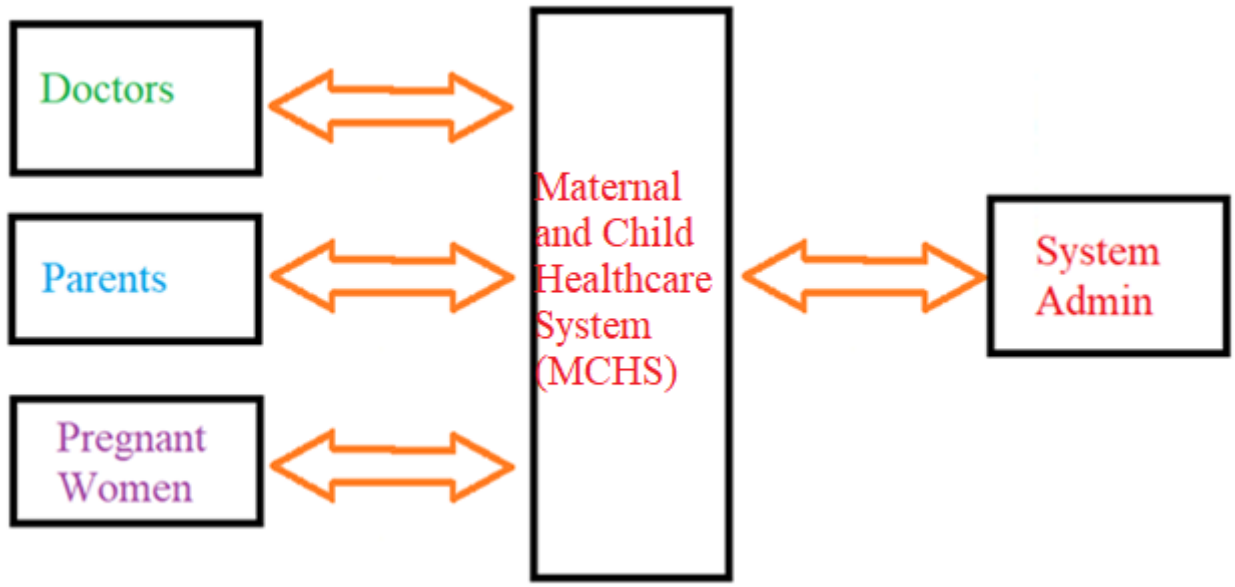

Figure 3- Proposed method

In this work, we used the Decision Tree technique to more accurately forecast the span of a newborn infant's illness according to its given or determined symptoms. The illness and its related symptoms are represented by two nodes in this dataset. By combining every symptom onto one row, triggering the symptoms that match the illness, and then setting the values of the other symptoms to 1, the dataset is then trained and evaluated. MySQL is used for this.

MySql Database: To keep track of registrations and announcement details, a database management system is used. The SMS Integrating service is used to send notifications to those who are registered end users. The Maternal Child Healthcare System (MCHS) is depicted in Figure 4 below.

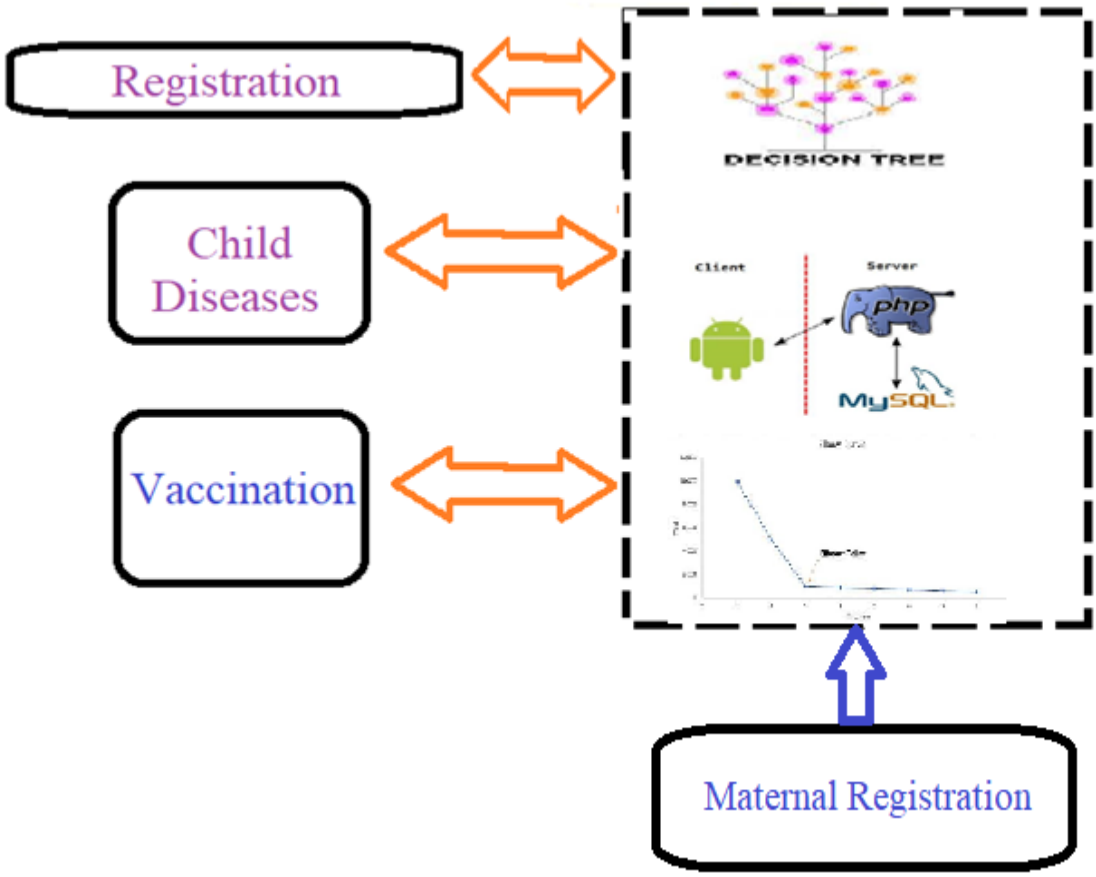

Figure 4- Maternal Child Healthcare system (MCHS)

Pregnancy care system –
Nowadays, when pregnancy hits, it's important to pay close attention to a few things, among them are more dangerous than others. What should be totally avoided, considerably reduced, or that ought to be carefully evaluated during pregnancy will be discussed with you by the physician (or another medical professional).

This system will be useful in managing such recommendations and memory.

• To warn the user and digitise the pregnancy precautions. • To raise awareness of the value of month-by-month pregnancy progression for the development of the unborn child • This system is also useful for maintaining records and data analysis.

Precautionary information notifications on exercise, diet, carrying weight, driving, mythology reading, medical treatments, yoga, etc. can be given to pregnant women every month. The notification might be communicated to the women through messaging. so that the healthy child will be successfully delivered. The K-means Elbow technique is used to implement the aforementioned system. In 4 phases, we'll demonstrate how to use the elbow approach. We'll start by creating a random dataset, after which we'll use k-means to analyse it and get the WCSS value that puts k between 1 and 4.

8. RESULTS AND DISCUSSIONS-
For father enhancement, parents need first register for the service with their kids and provide their parents with basic information. Basic information about the kid and the parent, including a cellphone number, is collected during the registration procedure in order to facilitate future communications and the provision of the necessary data. The registration screen is seen in Figure 5.

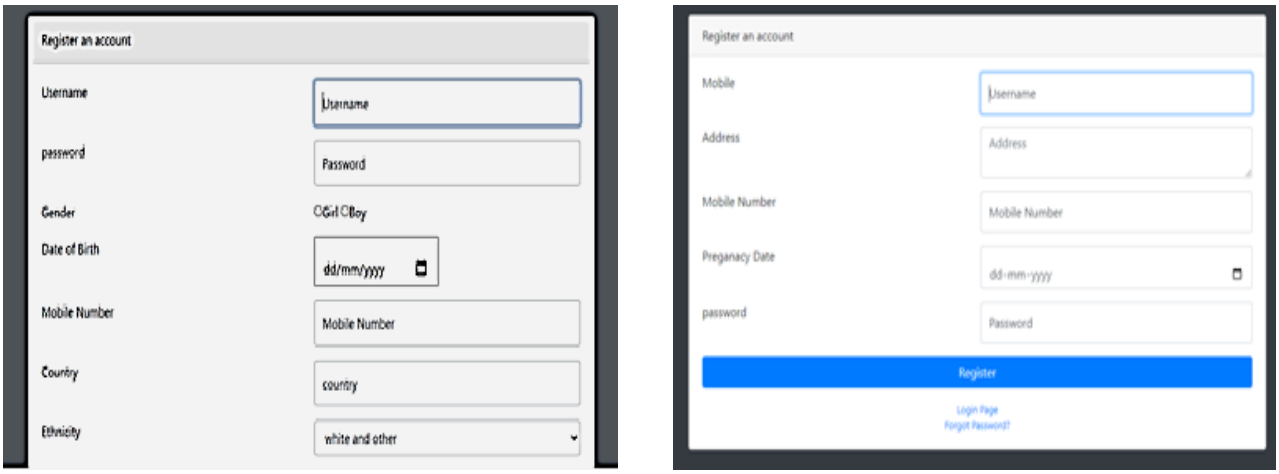

Figure 5 – MCHS registration procedure

All patients who have enrolled may offer details regarding the symptoms for illness prediction. The patents for the system need the screen of symptoms, which is then examined by ML-Decision Tree Algorithm and delivers the illness specifics along with the specialist doctor information who are knowledgeable in that area. Figures 6 and 7 depict the information processing.

Figure 6- Symptoms for MCHS

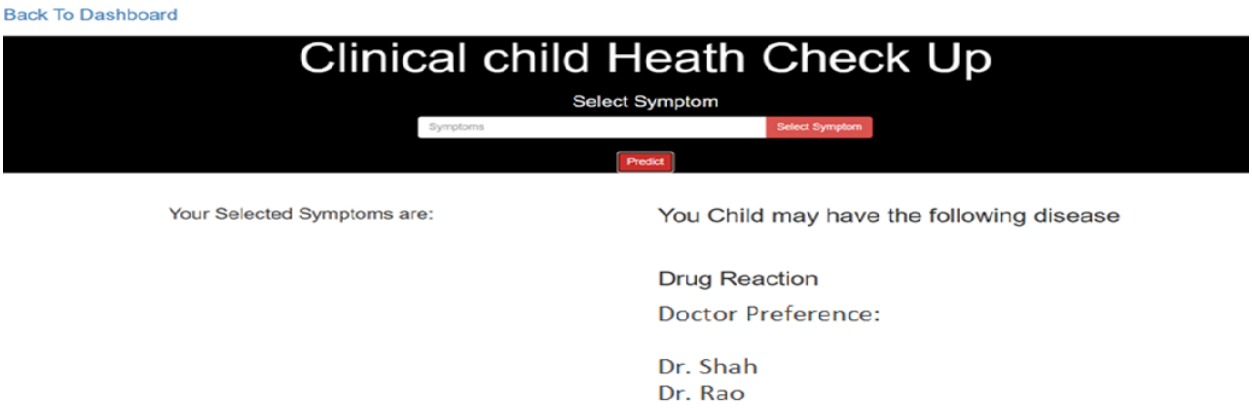

Figure 7- Info about diseases and specialists

Each youngster until the tender age of Ten must receive vaccinations in order to protect them from infections. The MCHS system also sends registered patients immunisation reminders. The vaccine information is delivered to parents' mobile devices based on the age provided (DOB). Parents are also urged to follow through with the same, which will be logged for future reminders of vaccinations. Figure 8 below depicts the letter that was mailed to the parents.

Subject: Vaccination Notification
To: balkrishnayemul.by@gmail.com
From: balkrishnayemul.by@gmail.com

You have vaccination drive of Cowin on date: 2022-12-09.

Reply Forward

Figure 8- Reminder about vaccinations.

Once the procedure depicted in figure 5 has been completed, basic data on pregnant women and mothers has been registered. In order for it to function correctly, the predetermined or predicted date of pregnancy is given here. Figure 9 illustrates how notifications are sent to registered candidates after registration with the women's basic information.

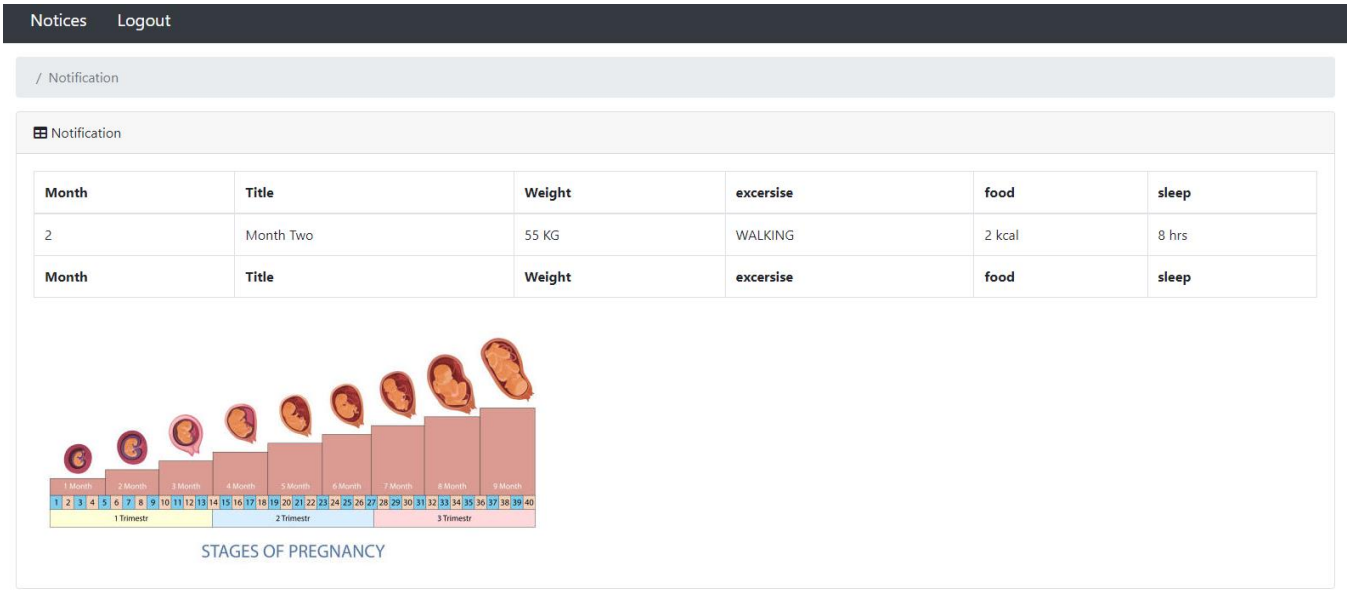

Figure 9- Information notification view

The diet plan is provided with the enrolled Candidates once all the data has been fed into the system. Figure 10 below depicts an illustration of a diet plan.

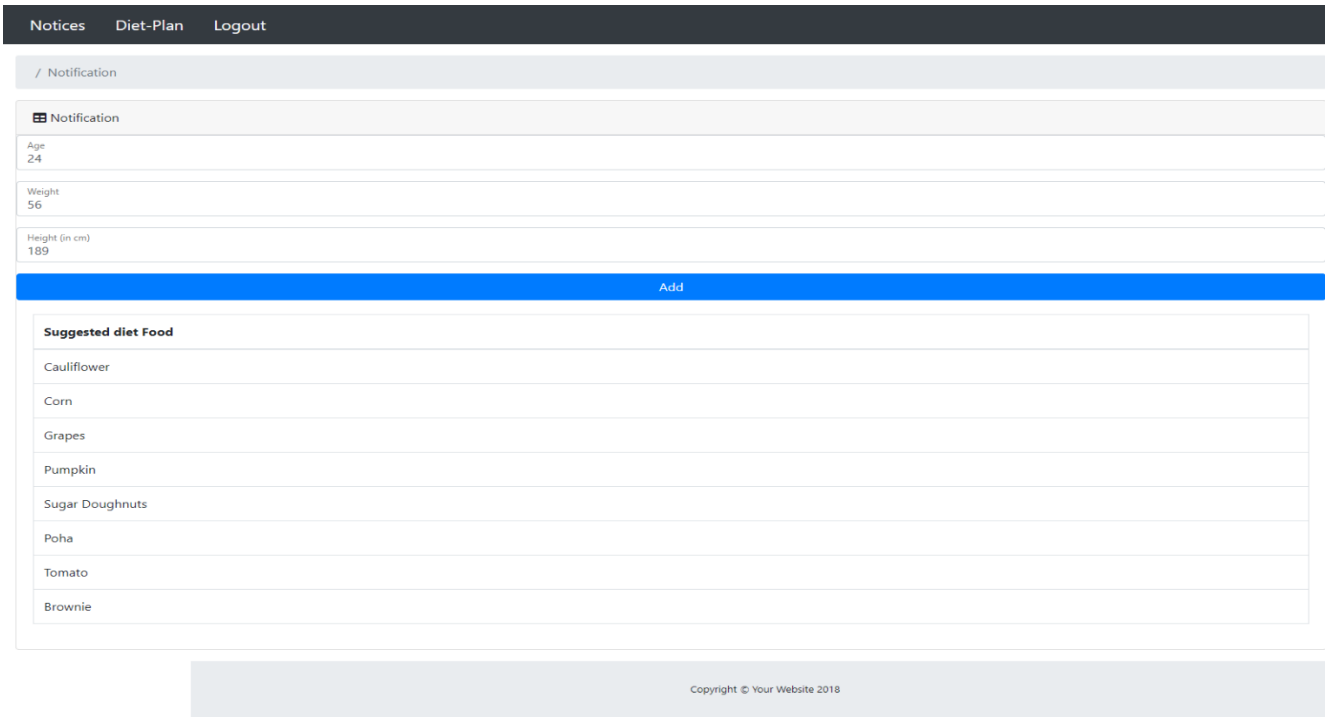

Figure 10- Diet plan notification

9. CONCLUSION-

Machine learning (ML), which is employed in areas like surgery and medical imaging, has already enabled robots to carry out important and time-consuming tasks in the medical field. Currently, it is often used to identify ailments and discover new treatments. But the question that is put out here is: What is the reach of ML within the healthcare industry? Concerning ML and DL usage, healthcare data is regarded as the most significant component that goes into healthcare systems. There's a tremendous opportunity for machine learning (ML) in this sector to help render medical treatment and care processes more effective and effortless whilst enhancing predictions provided by ML algorithms with greater reliability levels assisting doctors to decide more quickly. This potential is similar to present applications for healthcare and medical sub-fields. We have developed the data analytics architecture of the Maternal child healthcare (MCHS) systems by identifying the disease based on the child's symptoms and providing the parents with doctor information. Additionally, we provide parents with information about vaccines. By giving pregnant women an activity and food plan, we also give information about health issues and support for their wellbeing with the aforementioned system. We put the system into practice using a decision tree for CHS, MySQL for reminders about immunizations, and the K-means Elbow technique to feed maternal registration and notification.

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